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Adhesion of Orthodontic Braces to Different Restorative Materials: Influence of Surface Conditioning Methods

Ortodontik Braketlerin Farklı Restoratif Materyallere Adezyonu: Yüzey İşleme Yöntemlerinin Etkisi

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ABSTRACT

Objective: The purpose of this study was to analyze the shear bond strength of orthodontic metal braces to restorative materials with various constituents and manufacturing methods after different surface conditioning methods.

Methods: The samples were prepared from Vita Mark II, Shofu Block HC, Brilliant Crios computer-aided design/computer-aided manufacturing blocks, and Gradia Direct composite restorative material, and they were exposed to 5000 thermal cycles. Fabricated samples were divided into 6 groups based on the surface conditioning method (n = 12): control (no conditioning); etching with hydrofluoric acid; sandblasting with aluminum oxide; tribochemical silica coating with CoJet sand; bur abrasion; Monobond Etch and Prime application. The surface characteristics of the restorative materials were analyzed with a scanning electron microscope. The universal adhesive was applied to the specimens, and orthodontic braces were bonded with a light-cure adhesive paste. After thermal cycling, shear bond strength values were measured, and the adhesive remnant index was recorded. Two-way analysis of variance and Tukey tests were used for statistical analysis.

Results: Both the surface conditioning method and the material type significantly affected shear bond strength values. In addition, the interaction between these variables was significant ($P < .001$). Control groups of all restorative materials had significantly the lowest shear bond strength values.

Conclusion: Surface conditioning methods significantly enhanced the shear bond strength. Control groups of Vita Mark II and Shofu Block HC demonstrated shear bond strength values lower than the acceptable limit, but the rest of the groups showed adequate adhesion (above 6 MPa). Consequently, clinicians can prefer Monobond Etch and Prime along with a universal adhesive as a safer surface conditioning method.

Keywords: Bond strength, CAD/CAM, orthodontic braces, restorative materials, surface conditioning

ÖZ

Amaç: Bu çalışmanın amacı, ortodontik metal braketlerin çeşitli bileşenlere ve üretim süreçlerine sahip restoratif materyallere makaslama bağlanma direncini (MBD) farklı yüzey işlemleri sonrası analiz etmektir.

Yöntemler: Örnekler Vita Mark II, Shofu Block HC, Brilliant Crios CAD/CAM blokları ve Gradia Direct kompozit restoratif materyalinden hazırlanmıştır ve 5000 termal siklusa maruz bırakılmıştır. Hazırlanan örnekler, yüzey işleme yöntemine göre altı gruba ayrılmıştır (n = 12): kontrol (işlem yok); hidroflorik asit uygulaması; alüminyum oksit ile kumlama; CoJet kumu ile tribokimyasal silika kaplama; frez ile aşındırma; Monobond Etch and Prime (MEP) uygulaması. Restoratif materyallerin yüzey özellikleri taramalı elektron mikroskobu ile analiz edilmiştir. Örneklere üniversal adeziv uygulanmıştır ve ortodontik braketler ışıkla sertleşen adeziv pasta ile yapıştırılmıştır. Termal döngü sonrasında MBD değerleri ölçülmüştür ve artık adeziv indeksi kaydedilmiştir. İstatistiksel analiz için iki yönlü ANOVA ve Tukey testleri kullanılmıştır.

Bulgular: Hem yüzey işleme yöntemi hem de malzeme türü MBD değerlerini anlamlı derecede etkilemiştir. Ayrıca, bu değişkenler arasındaki etkileşim de anlamlı bulunmuştur ($P < .001$). Tüm restoratif materyallerin kontrol gruplarının anlamlı derecede en düşük MBD değerlerine sahip olduğu görülmüştür.

Sonuç: Yüzey işleme yöntemleri MBD'yi anlamlı derecede arttırmıştır. Vita Mark II ve Shofu Block HC'nin kontrol gruplarının MBD değerlerinin kabul edilebilir sınırın altında olduğu tespit edilmiştir, fakat grupların geri kalanı yeterli adezyon (6 MPa'ın üzerinde) göstermiştir. Sonuç olarak, klinisyenler daha güvenli bir yüzey işleme yöntemi olan üniversal adeziv ile birlikte MEP kullanınımını tercih edebilirler.

Anahtar Kelimeler: bağlanma dayanımı, CAD/CAM, ortodontik braketler, restoratif materyaller, yüzey işlemi

INTRODUCTION

Adult patients seeking orthodontic treatment increase day by day owing to the advancements in orthodontic treatment options and the increase in aesthetic demands.[1] According to a recent study adult patients with age ranging between 19 and 40 constitute 51.3% of orthodontic patients.[2] In optimal conditions, orthodontic brackets are usually bonded to healthy tooth surfaces. However, an increase in the prevalence of direct and indirect restorations is observed in the adult population because of the predisposing malocclusion and other factors related to aging.[3] The problem related to these restorations is that bonding braces to them with enough strength remains as a question mark since there are various types of restorative materials.

Over the last 2 decades, the use of dental computer-aided design/computer-aided manufacturing (CAD/CAM) systems became more common due to their advantages such as accuracy, speed, precision, and optimization of human errors. Due to these advantages, manufacturers are focused on developing tooth-colored CAD/CAM restorative materials with improved mechanical and aesthetic properties.[4] First, the feldspathic ceramic CAD/CAM block that is highly aesthetic with good strength is introduced, but it had some disadvantages such as chipping, wearing the antagonist teeth, the requirement of firing, and challenge in occlusal adjustment and repair.[5,6] Resin-matrix ceramic CAD/CAM blocks combining the resin composites and dental ceramics are produced to overcome known disadvantages of the felspathic ceramic CAD/CAM blocks. Additionally, resin-matrix ceramic CAD/CAM materials have the advantages of resin composites, including higher flexibility and easy and fast fabrication processes with better marginal adaptation.[7,8]

The bond strength between orthodontic braces and restorative materials is important since brace failure is a common problem encountered in dental clinics. Each brace failure prolongs the duration of treatment for almost 18 days due to relapse in tooth movements, increases the number of appointments, and causes discomfort for the patient.[9,10] For these reasons, it is critical to sustain enough bond strength between the orthodontic brace and the restorative material until the end of treatment. Therefore, as different restorative materials require different surface treatments to increase bond strength, various surface conditioning methods were proposed which can be classified as chemical or mechanical.[11,12] As chemical methods, hydrofluoric acid, silane, and bonding agents can be applied.[12] Hydrofluoric acid is applied especially on ceramics to make a porous surface by dissolving the glassy component and thereby maintaining a favorable surface for bonding. However, it requires a very careful application process since it can cause irritation or necrosis on soft tissue, in direct contact.[13] Silane application after hydrofluoric acid etching is reported to be the most reliable surface conditioning method for increasing bond strength of dental ceramics, but during the debonding process, dental ceramics might be damaged.[14] Another chemical surface preparation method is the application of bonding agents and universal adhesives are the most recent with the ease of use and reliable bond strength to different restorative materials such as composite resin, ceramic, and zirconia.[14] As mechanical methods, sandblasting with aluminum oxide, tribochemical silica coating, or bur abrasion can be preferred as the organic component of the restorative material increases.[15] However, in repeated exposure, aluminum oxide and tribochemical silica coating may cause side effects on the respiratory tract and lungs, respectively.[16] Furthermore, sandblasting with aluminum oxide or abrading with a diamond bur may cause the production of heat and stress resulting in chipping or cracking of the restoration.[17]

Because of the need for a simpler and non-destructive method, manufacturers produced a new self-etching ceramic primer, Monobond Etch and Prime (MEP; Ivoclar Vivadent AG, Schaan, Liechtenstein). This chemical surface conditioner contains ammonium polyfluoride and trimethoxypropyl methacrylate providing gentle etching and simultaneous silanization, respectively.[18] There are few studies about MEP's efficiency in the adhesion of orthodontic braces to restorative materials.[19-21] However, the bonding performance of orthodontic metal braces to resin matrix ceramics with the application of MEP along with a universal adhesive is not clarified. Since the bond strength of orthodontic braces adhered to the restorative material depends directly on the material composition, which the clinicians cannot be sure of through intra-oral examination, there is a requirement to define a suitable bonding protocol for all metal-free restorative materials, which can achieve enough bond strength to resist orthodontic forces with minimal damage to the surface of restorative material while debonding. Therefore, this study aimed to assess the influence of different surface conditioning methods along with a universal adhesive on the shear bond strength (SBS) of orthodontic metal braces to various restorative materials. The null hypotheses were that (i) restorative material does not affect the SBS and (ii) the surface conditioning method along with a universal adhesive does not influence the SBS.

MATERIAL AND METHODS

Specimens were prepared from four different restorative materials, including a feldspathic ceramic (Vita Mark II; Vita Zahnfabrik H. Rauter, Bad Sackingen, Germany), a hybrid ceramic (Shofu Block HC; Shofu Dental GmbH, Ratingen, Germany), a reinforced

Table 1. Materials Used in the Study

Material	Type	Composition	Manufacturer	Lot no.
Vita Mark II	Feldspar ceramic	Fine-particle feldspar ceramic.	Vita Zahnfabrik H. Rauter, Bad Sackingen, Germany	35360
Shofu Block HC	Hybrid ceramic	UDMA, TEGDMA. Filler: Silica powder, micro-fumed silica, zirconium silicate, 61% by weight.	Shofu Dental GmbH, Ratingen, Germany	111501
Brilliant Crios	Reinforced composite	Cross-linked methacrylates (Bis-GMA, Bis-EMA, TEGDMA). Filler: Barium glass, and silica particles, 71% by weight.	Coltène, Altstätten, Switzerland	J00659
Gradia Direct	Light-cured micro-filled hybrid resin composite	UDMA, multifunctional methacrylate. Filler: Silica, prepolymerized fillers, fluoroalumino-silicate glass, 70% by weight.	GC Corporation, Tokyo, Japan	200327A

Bis-EMA, bisphenol A polyethylene glycol diether dimethacrylate; Bis-GMA, bisphenol A diglycidylmethacrylate; TGDMA, triethylene glycol dimethacrylate; UDMA, urethane dimethacrylate.

composite (Brilliant Crios; Coltène, Altstätten, Switzerland) CAD/CAM blocks, and a light-cured micro-filled hybrid resin composite (Gradia Direct; GC Corp., Tokyo, Japan) restorative material. Detailed information on the evaluated restorative materials is shown in Table 1.

According to the power analyses performed on G* Power software (version 3.1; University of Dusseldorf, Germany), the sample size was determined as 12 for each group, with a level of significance (α) of 0.05, power ($1 − \beta$) of 0.80, and effect size (d) of 1.65, based on a previous study.[22] A sum of 72 samples, with a thickness of 2 mm, from each CAD/CAM block were fabricated with a micro-cutting machine (PRESI, Mecatome T180, France). In addition, 72 specimens of Gradia Direct composite resin were prepared in a square-shaped-silicone mold with a 10 width and 2 mm thickness. The composite resin was placed into the mold and covered with a glass plate to ensure a smooth, flat, and glossy surface. It was then light-cured for 40 seconds with an LED curing device (Elipar Deep Cure; 3M ESPE, St. Paul, Minn, USA). The thickness of each sample was checked with a digital caliper (Digimatic, Mitutoyo Co., Tokyo, Japan). Then the composite resin samples were kept in deionized water, at 37°C for 24 hours for the polymerization process to be completed. After that, all samples were implanted in a cold-cured acrylic resin (Vertex Dental, Zeist, Holland). The exposed surfaces of the specimens were ground finished with sandpapers of 600 to 1200-grit, along with water-cooling. The specimens were then cleaned in an ultrasonic bath filled with deionized water for 5 minutes and exposed to a thermocycling procedure (5000×, 5-55°C, dwell time of 30 seconds).[23,24] After thermocycling, specimens were randomly separated into 6 groups regarding the surface conditioning method (n=12):

- Control: Surface conditioning was not applied.
- Hydrofluoric acid (HF): Hydrofluoric acid (9%; Ultradent, South Jordan, UT, USA) was applied to the specimens for 60 seconds.
- Sandblasting with aluminum oxide (AL): Samples were conditioned with aluminum-oxide by a sandblaster (Airsonic mini sandblaster; Hager Werken, Duisburg, Germany) from a 10 mm distance, with a pressure of 2 bar, for 10 seconds.
- Tribochemical silica coating with CoJet (CJ): Tribochemical silica coating was applied to the specimens, with CoJet grits (CoJet sand; 30 μm, 3M ESPE, Seefeld, Germany), using the same sandblaster with the same conditions.
- Bur abrasion (BUR): The samples were polished for 8 seconds using water-cooled 600-grit sandpaper since it simulates extra-fine diamond bur. [25,26]
- Monobond Etch and Prime: Sample surfaces were conditioned with MEP, regarding the manufacturer's instructions. Monobond Etch and Prime was rubbed on the samples with a micro brush for 20 seconds, left there for additional 40 seconds, and was washed off and dried with an air spray for 10 seconds.

All sample groups, excluding MEP, were washed off for 30 seconds with deionized water and dried with an oil-free air spray directly after surface conditioning to remove the remnants. Then a universal adhesive (Single Bond Universal; 3M ESPE) was rubbed with an applicator tip on each sample surface, for 20 seconds and gently air-dried for 5 seconds, then polymerized with an LED curing light (Elipar Deep Cure; 3M ESPE) for 10 seconds as instructed by the manufacturer. After that, lower central incisor braces (Mini Master Metal Brace; American Orthodontics, Sheboygan, Wis, USA) were adhered to the samples using a light-polymerizing adhesive paste (Transbond XT; 3M Unitek, Monrovia, Calif, USA). While bonding the braces, a firm finger pressure was performed to provide evenly distributed adhesive layer thickness. The excessive adhesive paste around the brace was removed with an explorer and discarded. Then adhesive paste was polymerized using the LED curing light for 40 seconds, 1 mm above the sample, from 2 directions to obtain sufficient polymerization. The light intensity of the LED curing light was checked periodically with a curing radiometer. Following the polymerization, samples were immersed in distilled water at 37°C for 24 hours. For standardization purpose, all procedure was accomplished by a single operator who was blinded to the study groups. Before the SBS test, the samples were again exposed to the same thermocycling procedure to simulate intra-oral conditions.

The SBS of the groups were analyzed with an SBS testing device (MOD Dental, Esetron Smart Robotechnologies, Ankara, Turkey) by applying shear force (N) to the adhesive interface with 0.5 mm/min crosshead speed. The SBS data were calculated in MPa, by the following equation: debonding force (N)/area of the brace base (9.34 mm²). After debonding of braces, adhesive remnants on the restorative materials were observed under a stereomicroscope at a magnification of 40× and were categorized based on the adhesive remnant index (ARI) as follows: 1, 100% remnant; 2, ʾ90% remnant; 3, 10%-90% remnant; 4, ˂10% remnant; 5, no remnant of adhesive paste remained on the restorative material.[27]

After surface conditioning methods were applied, the surface characteristics of two samples from each restorative material (a total of 12 samples) were examined using a scanning electron microscope (SEM) (Apreo S; Thermo Fisher Scientific, Waltham, MA, USA). Gold sputter coated (Polaron SC7620; ThermoVG Scientific, West Sussex, England) samples were analyzed at 10 kV accelerating voltage, with 1000× magnification.

Statistical Analysis

Statistical analysis was accomplished with software SPSS (Statistical Package for the Social Sciences) version 20.0 (IBM Corp.; Armonk, NY, USA). The data were analyzed through the Shapiro–Wilk and Kolmogorov–Smirnov tests to evaluate the normal distribution. A 2-way analysis of variance (ANOVA) test was conducted to assess the effect of restorative material type and surface conditioning method on SBS. For pairwise analyses, the

Table 2. Influence of Restorative Material Type and Surface Conditioning Method on SBS Results According to the 2-Way ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected model	3051.094[a]	23	132.656	32.081	.000***
Intercept	37 956.380	1	37 956.380	9179.232	.000***
Material	1763.945	5	352.789	85.317	.000***
Conditioning	615.318	3	205.106	49.602	.000***
Material * Conditioning	671.831	15	44.789	10.832	.000***
Error	893.166	216	4.135		
Total	41 900.640	240			
Corrected total	3944.260	239			

[a]R Squared = .774 (Adjusted R Squared = .749), ***$P < .001$.

Tukey honestly significant difference (HSD) test was performed ($\alpha = 0.05$ for all tests).

RESULTS

Based on the 2-way ANOVA test (Table 2), both the surface conditioning method and the material type significantly influenced the SBS values ($P < .001$). In addition, the interaction between these 2 variables was detected to be significant ($P < .001$).

The SBS values of the orthodontic braces to the restorative materials after different surface conditioning procedures are presented in Table 3. According to the pairwise analysis, among the control groups, Gradia Direct specimens exhibited significantly the highest SBS values. There was no significant difference between restorative materials for BUR, HF, and MEP conditioning groups. Among AL and CJ conditioned groups, Vita Mark II specimens showed significantly the lowest SBS values.

When the SBS values obtained for restorative materials are analyzed, it is observed that Vita Mark II specimens demonstrated significantly higher values in HF and MEP groups, followed respectively by BUR, AL, CJ, and control groups. Shear bond strength values demonstrated by Shofu Block HC were significantly higher in CJ, AL, MEP, and HF groups followed by BUR and control groups. When the surface conditioning methods, applied to Gradia Direct specimens are compared, it is observed that significantly lowest values were obtained for the control group followed by the MEP group. However, there was no significant difference among the other conditioning methods. Surface conditioning methods favor the SBS values of Brilliant Crios significantly; however, no significant difference among surface conditioning methods was detected.

As presented in Table 4, Gradia Direct specimens conditioned with BUR or AL and Brilliant Crios specimens conditioned with CJ or AL had the highest incidence of score 1 (90%), while Vita Mark II specimens conditioned with CJ or AL had the lowest incidence of score 1 (50%) among surface conditioned groups. Control groups of Vita Mark II and Shofu Block HC have shown exclusively score 5 ARI score, and Brilliant Crios has shown a 90% score 5 ARI score, whereas Gradia Direct has shown evenly distributed ARI scores.

Scanning electron microscope micrographs of restorative materials after surface conditioning are demonstrated in Figures 1-4. The control groups of all restorative materials presented smoother surfaces compared to HF, AL, and CJ conditioning methods. The HF created microporosities in all the restorative materials, but Vita Mark II has an evident porous structure. The AL or CJ conditioning of the specimens resulted in sharp edges with a wavy pattern caused by elevation and depression areas, especially on Shofu Block HC, Gradia Direct, and Brilliant Crios. The BUR-conditioned Gradia Direct and Brilliant Crios specimens presented coarse finishing traces while the other restorative materials had more homogeneous surfaces. In addition, MEP filled in the microporosities of the restorative materials making them seem smooth and glassy compared to the controls.

DISCUSSION

The present study investigated the influence of different surface conditioning methods on the SBS of orthodontic metal braces to different restorative materials along with a universal adhesive. Based on the findings of the present study, both the restorative material and the surface conditioning method influenced the SBS significantly, and a significant interaction between 2 factors was found. Accordingly, both null hypotheses are rejected. Previous studies also revealed that the restorative material and the surface conditioning affect the SBS and even further that surface

Table 3. Mean and SD of Shear Bond Strength Values for Each Group According to Restorative Material and Surface Conditioning Method

	Vita Mark II	Shofu Block HC	Brilliant Crios	Gradia Direct
Control	$3.7 \pm 1.1^{B, d}$	$4.4 \pm 1.3^{B, c}$	$6.7 \pm 2.1^{B, b}$	$11.5 \pm 1.7^{A, b}$
HF	$15.1 \pm 2.4^{A, a}$	$11.8 \pm 2.7^{A, ab}$	$13.4 \pm 1.5^{A, a}$	$15.0 \pm 2.2^{A, a}$
AL	$10.7 \pm 1.3^{B, cb}$	$14.1 \pm 2.0^{A, ab}$	$15.7 \pm 2.0^{A, a}$	$16.9 \pm 1.6^{A, a}$
CJ	$8.0 \pm 1.1^{B, c}$	$14.9 \pm 2.6^{A, a}$	$15.4 \pm 2.1^{A, a}$	$16.2 \pm 1.6^{A, a}$
BUR	$13.3 \pm 1.7^{A, b}$	$10.9 \pm 3.7^{A, b}$	$14.2 \pm 2.7^{A, a}$	$16.3 \pm 1.3^{A, a}$
MEP	$14.8 \pm 2.0^{A, ba}$	$12.2 \pm 1.6^{A, a}$	$12.6 \pm 1.6^{A, a}$	$14.2 \pm 2.7^{A, ab}$

Different uppercase letters in each row for each restorative material indicates significant differences ($P < .05$).
Different lowercase letters in each column for each surface conditioning method indicates significant differences ($P < .05$).
AL, sandblasting with aluminum oxide; BUR, bur abrasion; CJ, tribochemical silica coating with CoJet; HF, etching with hydrofluoric acid; MEP, Monobond Etch and Prime.

Table 4. Frequency (%) of Failure Types in Each Experimental Group According to Modified Adhesive Remnant Index (ARI)

Material	Conditioning Method	Score 5	Score 4	Score 3	Score 2	Score 1
Vita Mark II	Control	100	0	0	0	0
	HF	0	0	10	30	60
	AL	0	0	10	40	50
	CJ	10	10	10	20	50
	BUR	0	10	20	10	60
	MEP	0	0	20	10	70
Shofu Block HC	Control	100	0	0	0	0
	HF	10	0	0	20	70
	AL	0	0	10	10	80
	CJ	0	10	10	10	70
	BUR	0	10	10	20	60
	MEP	0	0	20	10	70
Brilliant Crios	Control	90	10	0	0	0
	HF	0	10	0	10	80
	AL	0	0	0	10	90
	CJ	0	0	0	10	90
	BUR	0	0	10	20	70
	MEP	10	0	10	10	70
Gradia Direct	Control	40	20	0	20	20
	HF	0	20	10	10	60
	AL	0	0	0	10	90
	CJ	0	10	10	10	70
	BUR	0	0	0	10	90
	MEP	0	10	0	30	60

AL, sandblasting with aluminum oxide; BUR, bur abrasion; CJ, tribochemical silica coating with CoJet; HF, etching with hydrofluoric acid; MEP, Monobond Etch and Prime.
Scores: 5 = no remnant; 4 = <10% remnant; 3 = 10%-90% remnant; 2 = >90% remnant, and 1 = 100% remnant of adhesive paste remained on the restorative material.
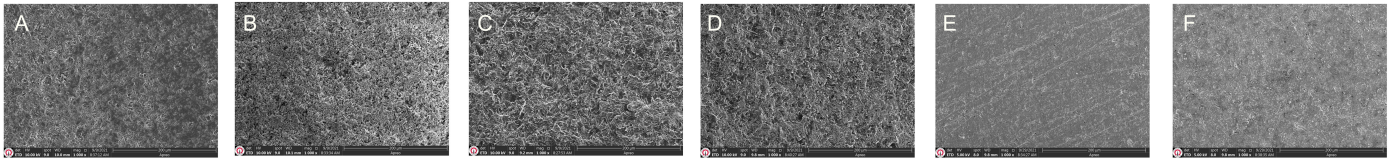
Figure 1. Scanning electron microscope micrographs of Vita Mark II exposed to different surface conditioning methods, at 1000× magnification. A, control; B, etching with hydrofluoric acid; C, sandblasting with aluminum-oxide; D, tribochemical silica coating with CoJet; E, bur abrasion; F, Monobond Etch and Prime.
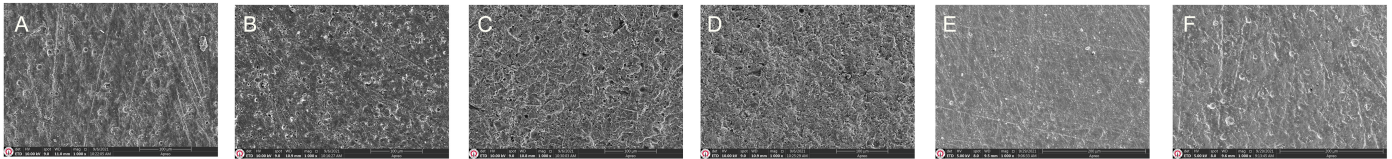
Figure 2. Scanning electron microscope micrographs of Shofu Block HC exposed to different surface conditioning methods, at 1000× magnification. A, control; B, etching with hydrofluoric acid; C, sandblasting with aluminum-oxide; D, tribochemical silica coating with CoJet; E, bur abrasion; F, Monobond Etch and Prime.
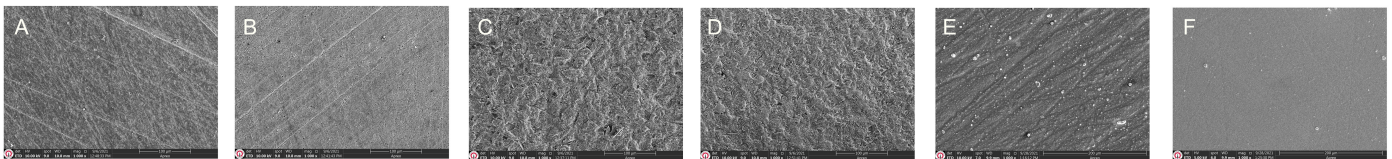
Figure 3. Scanning electron microscope micrographs of Brilliant Crios exposed to different surface conditioning methods, at 1000× magnification. A, control; B, etching with hydrofluoric acid; C, sandblasting with aluminum-oxide; D, tribochemical silica coating with CoJet; E, bur abrasion; F, Monobond Etch and Prime.
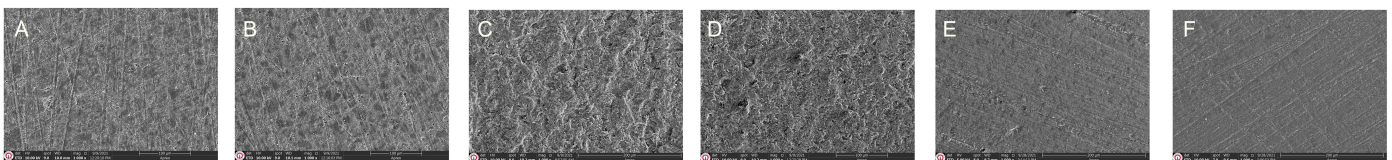
Figure 4. Scanning electron microscope micrographs of Gradia Direct exposed to different surface conditioning methods, at 1000× magnification. A, control; B, etching with hydrofluoric acid; C, sandblasting with aluminum-oxide; D, tribochemical silica coating with CoJet; E, bur abrasion; F, Monobond Etch and Prime.

conditioning increases SBS significantly ($P < .001$) which coincides with the results of our study.[28,29] An increase in SBS associated with surface conditioning could be related to higher surface roughness that enhances the penetration of bonding agents.[30]

Conventional adhesive systems require high technical sensitivity and more time, due to multiple application steps. Therefore, to overcome these disadvantages, universal adhesives which can be used in self-etch or etch-and-rinse modes in single-step are developed. In addition, they can be applied to different types of restorative materials to enhance bonding performance.[14] Previous studies reported that universal adhesives can sustain adequate bond strength between orthodontic metal braces and resin composites even without extra surface conditioning which supports the findings of this study.[31,32] In addition, ARI scores of the control group of Gradia Direct presented an even distribution proving high SBS between the adhesive resin and the restorative material.[3] Furthermore, Essayagh Tourot et al[33] concluded that SBS values between orthodontic metal braces and lithium disilicate ceramics, conditioned with universal adhesive, appear to be sufficient. However, in the present study, conditioning feldspar ceramic with a universal adhesive did not demonstrate adequate bond strength which is reported to be 6-8 MPa.[3,19] Moreover, the

ARI score of this group showed that no adhesive resin remained on Vita Mark II specimens. Therefore, an additional surface conditioning method is required to increase the SBS.

For conditioning glass ceramics, it is reported that the application of HF and silane is considered the gold standard.[15,34] The HF creates surface roughness by the dissolution of the glassy phase as demonstrated in SEM images of Vita Mark II, in a previous study and the present study.[28] This results in promoted micromechanical retention and thereby increases the SBS.[29] El-Damanhoury and Gaintantzopoulou[35] also suggested that conditioning with 9.6% HF and silane or bonding agent application afterward provides the highest SBS for ceramics. In the present study, after HF, the surface was conditioned with a silane-incorporated universal adhesive and the results showed that mostly HF promoted the SBS values observed for Vita Mark II. Also, regarding resin-matrix ceramic blocks (Shofu Block HC and Brilliant Crios) and direct composite resin (Gradia Direct), HF again significantly increased the SBS values. This is probably because HF etches the glassy filler component and creates micropores through the resin matrix which increases the surface energy and wettability of bonding agents.[21] Although surface conditioning with HF along with silane or bonding agents proved to increase SBS, it may damage the

ceramic surface during debonding.[14] In addition, clinicians should take safety precautions while using HF intraorally as it has a hazardous effect on soft tissues.[13]

Mechanical surface conditioning methods can be considered as an alternative since hydrofluoric acid etching has potential side effects.[35] One of these methods is sandblasting with aluminum oxide particles which results in micro-retentive porous surfaces.[36] The other one is tribochemical silica coating which can increase bond strength by abrading the restorative material and producing micromechanical retention and by chemical bonding along with silane.[37] Considering the SEM images of this study, both the AL and the CJ caused laminar porosities, with significant irregularities that possibly expanded the surface area and provided micromechanical interlocking. Regarding the SBS values, these methods increased the SBS significantly in all restorative materials that have resin components. Supportingly, according to the ARI scores, Gradia Direct specimens conditioned with AL and Brilliant Crios specimens conditioned with AL or CJ presented the highest incidence of score 1 related to high bond strength whereas Vita Mark II conditioned with AL or CJ had the lowest incidence of score 1, referring to lower bond strength. In previous studies that analyzed the SBS between metal braces and resin matrix ceramic blocks or direct resin composites, it was found that sandblasting provided the highest SBS values.[22,36] In addition, Turunç-Oğuzman and Şişmanoğlu[28] found that CJ enhanced SBS values for resin matrix ceramics significantly which is in line with the present study. This can be explained by that the silane inside the universal adhesive chemically bonds with both the silica and the methacrylate part of the resin matrix ceramics and the direct resin composite, resulting in an increase in SBS values.[38]

Another mechanical surface conditioning method is surface abrasion using a diamond bur, which is practical in the clinic as it eliminates the need for an additional instrument. It creates macro and micro-retentive surfaces by forming deep grooves and scratches.[39] In this study, the BUR method significantly increased the SBS values demonstrated by Gradia Direct and Brilliant Crios specimens; however, it was not successful for Vita Mark II and Shofu Block HC specimens regarding the SBS advancement. This might be because SEM images of Gradia Direct and Brilliant Crios specimens presented coarse polishing traces that could contribute to retention, while the SEM images of Vita Mark II and Shofu Block HC presented more homogeneous surfaces. The significant differences in SBS values found for different restorative materials are probably related to the variations in the chemical components, the type of organic matrix, the type of inorganic fillers and their ratios, and the manufacturing techniques. These are the factors that influence the materials' properties and their reaction to different surface conditioning methods and thereby affecting the SBS.[15,22] Considering this, relatively low SBS values demonstrated by Vita Mark II samples conditioned with AL, CJ, or BUR could be explained by its chemical composition which has glass ceramic, but no organic component. Still, all the mechanical conditioning methods enhanced the SBS values, and they were all clinically acceptable, above 6 MPa.[3,19] However, they have possible adverse effects on restorative materials such as chipping, heat production, and residual stresses which might reduce bond strength or general respiratory tract irritations.[17]

Monobond Etch and Prime, a self-etching ceramic primer can be used as a chemical conditioning method to eliminate the adverse effects of mechanical conditioning methods. Monobond Etch and Prime is produced to make the surface conditioning protocol easier for indirect restorative placement procedures. It simultaneously etches the restorative material with a mild acid (ammonium polyfluoride) and provides silanization (trimethoxypropyl methacrylate) in a single step.[18] Previous studies on the SBS of metal braces to dental ceramic CAD/CAM blocks, including resin nanoceramic, resin composite, hybrid ceramic, feldspar ceramic, and reinforced glass-ceramic blocks, have reported that MEP's efficiency is promising, better than the control group, but not as good as manufacturer instructions.[21,22,28] Moreover, a recent study reported that it causes lower SBS values compared to the two separate steps of etching and silanization since MEP consists of a weaker acid (pH = 4.4).[40] Therefore, in the present study, the MEP-conditioned specimens were conditioned with a universal adhesive which has a lower pH (pH = 2.7) value than ammonium polyflouride (pH = 4.4) to evaluate if it increases SBS values.[41] Based on the findings of this study, MEP application along with universal adhesive increased the SBS values as significantly as the manufacturer instructions for all materials, except direct resin composite. Still, all restorative materials, including direct resin composite, demonstrated sufficient SBS values for metal brace bonding.

Regarding the results of this study, it can be derived that MEP along with a universal adhesive could be a better option for surface conditioning to enhance adhesion between orthodontic braces and dental CAD/CAM blocks. Because of the problems related to other surface conditioning methods, referred earlier, MEP might be a safer alternative because it is not harmful for a short contact time. In addition, since it is not influenced significantly by contamination of saliva, there is no necessity to take precautions, which makes it also practical.[42] Regarding the results of the current study and the previous studies about MEP's performance on various dental CAD/CAM blocks with different compositions[18-22,28], it can be derived that MEP along with a universal adhesive can be a suitable surface conditioning method, close to manufacturer instructions, for all tooth-colored CAD/CAM blocks that clinicians are not certain of the formulation.

There are various limitations associated with this study. Primarily, in vitro studies do not present an exact reflection of intra-oral conditions with regard to biofilm existence, masticatory forces, and thermal changes that can influence SBS.[3,21] However, to simulate aging, samples were exposed to thermal cycling before surface conditioning and after bonding of the braces for 5000 cycles as administered in previous studies too.[23,24] Furthermore, to simulate the diamond bur, sandpaper was used for surface conditioning as referred to in previous studies to achieve standardization[25,26], but this might have caused a smoother surface that can be observed on SEM images and decreased the SBS results. Further laboratory and clinical studies should be accomplished, eliminating these restrictions, to confirm the findings of this study. In addition, future studies can assess different restorative materials to make sure MEP is an appropriate surface conditioning method for all dental ceramic types. Moreover, surface roughness and surface wettability of the restorative materials can be evaluated after surface conditioning methods.

In conclusion, surface conditioning methods significantly enhance the SBS, but the amount of increase also depends on the restorative material. Application of a universal adhesive alone (control group) maintained adequate bond strength for light-cured micro-hybrid composite (Gradia Direct) and reinforced

composite block (Brilliant Crios), but additional surface conditioning should be considered for feldspathic ceramic (Vita Mark II) and hybrid ceramic (Shofu Block HC) blocks which had SBS values below 6 MPa. As a safer and more practical method of surface conditioning, MEP along with a universal adhesive can be used on all restorative materials tested, with adequate adhesion of orthodontic metal braces.

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Perspectives of Dentistry Students on Orthodontics Specialty in Career Choices

Diş Hekimliği Öğrencilerinin Kariyer Tercihlerinde Ortodonti Uzmanlığına Bakış Açıları

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ABSTRACT

Objective: The aim of this study is to determine the perspectives of the third-, fourth-, and fifth-grade students in the faculty of dentistry on orthodontics specialty in career choices.

Methods: This epidemiological descriptive study was conducted by administering a 12-question questionnaire to 150 students (101 females and 49 males) enrolled in the third, fourth, and fifth grades of the faculty of dentistry. Out of the total of 150 students, 45 belonged to the third grade, 52 belonged to the fourth grade, and 53 belonged to the fifth grade. The collected data were subjected to the chi-square analysis.

Results: The mean age of 150 participants whose ages were between 20 and 27 years was 21.08 ± 1.98. It was observed that the opinions about orthodontic specialization did not differ according to the age, gender, and education period of the students. Of them, 41.9% thought that there would be a great need in the field of orthodontics in their career choice. The most preferred specialization areas in future were orthodontics (42.6%); prosthetic dentistry (17.6%); and oral, dental, and maxillofacial surgery (15.5%). The students stated that the most important reason for wanting to specialize in orthodontics was financial gain with a rate of 23.6%.

Conclusion: It was concluded that the opinions about the orthodontic specialization were generally positive, and the preference was mainly favorable. Factors such as clinical experience, financial gain, and interest in the specialty were found to be important in the selection of the specialty branch.

Keywords: Dentistry, orthodontics, career choices, specialty

ÖZ

Amaç: Bu çalışmanın amacı, diş hekimliği fakültesinin üçüncü, dördüncü ve beşinci sınıf öğrencilerinin meslek seçimlerinde ortodonti uzmanlığına yönelik bakış açılarını belirlemektir.

Yöntemler: Bu epidemiyolojik tanımlayıcı çalışma, diş hekimliği fakültesinin üçüncü, dördüncü ve beşinci sınıflarına kayıtlı 150 öğrenciye (101 kadın ve 49 erkek) 12 soruluk bir anket uygulanarak yapıldı. Toplam 150 öğrenciden 45'i üçüncü sınıfta, 52'si dördüncü sınıfta ve 53'ü beşinci sınıftaydı. Verilerin analizi Ki-kare testi ile yapıldı.

Bulgular: Yaşları 20 ila 27 arasında değişen 150 katılımcının yaş ortalaması 21.08 ± 1.98 idi. Ortodonti uzmanlığı ile ilgili görüşlerin öğrencilerin yaş, cinsiyet, eğitim dönemine göre farklılık göstermediği görüldü (p>0.05). %41. 9'u gelecekte Ortodonti alanında ihtiyacın fazla olacağını düşünmektedir. Gelecekte en çok tercih edilen uzmanlık alanları sırasıyla Ortodonti (%42.6), Protetik Diş Tedavisi (%17.6) ve Ağız, Diş ve Çene Cerrahisi (%15.5) idi. Öğrencilerin ortodonti alanında uzmanlaşma isteklerinin en önemli nedeni, %23.6 oranında maddi kazanç oldu.

Sonuç: Ortodonti uzmanlığına yönelik görüşlerin genellikle olumlu olduğu ve bu alanın kariyer tercihlerde nispeten yüksek oranda yer aldığı sonucuna varıldı. Uzmanlık dalının seçiminde klinik deneyim, maddi kazanç ve uzmanlık alanına olan ilginin önemli faktörler olduğu belirlendi.

Anahtar Kelimeler: Diş hekimliği, ortodonti, kariyer seçimi, uzmanlık

INTRODUCTION

Career, in general terms, means advancing in a chosen line of work and as a result, taking responsibility, gaining status, and gaining prestige. It is the development of a person's activities, responsibilities, attitudes, and behaviors in business life.[1] The concept of specialization is defined as increasing productivity by concentrating on a limited area. Developing research skills and increasing clinical skills will benefit dentistry one step further by improving patient satisfaction and service level and reducing complication rates.[2] In order to achieve these, post-graduate education becomes important. In cases where general dentistry is insufficient, continuing specialty training after the faculty of dentistry plays an important role.[3] Students who graduate after undergraduate education can continue their graduate education if they are successful in the exams held throughout the country. The financial income to be obtained, the desire to work in a specific field, the interest of the dentist in specialty education, and the academic career option are effective in the selection of graduate education.[4] However, it is a well-known fact that academicians, who are seen as role models, have a positive effect on students' choice of specialization. In addition, although it is not very effective at the moment, it is thought that malpractice cases will be effective in the selection of graduate education in the future.[5] Oral, dental, and maxillofacial radiology; oral, dental, and maxillofacial surgery; prosthetic dentistry; endodontics; restorative dentistry; pediatric dentistry; periodontology; and the department of orthodontics have been determined as areas that can be specialized in the 'Bag Law' No. 6225 published in the Official newspaper dated 26.04.2011 and numbered 27916, in our country.[6,7] Orthodontics constitutes a small part of the dentistry curriculum and this has been going on for years. Aesthetic dentistry, the development of jaw and facial systems, developments in materials, and innovations in science and technology have had a positive impact on orthodontic expertise. Over the years, the number of graduates, the number of specialist applications, and the number of specialist physicians have increased. Variables such as financial gain, ease of work, and malpractice are effective in the selection of the field of specialization.[8] Various studies have been conducted on the choice of specialization of dentistry students.[9,10] There are various studies evaluating the motivation of dentistry students in different specialties, the criteria they pay attention to in selection, and their perspectives on specialties. Kaptı and Ozdogan[11] conducted a study in which the students of the faculty of dentistry evaluated their motivation to specialize in the department of prosthetic dentistry, and it was determined that the thoughts about the department first started to form in the preclinical period and that factors such as the clinical experiences they had and the effect of the faculty members they took were effective in their career choices. In our country, no study has been found that examines the place of the department of orthodontics in the future plans and career goals of dentistry students.

In this study, it is aimed to determine the perspectives of the third-, fourth-, and fifth-grade students of the faculty of dentistry on orthodontics specialty in career choices.

The aim of this study is to make the view of dentistry students in different education periods toward orthodontic specialization in career choices. The hypothesis of the study is orthodontics will be preferred among the first 3 departments when all factors are taken into consideration.

MATERIAL AND METHODS

This study was carried out with the participation of 150 students in total, third-, fourth-, and fifth-grade students studying at Istanbul Aydın University Faculty of Dentistry, Turkey in the 2020-2021 academic term. The study is an epidemiological descriptive study applied to mid-term and intern students actively continuing their education. Students who took a break from their education (inactive) were excluded from this study. Ethics committee approval was obtained from İstanbul Aydın University Non-Interventional Ethics Committee (Number: 2022/103). One hundred fifty individuals (101 females and 49 males) aged between 20 and 27 years were included in our study. Forty-five individuals were third-grade students, 52 individuals were fourth-grade students, and 53 individuals were fifth-grade students. The study was carried out by the method of data collection with a questionnaire. Data were collected using the Google Forms program. The survey questions in the research were prepared by analogy with the questions that Aksoy and Yanıkoglu[12] used in their studies and were delivered to the participants online via a link. Consent was obtained from the participants before starting the survey. The questionnaire consisted of 15 questions in total. The first 3 questions consisted of questions about age, gender, and education period. The rest of the questionnaire comprised 10 questions that were designed using the Likert scale. These questions specifically pertained to clinical and specialized areas of orthodontics.

The last 3 questions are about the comparison and ranking of the orthodontics department with other departments.

The analysis of the obtained data was performed using the computer statistical package program Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp.; Armonk, NY, USA). Descriptive statistical methods and the chi-square test were used to evaluate the data. $P < .05$ was considered statistically significant. As a result of the power analysis using the 'G Power 3.1.9.2' package program, the effect size was 0.420, the alpha error was 0.05, while the power of the study was found to be 0.99 with the current sample size.

RESULTS

The mean age of the population participating in the study was 21.08 ± 1.98 years, and the participants were at least 20 and at most 27 years old. In this study, in which a total of 150 individuals participated, the female population was 101 (68.7%) and the male population was 49 (31.3%) (Table 1). According to the education period of the students; third graders comprised 30% (45), fourth graders 34.7% (52), and fifth graders 35.3% (53) (Table 2). According to the results of the chi-square test in the cross-assessment and independent samples, it was seen that the views on orthodontic specialization did not differ according to the age, gender, and education period of the students (Table 1). A high percentage of 56% of the students who participated in the study stated that they were aware of the orthodontics department during the pre-school period (Table 3). There was no significant difference in the answer given to this question between men and women ($P = .138$). There was no significant difference in the response given between the classes ($P = .213$) (Table 3).

The students reported that the least reason for why they meet with the orthodontics department is textbook (6%). Clinical experience was found to be the second most influential experience for

Table 1. Significance of gender distribution by age and grade.

		Gender				
		Male		Female		
		n	%	n	%	*P*
Age	18-24	38	32.8	78	67.2	.487
	25-29	9	26.5	25	73.5	
Grades	Third grade	12	26.7	33	73.3	.565
	Fourth grade	19	36.5	33	63.5	
	Fifth grade	16	30.2	37	69.8	

Table 2. Age, gender, and grades of the individuals participated in this study.

		n	%
Age	18-24	116	77.3
	25-29	34	22.7
Gender	Male	47	31.3%
	Female	103	68.7%
Grades	Third grade	45	30.0%
	Fourth grade	52	34.7%
	Fifth grade	53	35.3%

students (26.7%). A significant difference was found between the classes in the answer given to this question (*P* = .049) (Table 3). Thirty percent of respondents are undecided about whether their first experience with orthodontic treatment is positive or negative; however, it was observed that individuals had a more positive approach in general. There was no difference in the response between men and women (*P* = .158) (Table 3).

Students stated that there will be a great need for orthodontics in the future (Table 3). There was no significant difference between the genders in the answer given to the question (*P* = .381) (Tables 3). The students listed the first 3 departments that they dream of specializing in as orthodontics (43.3%); prosthodontics (17.3%); and oral, dental, and maxillofacial surgery (15.3%) (Table 3). The least preferred department was the department of endodontics (2.7%). Men and women gave significantly different answers to this question (*P* = .034). The answers they gave in the third, fourth, and fifth grades showed a significant difference (*P* = .01) (Table 3). Which specialty of dentistry do you think is the most important? Forty percent of the students answered the question as the orthodontics department. The department that was thought to be least effective was the department of oral and maxillofacial radiology with 3.2%. It was observed that there was no significant difference in the answer given to this question between men and women (*P* = .439) (Table 3). The students who participated in the study stated that the most important reason for wanting to specialize in orthodontics was financial gain with a rate of 23.3% (Table 3). It was seen that the need of the patients was the least preferred option with 12%. There was no significant difference in the answer given to this question between the genders (*P* = .899). There was no significant difference in the answers given between the classes (*P* = .61) (Table 3).

DISCUSSION

The process of specialization in dentistry is an important decision that will shape the lives of students. In making this decision, it is important to complete the knowledge of the students about the specialty they want to choose, to determine their abilities in this specialty, and to guide the students with the right guidance.

Postgraduate education has an important place in the field of dentistry, as in all professional branches. Although private clinical practices are popular due to the nature and historical development of the profession, with the changing specialty system

in recent years, private fields of study have also begun to turn to and prefer specialist physicians. In addition, when considering academic careers, the number of dentists working as specialists, doctors, and academicians is increasing every day due to the increase in the number of universities in recent years. Factors such as the popularity of departments, needs of faculty members, financial gain, and comfortable working conditions play an important role in choosing a specialty. A situation similar to this significant increase in specialized education in our country is also found in other states. In a study conducted in Saudi Arabia, it was reported that orthodontic expertise in dentistry is gaining importance day by day.[13] Specialty training has become a condition that should be in dentistry. New research focuses on what students pay attention to when choosing a department for specialized education.[14]

Methodologically, it was a survey study to gather the opinions of undergraduate students enrolled in a dentistry faculty. Moreover, it is aimed to evaluate the perceptions of knowledge and competence in the orthodontics department and their ranking according to other departments. The first-grade dentistry students usually were not included in the evaluation of students' career choices in previous studies,[15] Similarly, the third-, fourth-, and fifth-grade students were included in our study also considering the start of clinical orthodontic training.

In this study, it was questioned why the students of our faculty would prefer orthodontic specialization and it was predicted that it is for economical reasons, despite the fact that they look coldly at the expertise in this field due to the long-lasting treatments. While departments are preferred in the specialty exam applied in our country, orthodontics is generally the first or second preferred area. The fact that the average of the answers received to the question for preference ranking was found to be 5.05 in this study, statistically supporting this situation. Most of the students stated that they were most impressed by the clinical experience related to the orthodontics department, and it was seen that the fifth graders were more affected. This result may have been encountered because there was a difference of 2 years between third graders and fifth graders and 1 year between fourth and fifth graders in terms of clinical experience. In addition, students are uncertain about whether their first experience with orthodontics was positive or negative; but it was found that they mostly thought positively. It is known that students increase their stress levels toward clinical classes in studies,[16] but in our study, it was seen that this stress did not form a negative opinion about orthodontics in individuals. In a study that evaluated the place of orthodontics in the future career planning of dentistry students, 10% of second-grade students and 14% of all fourth-grade students and fifth-grade students stated that the reason they wanted to specialize in the orthodontics department was a positive university experience.[15] The answer given to the question in our study may have resulted from a positive university experience that supports this information.

Students stated that the most important criterion they paid attention to when choosing a specialty was their interest in the specialty. Although it is known that the cost of dental education is quite high, the cost of education was found to be the most insignificant criterion. This result is also consistent with similar studies.[17, 18] In all 3 grades, students consider that their interest in the specialty is the most important criterion for choosing a

Table 3. Evaluation of survey findings according to gender, grade, and age.

Questions	All Individuals n (%)	Female n (%)	Male n (%)	P^a	Third grade n (%)	Fouth grade n (%)	Fifth grade n (%)	P^a	18-24 n (%)	25-29 n (%)	P^a
1. When did you learn orthodontics at first?				.213				<.001**			.016*
A. Pre-school period	84 (56.00%)	59 (57.3%)	25 (53.2%)		37 (82.2%)	25 (48.1%)	22 (41.5%)		72 (62.1%)	12 (35.3%)	
B. University preference period	14 (9.30%)	7 (6.8%)	7 (14.9%)		1 (2.2%)	8 (15.4%)	5 (9.4%)		11 (9.5%)	3 (8.8%)	
B. University preference period- preclinic	9 (6.00%)	7 (6.8%)	2 (4.3%)		3 (6.7%)	4 (7.7%)	2 (3.8%)		8 (6.9%)	1 (2.9%)	
C. Preclinic period	8 (5.30%)	5 (4.9%)	3 (6.4%)		1 (2.2%)	5 (9.6%)	2 (3.8%)		4 (3.4%)	4 (11.8%)	
D. Clinic period	15 (10.00%)	8 (7.8%)	7 (14.9%)		2 (4.4%)	6 (11.5%)	7 (13.2%)		9 (7.8%)	6 (17.6%)	
E. Others	20 (13.30%)	17 (16.5%)	3 (6.4%)		1 (2.2%)	4 (7.7%)	15 (28.3%)		12 (10.3%)	8 (23.5%)	
2. Which introductory experience about the orthodontics department has impressed you the most?				.322				.049*			.006**
A. Preclinic experience	28 (18.70%)	20 (19.4%)	8 (17.0%)		7 (15.6%)	12 (23.1%)	9 (17.0%)		22 (19.9%	6 (17.6%)	
B. Clinic experience	40 (26.70%)	23 (22.3%)	17 (36.2%)		14 (31.1%)	15 (28.8%)	11 (20.8%)		37 (31.9%)	3 (8.8%)	
C. The academician who teaches the orthodontics	18 (12.00%)	11 (10.7%)	7 (14.9%)		2 (4.4%)	10 (19.2%)	6 (11.3%)		12 (10.3%)	6 (17.6%)	
D. Textbook	11 (7.30%)	7 (6.8%)	4 (8.5%)		1 (2.2%)	2 (3.8%)	8 (15.1%)		8 (6.9%)	3 (8.8%)	
E. Journal or website of dentistry	9 (6.00%)	7 (6.8%)	2 (4.3%)		2 (4.4%)	4 (7.7%)	3 (5.7%)		3 (2.6%)	6 (17.6%)	
F. Others	44 (29.30%)	35 (34.0%)	9 (19.1%)		19 (42.2%)	9 (17.3%)	16 (30.2%)		34 (29.3%)	10 (29.4%)	
3. How should the orthodontics specialty exam be?				.576				.024*			
A) Dus	54 (36.00%)	33 (32.0%)	21 (44.7%)		25 (55.6%)	17 (32.7%)	12 (22.6%)		47 (40.5%)	7 (2.6%)	
B) Audition	50 (33.30%)	36 (35.0%)	14 (29.8%)		11 (24.4%)	21 (40.4%)	18 (34.0%)		38 (32.8%)	12 (35.3%)	
C) A foreign language exam is sufficient	20 (13.30%)	14 (13.6%)	6 (12.8%)		5 (11.1%)	4 (7.7%)	11 (20.8%)		13 (11.2%)	7 (2.6%)	
D) The average of scores in central exam like ALES and graduation grades	16 (10.70%)	13 (12.6%)	3 (6.4%)		2 (4.4%)	5 (9.6%)	9 (17.0%)		12 (10.3%)	4 (1.18%)	
E) Degree in dental education or who entered the top 3	10 (6.70%)	7 (6.8%)	3 (6.4%)		2 (4.4%)	5 (9.6%)	3 (5.7%)		6 (5.2%)	4 (11.8%)	
4. How would you rate your experience with orthodontic treatment?				.262				.014*			.138
A. Mostly positive	21 (14.00%)	16 (15.5%)	5 (10.6%)		4 (8.9%)	9 (17.3%)	8 (15.1%)		17 (14.7%)	4 (11.8%)	
B. Positive	39 (26.00%)	30 (29.1%)	9 (19.1%)		20 (44.4%)	9 (17. 3%)	10 (18.9%)		34 (29.3%)	5 (14.7%)	
C. Little positive	27 (18.00%)	16 (15.5%)	11 (23.4%)		2 (4.4%)	12 (23.1%)	13 (24.5%)		18 (15.5%)	9 (26.5%)	
D. Undecided	45 (30.00%)	30 (29.1%)	15 (31.9%)		16 (35.6%)	15 (28.8%)	14 (26.4%)		36 (31.0%)	9 (26.5%)	
E. Little negative	12 (8.00%)	9 (8.7%)	3 (6.4%)		2 (4.4%)	6 (11.5%)	4 (7.5%)		8 (6.9%)	4 (11.8%)	
F. Mostly negative	6 (4.00%)	2 (1.9%)	4 (8.5%)		1 (2.2%)	1 (1.9%)	4 (7.5%)		3 (2.6%)	3 (8.8%)	
5. How do you valuate the department of orthodontics in terms of education and social environment?				.897				.640			.169
A) Very well	54 (36.00%)	38 (36.9%)	16 (34.0%)		21 (46.7%)	18 (34.6%)	15 (28.3%)		43 (37.1%)	11 (32.4%)	
B) Well	46 (30.70%)	29 (28.2%)	17 (36.2%)		12 (26.7%)	14 (26.9%)	20 (37.7%)		37 (31. 9%)	9 (26.5%)	
C) Medium	40 (26.70%)	28 (27.2%)	12 (25.5%)		11 (24.4%)	15 (28.8%)	14 (26.4%)		31 (26.7%)	9 (26.5%)	
D) Bad	6 (4.00%)	5 (4.9%)	1 (2.1%)		1 (2.2%)	3 (5.8%)	2 (3.8%)		4 (3.4%)	2 (5.9%)	
E) Very bad	4 (2.70%)	3 (2.9%)	1 (2.1%)		0 (0.0%)	2 (3.8%)	2 (3.8%)		1 (0.9%)	3 (8.8%)	
6. What is your general perception about the future needs of the orthodontics department?				.381				.001**			.158
A. Mostly positive	41 (27.30%)	30 (29.1%)	11 (23.4%)		6 (13.3%)	17 (32.7%)	18 (34.0%)		29 (25.0%)	12 (35.3%)	
B. Positive	62 (41.30%)	40 (38.8%)	22 (46.8%)		30 (66.7%)	17 (32.7%)	15 (28.3%)		55 (47.4%)	7 (20.6%)	
C. Little positive	25 (16.70%)	15 (14.6%)	10 (21.3%)		3 (6.7%)	14 (26.9%)	8 (15.1%)		14 (12.1%)	11 (32.4%)	
D. Undecided	16 (10.70%)	14 (13.6%)	2 (4.3%)		4 (8.9%)	4 (7.7%)	8 (15.1%)		13 (11.2%)	3 (8.8%)	
7. What do you think is the most important area in dentistry?				.968				.693			.201
A. Oral, dental, and maxillofacial radiology	7 (4.7%)	5 (4.9%)	2 (4.3%)		2 (4.4%)	0 (0.0%)	5 (9.4%)		5 (4.3%)	2 (5.9%)	
B. Prosthodontics	26 (17.30%)	16 (15.5%)	10 (21.3%)		7 (15.6%)	10 (19.2%)	9 (17.0%)		24 (20.7%)	2 (5.9%)	
C. Oral, dental, and maxillofacial surgery	38 (25.30%)	27 (26.2%)	11 (23.4%)		14 (31.1%)	14 (26.9%)	10 (18.9%)		27 (23.3%)	11 (32.4%)	
D. Pedodontics	10 (6.70%)	8 (7.8%)	2 (4.3%)		2 (4.4%)	4 (7.7%)	4 (7.5%)		6 (5.2%)	4 (11.8%)	
E. Endodontics	5 (3.30%)	3 (2.9%)	2(4.3%)		2 (4.4%)	2 (3.8%)	1 (1.9%)		3 (2.6%)	2 (5.9%)	
F. Periodontology	6 (4.00%)	4 (3.9%)	2 (4.3%)		2 (4.4%)	3 (5.8%)	1 (1.9%)		4 (3.4%)	2 (5.9%)	
G. Orthodontics	57 (38.00%)	39 (37.9%)	18 (38.3%)		16 (35.6%)	19 (36.5%)	22 (41.5%)		46 (39.7%)	11 (32.4%)	
H. Restorative dentistry	1 (0.70%)	1 (1.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	1 (1.9%)		1 (0.9%)	0 (0.0%)	
8. What is the first department you dream of specializing in?				.577				.247			.434
A. Oral, dental, and maxillofacial radiology	3 (2.00%)	2 (1.9%)	1 (2.1%)		0 (0.0%)	2 (3.8%)	1 (1.9%)		3 (2.6%)	0 (0.0%)	
B. Prosthodontics	26 (17.30%)	18 (17.5%)	8 (17.0%)		12 (26.7%)	9 (17.3%)	5 (9.4%)		22 (19.0%)	4 (11.8%)	
C. Oral, dental, and maxillofacial surgery	23 (15.30%)	17 (16.5%)	6 (12.8%)		8 (17.8%)	6 (11.5%)	9 (17.0%)		20 (17.2%)	3 (8.8%)	
D. Pedodontics	14 (9.30%)	8 (7.8%)	6 (12.8%)		3 (6.7%)	9 (17.3%)	2 (3.8%)		9 (7.8%)	5 (14.7%)	
E. Endodontics	4 (2.70%)	4 (3.9%)	0 (0.0%)		1 (2.2%)	1 (1.9%)	2 (3.8%)		2 (1.7%)	2 (5.9%)	
F. Periodontology	13 (8.70%)	11 (10.7%)	2 (4.3%)		5 (11.1%)	3 (5.8%)	5 (9.4%)		1 (0.9%)	4 (11.8%)	
G. Orthodontics	65 (43.30%)	41 (39.8%)	24 (51.1%)		16 (35.6%)	21 (40.4%)	28 (52.8%)		49 (42.2%)	16 (47.1%)	
H. Restorative dentistry	2 (1.30%)	2 (1.9%)	0 (0.0%)		0 (0.0%)	1 (1.9%)	1 (1.9%)		2 (1.7%)	0 (0.0%)	

(*Continued*)

Table 3. Evaluation of survey findings according to gender, grade, and age. (*Continued*)

Questions	All Individuals n (%)	Gender Female n (%)	Male n (%)	P^a	Grade Third grade n (%)	Fourth grade n (%)	Fifth grade n (%)	P^a	Age 18-24 n (%)	25-29 n (%)	P^a
9. In which specialization do you think you can earn more financially?				.672				.201			.034*
A. Oral, dental, and maxillofacial radiology	1 (0.70%)	1 (1.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	1 (1.9%)		1 (0.9%)	0 (0.0%)	
B. Prosthodontics	22 (14.70%)	17 (16.5%)	5 (10.6%)		10 (22.2%)	7 (13.5%)	5 (9.4%)		20 (17.2%)	2 (5.9%)	
C. Oral, dental, and maxillofacial surgery	31 (20.70%)	24 (23.3%)	7 (14.9%)		12 (26.7%)	6 (11.5%)	13 (24.5%)		23 (19.8%)	8 (23.5%)	
D. Pedodontics	6 (4.00%)	3 (2.9%)	3 (6.4%)		1 (2.2%)	2 (3.8%)	3 (5.7%)		3 (2.3%)	3 (8.8%)	
E. Endodontics	7 (4.70%)	5 (4.9%)	2 (4.3%)		1 (2.2%)	5 (9.6%)	1 (1.9%)		3 (2.3%)	4 (11.8%)	
F. Periodontology	7 (4.70%)	4 (3.9%)	3 (6.4%)		1 (2.2%)	2 (3.8%)	4 (7.5%)		5 (4.3%)	2 (5.9%)	
G. Orthodontics	75 (50.00%)	48 (46.6%)	27 (57.4%)		19 (42.2%)	30 (57.7%)	16 (49.1%)		61 (52.6%)	14 (41.2%)	
H. Restorative dentistry	1 (0.70%)	1 (1.0%)	0 (0.0%)		1 (2.2%)	0 (0.0%)	0 (0.0%)		0 (0.0%)	1 (2.9%)	
10. Which specialization do you think is most important for patient care?				.734				**.023***			.660
A. Oral, dental, and maxillofacial radiology	9 (6.00%)	6 (5.8%)	3 (6.4%)		1 (2.2%)	4 (7.7%)	4 (7.5%)		8 (6.9%)	1 (2.9%)	
B. Prosthodontics	14 (9.30%)	11 (10.7%)	3 (6.4%)		7 (15.6%)	4 (7.7%)	3 (5.7%)		11 (9.5%)	3 (8.8%)	
C. Oral, dental, and maxillofacial surgery	32 (21.30%)	21 (20.4%)	11 (23.4%)		12 (26.7%)	9 (17.3%)	11 (20.8%)		28 (24.1%)	4 (11.8%)	
D. Pedodontics	13 (8.70%)	8 (7.8%)	5 (10.6%)		4 (8.9%)	5 (9.6%)	4 (7.5%)		10 (8.6%)	3 (8.8%)	
E. Endodontics	6 (4.00%)	4 (3.9%)	2 (4.3%)		5 (11.1%)	1 (1.9%)	0 (0.0%)		5 (4.3%)	1 (2.9%)	
F. Periodontology	16 (10.70%)	10 (9.7%)	6 (12.8%)		7 (15.6%)	6 (11.5%)	3 (5.7%)		12 (10.3%)	4 (11.8%)	
G. Orthodontics	55 (36.70%)	41 (39.8%)	14 (29.8%)		7 (15.6%)	21 (40.4%)	27 (50.9%)		39 (33.6%)	16 (47.1%)	
H. Restorative dentistry	5 (3.30%)	2 (1.9%)	3 (6.4%)		2 (4.4%)	2 (3.8%)	1 (1.9%)		3 (2.6%)	2 (5.9%)	
11. Which specialization do you think is the most effective department in dentistry?				.439				**.032***			.581
A. Oral, dental, and maxillofacial radiology	10 (6.70%)	8 (7.8%)	2 (4.3%)		3 (6.7%)	3 (5.8%)	4 (7.5%)		8 (6.9%)	2 (5.9%)	
B. Prosthodontics	15 (10.00%)	12 (11.7%)	3 (6.4%)		5 (11.1%)	5 (9.6%)	5 (9.4%)		14 (12.1%))	1 (2.9%)	
C. Oral, dental, and maxillofacial surgery	31 (20.70%)	21 (20.4%)	10 (21.3%)		13 (28.9%)	5 (9.6%)	13 (24.5%)		25 (21.6%)	6 (17.6%)	
D. Pedodontics	13 (8.70%)	7 (6.8%)	6 (12.8%)		6 (13.3%)	7 (13.5%)	0 (0.0%)		8 (6.9%)	5 (14.7%)	
F. Periodontology	11 (7.30%)	6 (5.8%)	5 (10.6%)		3 (6.7%)	6 (11.5%)	2 (3.8%)		9 (7.8%)	2 (5.9%)	
G. Orthodontics	60 (40.00%)	40 (38.8%)	20 (42.6%)		11 (24.4%)	23 (44.2%)	26 (49.1%)		44 (37.9%)	16 (47.1%)	
H. Restorative dentistry	10 (6.70%)	9 (8.7%)	1 (2.1%)		4 (8.9%)	3 (5.8%)	3 (5.7%)		8 (6.9%)	2 (5.9%)	
12. If you want to specialize in orthodontics, what is the most important reason for this?				.899				.061			.462
A. Contribution to professional life	18 (12.00%)	13 (12.6%)	5 (10.6%)		8 (17.8%)	6 (11.5%)	4 (7.5%)		15 (12.9%)	3 (8.8%)	
B. Patients' need	18 (12.00%)	12 (11.7%)	6 (12.8%)		8 (17.8%)	6 (11.5%)	4 (7.5%)		14 (12.1%)	4 (11.8%)	
C. Financial gain	35 (23.30%)	24 (23.3%)	11 (23.4%)		14 (31.1%)	6 (11.5%)	15 (28.3%)		30 (25.9%)	5 (14.7%)	
D. Personal abilities	20 (13.30%)	12 (11.7%)	8 (17.0%)		5 (11.1%)	9 (17.3%)	6 (11.3%)		13 (11.2%)	7 (20.6%)	
E. Other	59 (39.30%)	42 (40.8%)	17 (36.2%)		10 (22.2%)	25 (48.1%)	24 (45.3%)		44 (37.9%)	15 (44.1%)	

aChi-square test.
*P < .05; **P < .01. Bold values denote statistically significant changes.

specialty; but the fourth grades made this choice with a higher percentage. Fourth graders are more enthusiastic because they have just started clinical education and may have chosen this option more.

The present study has identified that the top three departments that students consider specializing in are orthodontics; oral, dental, and maxillofacial surgery; and prosthetic dental treatment, respectively. It has been reported in the literature that orthodontics took the first place in the studies, followed by oral, dental, and maxillofacial surgery.[19, 20] In our study, it was found that women students dream of specializing in the departments of oral, dental, and maxillofacial surgery; orthodontics; and pedodontics with a much higher rate than men. Dhima et al[21] showed that, unlike our study, men preferred the department of oral and maxillofacial surgery more than women. In a similar study conducted in our country, it was found that women wanted to specialize more in the department of oral, dental, and maxillofacial surgery.[14] In a study investigating motivation in the department of prosthetic dentistry, the pleasure of providing specialist services was stated as the most important factor affecting the choice of specialization. In our study, it was also not investigated why the department of prosthodontics was chosen the most.[21] It may be considered to conduct more detailed survey studies to investigate the reason for this situation.

In the comparison between the fourth and fifth grades, there was no significant difference and no significant relationship between their desire to specialize in orthodontics. Students in both classes preferred the orthodontics department in the third place.

It is seen that the most effective department in terms of dentistry is the department of oral, dental, and maxillofacial surgery, followed by the department of prosthetic dentistry. In a study in which the general impact on dentistry was questioned, orthodontics and oral, dental, and maxillofacial surgery departments ranked first among the specialties with an equal percentage.[13] In our study, the branch of orthodontics ranks fifth among 8 areas of specialization. In a similar study conducted in our country, the orthodontics department is ranked (fourth) similar to our study in terms of dentistry. In our country, the orthodontics department is in the last place in terms of its effectiveness in dentistry and patient care.

When we questioned whether the orthodontics department will be needed in the future in our study, it was seen that the answer was quite positive. In our country, the incidence of angle class I, II, III, and IV malocclusions is 82.7% in the Mediterranean Region, 24.4% in the Eastern Anatolia Region, 72%.1 in the Aegean Region, 63.4% in the South East Anatolian Region, 53.4% in the Central Anatolia Region, 38.1% in the Black Sea Region, and 65.6% in the

Marmara Region.[22] Considering that the prevalence of malocclusion is quite high, it is seen that the students' opinions on this subject are correct. Based on the responses of the students, they consider orthodontics as the most lucrative specialization, followed by prosthetic dentistry. The results of different studies conducted in other countries do not support our study; oral, dental, and maxillofacial surgery department comes first and orthodontics department comes second.[10] They considered the department of restorative dentistry as the department with the least financial gain. In other studies, the department with the least financial gain was stated as oral, dental, and maxillofacial radiology.[13] The department of prosthetic dentistry, which is the most desired field among students, and the department of oral, dental, and maxillofacial surgery, which ranks second, are behind the orthodontics department in terms of financial gain. In our study, the answer given by the students to the question of the most important criterion they pay attention to in the selection of the specialty branch confirms this result.

Considering the internship difficulties of students in faculties, we know that especially intern students look away from their expertise in that branch. In this case, we believe that the order of preference and popularity of orthodontics will increase if students can better explain all the advantages of orthodontic specialization, its technological side, its field of interest and the fact that it is the most prone to multidisciplinary work.

According to the results of our study, the opinions about the orthodontic specialization were generally positive and the preference was in a good place. Factors such as clinical experience, financial gain, and interest in the specialty were found to be important in the selection of the specialty branch. Moreover, opting to become an expert and selecting a specific department is a highly personal choice influenced by the student's experiences and interests during their undergraduate years. Additionally, job prospects and financial considerations regarding specialized training play significant roles in the decision-making process for choosing a specialization.

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Is There Any Association Between Health Literacy Level, Periodontal Status, and Adverse Pregnancy Outcomes in Pregnant Women?

Hamilelerin Sağlık Okuryazarlığı Seviyeleri ile Periodontal Durumları ve İstenmeyen Hamilelik Sonuçları Arasında İlişki Var mı?

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ABSTRACT

Objective: As a part of general health, the periodontal health status of the pregnant women is not only important for pregnancy but also utmost for antenatal and postnatal life of a fetus. This study aimed to determine the health literacy level of pregnant women and to demonstrate the association between health literacy level, periodontal status, and adverse pregnancy outcomes compared to nonpregnant women.

Methods: A total of 216 participants (pregnant/nonpregnant = 104/112) were included in this cross-sectional study. Health literacy level was determined using a self-completed Turkish Health Literacy Scale, 32-item questionnaire. Plaque index, gingival index, bleeding on probing, probing depth, and clinical attachment level were recorded. The records of pregnant women were evaluated for preeclampsia, preterm delivery, and low birthweight. Statistical significance was set at $P < .05$.

Results: The health literacy level, plaque index, gingival index, and bleeding on probing values were higher in pregnant women ($P = .022$, $P = .007$, and $P = .034$ respectively). While a positive correlation was observed between health literacy level and birthweight, a negative one was found between periodontal parameters, either birthweight or birth week ($P < .05$). Nevertheless, there was not any association between health literacy level and periodontal parameters ($P > .05$).

Conclusion: Our results showed that health literacy level was higher in pregnant women without any effects on periodontal status. Given the unique conditions of pregnancy, our study provides remarkable data that may help establish oral health care during pregnancy routinely for both pregnant women and caregivers.

Keywords: Health literacy, maternal health, periodontal status, periodontal indices, pregnancy outcomes

ÖZ

Amaç: Genel sağlığın bir parçası olan periodontal sağlık, gebelerde sadece gebeler için değil, fetüsün antenatal ve postnatal yaşamı için de son derece önemlidir. Bu çalışmanın amacı, gebe kadınların sağlık okuryazarlık (SOY) düzeyini belirlemek ve gebenin SOY düzeyi ile periodontal durumu ve istenmeyen gebelik sonuçları arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntem: Bu kesitsel çalışmaya toplam 216 katılımcı (gebe/gebe olmayan = 104/112) dahil edildi. SOY düzeyleri, katılımcılar tarafından doldurulan Türkiye SOY Ölçeği-32 kullanılarak belirlendi. Katılımcılardan plak indeks (PI), gingival indeks (GI), sondalamada kanama (SK), sondalama derinliği (SD) ve klinik ataşman seviyesi (KAS) klinik parametreleri kayıt altına alındı. Gebelerin rutin jinekolojik kayıtları preeklampsi, erken doğum ve düşük doğum ağırlığı açısından değerlendirildi. İstatistiksel anlamlılık p<.05 olarak belirlendi.

Bulgular: Gebelerde SOY, GI ve SK değerleri daha yüksekti (sırasıyla, $P = .022$, $P = .007$, $P = .034$). SOY ile doğum ağırlığı arasında pozitif bir korelasyon gözlenirken, periodontal parametreler ile

hem bebeğin doğum ağırlığı hem de doğum haftası arasında negatif yönlü bir ilişki bulundu (*P* <.05). Bununla birlikte, SOY ile periodontal parametreler arasında herhangi bir ilişki yoktu (*P* >.05).

Sonuç: Bulgularımız, SOY'un gebelerde daha yüksek olduğunu ancak bu yüksekliğin periodontal duruma herhangi bir etkisinin olmadığını göstermiştir. Gebeliğin kendine özgü koşulları göz önüne alındığında, çalışmamız hem gebeler hem de bakıcılar için gebelikte ağız sağlığı bakımının rutin olarak oluşturulmasına yardımcı olabilecek dikkate değer veriler sunmaktadır.

Anahtar Kelimeler: Anne sağlığı, hamilelik sonuçları, sağlık okur yazarlığı, periodontal durum, periodontal indeksler

INTRODUCTION

Health literacy (HL) can be described as "the ability of people to use, process, and understand basic health-related information and services to make educated medical decisions."[1] According to the comprehensive definition, "HL is linked to literacy and requires people's knowledge, motivation, and skills. Similarly, they can access, understand, evaluate, and act on this information to make daily decisions. As a result, people can help prevent disease and promote health to maintain or improve quality of life throughout their life."[2] Low level of HL is a global problem that requires attention, as the World Health Organization presents HL as one of the most critical determinants of health.

Considering the well-documented outcomes that HL affects individual's accessibility to healthcare services/providers and overall health status; it can be anticipated that low levels of HL is associated with both insufficient self-care habits and mortality. Low levels of HL lead to an increased incidence of disease and thus a global burden on the economy.[2,3] The first survey on HL in 8 European countries showed that approximately 47% of the population in these countries had low levels of HL.[4] Inadequate or limited HL is a widespread problem also in Turkey, with studies reporting that 52%-82% of adults have basic or below-average HL skills.[5,6] In Greece and Bulgaria, which border Turkey, inadequate and problematic levels of HL are 45% and 62%, respectively.[4]

HL is essential in several target populations, such as pregnant women. This term is considered a critical component that allows women to participate in self-care and childcare activities.[7] Before, during, and after pregnancy, a mother's medical conditions and health knowledge significantly affect her child.[8] Research has shown that women with suboptimal HL have a poor understanding of medical instructions and medication labels and do not take their medications properly.[9] In addition, previous studies have shown that low levels of HL is associated with unplanned pregnancies and negatively affects women's health care and child care.[3,10] Research on HL during pregnancy is limited in the literature.[11,12] A recent large-scale study of HL conducted in 775 pregnant women found that 15.5% of the participants had inadequate, 41.7% had borderline, and 42.8% had adequate HL.[13]

Pregnancy-related immunological changes increase the mother's susceptibility to infections, including periodontal disease. Periodontal diseases can increase the risk of adverse pregnancy outcomes such as preeclampsia, preterm birth, and low birthweight (LBW).[13] Thanks to this bidirectional relationship between periodontal disease and pregnancy, periodontal health is paramount for overall health. Moreover, based on the fact that the mother is a role model for the baby in terms of oral hygiene requirements, it can be stated that pregnant women have an important place in the establishment of the concept of periodontally healthy society.

In this study, it was assumed that HL in pregnant women has a positive effect on decision-making regarding both maternal and child health care. Therefore, this research evaluated HL levels (HLLs) in pregnant women, outlined the relationship between HL, periodontal status, and adverse pregnancy outcomes, and compared the results with nonpregnant individuals.

MATERIAL AND METHODS

The Ethics Committee for Non-Interventional Clinical Research of İstanbul Aydın University (Date: 14.02.2019, Number: 2019/40) approved this descriptive, cross-sectional study design according to the principles outlined in the World Medical Association Declaration of Helsinki. Also, all participants were informed about the study and informed consent forms were obtained before the baseline.

Study Population and Sample Size

The sample size was calculated based on the clinical outcome of a similarly designed study.[14] Gingival index (GI), described below as a variable, was evaluated as the primary outcome of the study. Seventy-two subjects per group would provide 85% power to detect a true difference of 0.99 in mean GI between groups with a 0.32 mean SD. The study included 104 pregnant women (aged 23-37 years) in their second trimester and 112 nonpregnant (aged 21-40 years) participants between July 2020 and December 2020. The participants in the both study groups were fulfilled the inclusion criteria were as follows: (1) being native Turkish speakers; (2) being systemically healthy; (3) having no previous pregnancies, also, no miscarriage, dilatation and curettage; (4) having a total of ≥20 teeth, except the third molars; (5) having no disability affecting daily self-performed oral care; (6) having no periodontal treatment within the last 6 months; (7) no use of antibiotics, anti-inflammatory drugs, or other drugs affecting the periodontium within the last 6 months; and (8) consent to participate in the study. Pregnancy status is the only inclusion criterion that differentiates the groups. A history of systemic disease or the use of medications that could affect periodontal status was considered as an exclusion criterion.

Data Collection Form and Evaluation of the TSOY-32 Questionnaire

All participants received a 2-part form with questions on age, education level (primary/middle/high/college or university/post graduate), monthly income (low/middle/upper), frequency of brushing (at least once a week/once a day/twice a day), and flossing (yes/no) as the first part.

All patients completed the Turkey Health Literacy Scale, 32-Item Questionnaire (TSOY-32) as the second part of the form. The TSOY-32 was developed by Okyay et al based on the theoretical structure of the European Health Literacy Survey Questionnaire study.[6] This self-report scale with 32 items was developed to

measure the HL of individuals over 15 years of age. Participants' responses were recorded on a 5-point Likert scale ranging from 1 (extremely difficult) to 4 (extremely easy). Code 5 was used for the response "I have no idea." The overall HLL score was calculated using the following formula:

$$HLL = [(Questionnaire\ mean - 1) \times (50/3)]$$

The HLL scores, ranging between 0 and 50, were classified according to cutoff points as inadequate (0 < HLL ≤25), problematic limited (25 < HLL ≤33), adequate (33 < HLL ≤42), and excellent (42 < HLL ≤50). Four dimensions of HL in health care, disease prevention, and health promotion were assessed: access/obtain information relevant to health, understand information relevant to health, process information relevant to health, and apply/use information relevant to health.

Clinical Examination Measures

All clinical examinations were performed by a single calibrated examiner (SEM). To assess intraexaminer reliability, whole-mouth probing depth (PD) scores were measured twice 5 days apart in 5 subjects who did not participate in the study. The first and second measurements were 96.80% compatible with each other, and the Cohen's kappa value was 0.95, which means that the strength of agreement is "almost perfect."

Clinical periodontal parameters were recorded at the mesio-buccal, mid-buccal, distobuccal, mesiopalatal, mid-palatal, and distopalatal sites of all teeth present, except the third molars. The parameters consisting of plaque index (PI),[15] GI,[16] bleeding on probing (BoP), PD, and clinical attachment level (CAL) were recorded using a University of North Carolina periodontal probe (PCPUNC15, HuFriedyGroup, Chicago, Ill, USA).

PI, ranging between 0 and 3, ascertains the thickness of microbial dental plaque along the gingival margin. The 6 aforesaid sites were scored for PI. The PI level of a patient is defined as the mean value of the sum of given scores.[15] The interpretation of the PI scores is as follows:

> 0: No plaque
>
> 1: A thin plaque layer at the gingival margin, only detectable by scraping with probe. Undetectable with naked eyes.
>
> 2: Moderate layer of plaque detectable with naked eyes.
>
> 3: Abundant plaque along gingival margin and interdental areas.

The GI records gingival inflammation, and similar to PI, 6 sites of each tooth were scored. The mean value of the sum of given scores ranges between 0 and 3 and gives the patient's GI level.[16] The scores of the GI and their clinical meanings are as follows:

> 0: Healthy gingiva, no inflammation and bleeding, no discoloration.
>
> 1: Mild inflammation, slight erythema without bleeding.
>
> 2: Moderate inflammation, erythema with bleeding.
>
> 3: Severe inflammation with a tendency for spontaneous bleeding, severe swelling.

BoP was calculated with the ratio of the number the sites with bleeding following probing to the number of all sites and showed as a percentage. The distance from the gingival margin to the base of the gingival sulcus/periodontal pocket is defined as PD, while the distance from the cementoenamel junction to the base of the gingival sulcus/periodontal pocket is described as CAL.

Follow-Up and Evaluation of Adverse Pregnancy Outcomes

The following information on pregnant women and their babies who participated in the study was obtained from obstetricians through consultation:

- To determine whether the mother was diagnosed with pre-eclampsia during pregnancy,
- In which week of pregnancy the birth took place,
- Birthweight of the newborn.

The following clinical data were considered in conjunction with the above information when evaluating adverse pregnancy outcomes.

In a normotensive patient, an increase in systolic blood pressure to ≥ 140 mmHg or diastolic pressure to ≥90 mmHg with any following occasions after 20 weeks of gestation is defined as preeclampsia. These occasions are listed as proteinuria; platelet count <100 000/μL; impaired liver function, as evidenced by abnormally elevated liver enzymes up to twice the normal concentration or persistent severe right upper quadrant or epigastric pain; renal failure with a serum creatinine level >1.1 mg/dL (97.2 μmol/L) or double serum creatinine; pulmonary edema; or new-onset cerebral or visual disturbances.[17]

The preterm birth is defined as babies born alive before 37 weeks of gestation are completed. According to the WHO, LBW is described as a birthweight of less than 2500 g (up to and including 2499 g).

Statistical Analysis

The data obtained from the participants were transferred to the Statistical Package for the Social Sciences, version 24.0 (IBM Corp.; Armonk, NY, USA) program for statistical analysis. Descriptive analyses were performed on the transferred data and obtained descriptive values were displayed as minimum and maximum values, mean, SD, frequencies, and percentages. The Shapiro–Wilk test was used to check whether the quantitative variables had a normal distribution, and since $P <.05$, the distribution was accepted as not normal. For this reason, nonparametric statistical tests were used in data analysis. Means of non-normally distributed numerical variables and categorical variables of the participants in the abovementioned 2 study groups were calculated with the Mann–Whitney U-test and chi-square test, respectively. Bivariate relationships among HLL, periodontal parameters, and adverse pregnancy outcomes were evaluated using Spearman's correlation. Statistical significance was established at the $P <.05$ level.

RESULTS

Table 1 shows an intergroup comparison of pregnant and nonpregnant participants' demographic characteristics and oral health behaviors. As shown in Table 1, the mean age of participants in both groups was similar ($P >.05$). The results showed that the majority of participants in both groups had a college/university or higher education degree and a middle income, with no statistically significant differences between groups ($P >.05$). Moreover, the intergroup comparisons showed that the frequency of toothbrushing and daily flossing were statistically similar ($P >.05$). About 61.5% of pregnant women and 57.1% of nonpregnant women brush their teeth twice daily. However, it

Table 1. Demographic Characteristics and Oral Health Care Habits of the Participants

Age		Pregnant Women	Nonpregnant Women	P*	P**
	Mean ± SD (minimum–maximum)	30.23 ± 4.07 (23-37)	30.43 ± 5.50 (21-40)	.685	
Education level, N (%)	Primary school	20 (18.9)	24 (21.4)		.372
	High school	31 (30.8)	38 (34.3)		
	College/University	33 (31.5)	34 (30.0)		
	Postgraduate degree	20 (18.8)	16 (14.3)		
Monthly income, N (%)	Low	5 (5.0)	16 (4.3)		.648
	Middle	80 (76.9)	80 (71.4)		
	Upper	19 (18.1)	16 (14.3)		
Brushing, N (%)	Once/twice a week	8 (7.7)	10 (8.9)		.695
	Once a day	32 (30.8)	39 (34.0)		
	Twice a day	64 (61.5)	63 (57.1)		
Interdental cleaning, N (%)	No	72 (69.2)	88 (78.6)		.678
	Yes	32 (30.8)	24 (21.4)		

*Mann–Whitney U-test, P <.05.**Chi-square test, P <.05.

must be noted that these frequencies are not ideal. In addition, a considerable number of pregnant and nonpregnant participants did not floss daily (Table 1).

The periodontal status of the patients included in the study is shown in Figure 1A. Based on these data, periodontally healthy individuals in the total population are 3.7%. When we examine the patients in the groups in terms of their periodontal status, it can be seen that about 85% of pregnant women and about 43% of nonpregnant women suffered from gingivitis. Regarding periodontal parameters, as the objective indicators of gingival inflammation, the GI and BoP values of pregnant participants were significantly higher than those of nonpregnant women (P=.007 and P=.034, respectively). In contrast, no significant differences were found for other clinical periodontal parameters (Figure 1B).

As shown in Table 2, pregnant women had higher HLL than nonpregnant individuals (P=.022). The results of pregnant women showed that 23.1% had problematic-limited, 30.8% had adequate, and 46.1% had excellent HLL. In comparison, 50% of the nonpregnant group showed problematic-limited, 35.7% adequate, and 14.3% excellent HLL. Intergroup comparisons of the mean scores for the 4 subdomains of HL were also presented in Table 2. The mean scores for accessing, understanding, and using information relevant to health were higher in pregnant women in the general HL subdomain and in the disease prevention and health promotion subdomain. However, all dimensions of the health-care subdomain were similar between the groups (P >.05).

Obstetricians assessed the pregnant participants to determine the adverse outcomes, and the according to these data, only 3 in 104 pregnant women were diagnosed with preeclampsia. Twenty-four of the 104 babies were preterm and LBW, born at an average of 35 weeks and weighting 2166.66 ± 208.16 g at birth.

Correlation analysis between HLL and periodontal parameters showed no significant bivariate correlations in all participants (P >.05) (Table 3). Similar to this, the results of the correlation analysis performed only in pregnant participants showed no statistically significant correlation between HLL and any periodontal parameter in this group (P >.05) (Table 3). On the contrary, a significant positive correlation was found between HLL and the infant birthweight (r=.465, P <.01). Furthermore, there were significant negative correlations between maternal periodontal parameters and infant birthweight and also birth week (P <.05).

DISCUSSION

To our knowledge, few studies are investigating the relationship between HLL and periodontal status in pregnant women.[18,19]
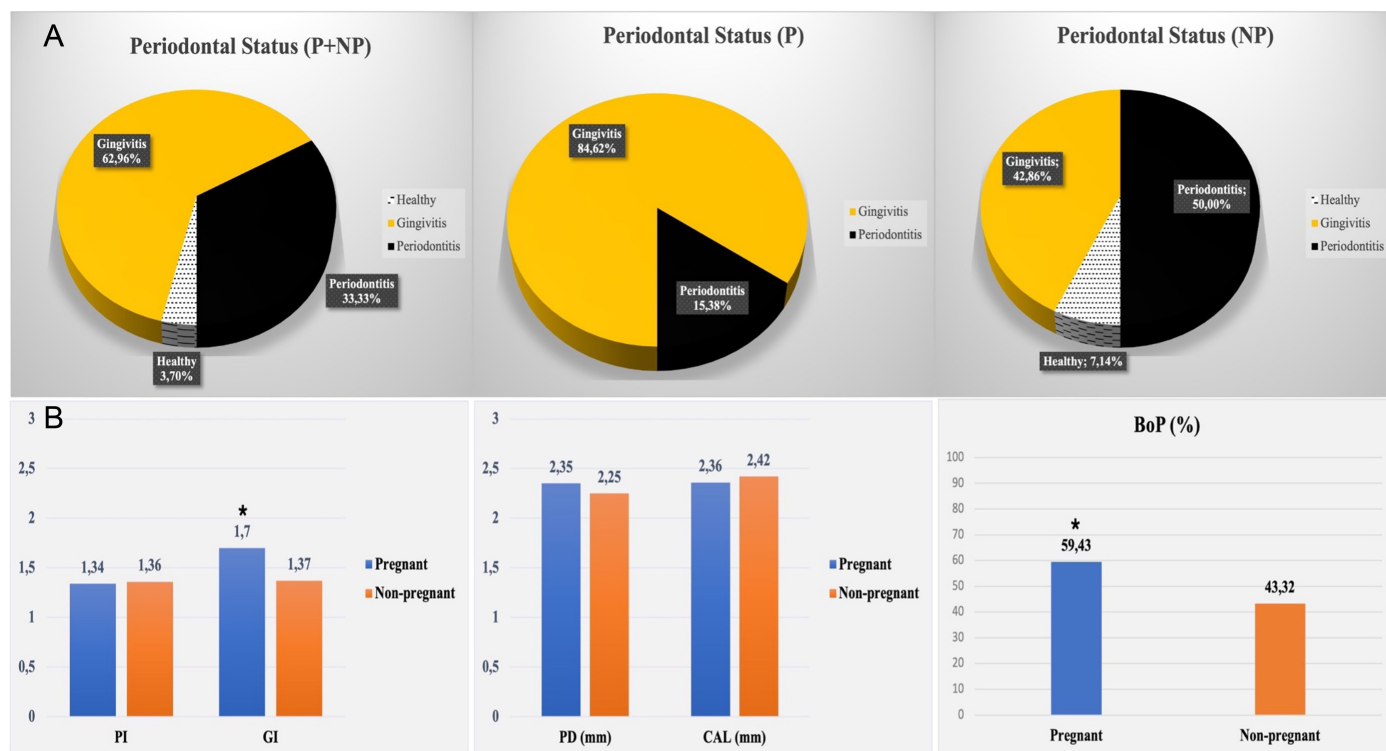

Figure 1. (A). Periodontal status of pregnant (P) and nonpregnant women (NP). (B) Comparison of periodontal parameters between groups (*Mann–Whitney U-test, P<.05.)

Table 2. Data of Health Literacy Levels and Its Subdomains

Dimensions	Pregnant Mean ± SD (Minimum–Maximum)	Nonpregnant Mean ± SD (Minimum–Maximum)	P*
General	39.67 ± 6.18 (30.67-48.00)	33.44 ± 5.87 (26.00-47.33)	.022
Access/obtain information relevant to health	41.99 ± 7.06 (31.25-50.00)	35.71 ± 6.27 (27.08-47.92)	.038
Understand information relevant to health	42.31 ± 5.85 (33.33-50.00)	35.57 ± 6.96 (20.83-50.00)	.012
Process information relevant to health	33.81 ± 7.52 (22.92-45.83)	31.70 ± 7.13 (22.92-50.00)	.519
Apply/use information relevant to health	40.22 ± 6.27 (29.17-50.00)	31.25 ± 8.25 (18.75-45.83)	.008
Health Care			
Access/obtain information	42.63 ± 7.64 (29.17-50.00)	38.10 ± 7.10 (29.17-50.00)	.116
Understand information	42.31 ± 6.33 (33.33-50.00)	36.01 ± 8.89 (20.83-50.00)	.068
Process information	32.37 ± 7.64 (25.00-45.83)	31.55 ± 8.91 (20.83-50.00)	.720
Apply/use information	43.27 ± 8.08 (25.00-50.00)	36.90 ± 8.93 (25.00-50.00)	.068
Disease prevention and health promotion			
Access/obtain information	41.35 ± 7.88 (25.00-50.00)	33.33 ± 06.93 (20.83-50.00)	.009
Understand information	42.31 ± 5.85 (33.33-50.00)	35.12 ± 07.07 (20.83-50.00)	.015
Process information	35.26 ± 7.91 (20.83-45.83)	31.85 ± 08.59 (12.50-50.00)	.325
Apply/use information	37.18 ± 7.31 (25.00-50.00)	25.60 ± 12.21 (08.33-45.83)	.011

*Mann–Whitney *U*-test*P* <0.05.* Bold values shown presented on table are significant

The findings of this preliminary study, conducted in pregnant and nonpregnant Turkish women, included data on HLL, periodontal status, and adverse pregnancy outcomes.

As a concept that influences a person's health-care decisions and actions, the HLL can predictably affect oral health, like its potential impact on overall health. There is growing evidence of an association between periodontal status, a key component of oral health, and some systemic diseases/conditions such as diabetes, cardiovascular disease, and more recently, coronavirus disease 2019.[20,21] The potential association between periodontal status and adverse pregnancy outcomes is a topic that continues to be the focus of periodontal medicine.[22]

Advances in the medical treatment of preterm infants have made significant progress, and the survival rate of these infants with LBW (less than 2500 g) has increased.[23] Developmental delays are more likely to occur later in life.[24,25] Motor and cognitive function

are 2 critical areas of delay,[26] and several studies have shown cross-sectional links between motor and cognitive deficits in preterm and LBW infants.[27,28] The link between periodontal disease, prematurity, and LBW has been shown in several studies.[29,30] The expecting mother must understand the importance of education and oral health to avoid these negative consequences.

The pregnant women showed higher HLL compared to the nonpregnant individuals. Pregnancy can positively influence the motivation of the mother in health issues to achieve the best results for both the mother and child. From this perspective, maternal HLL is an interesting topic, both for its direct positive contribution to maternal and infant health and for its indirect contribution to the maintenance of periodontal health.

Low HLLs negatively affect women's behavior with regard to contraception, health care, and childcare, highlighting a possible link between HLL and adverse pregnancy outcomes.[31] Research on periodontal disease and its negative repercussions on pregnancy demonstrates the importance of periodontal health for both mother and baby.[20] We expected that an increase in HLL in pregnant women would have a more beneficial effect on periodontal status. However, our study did not show a direct relationship between clinical periodontal parameters and HLL. The negative impact of periodontal/oral diseases on general health is a proven fact. However, this proven fact remains largely unknown to the Turkish public.

Our study also indicates that HLL had no effect on promoting the importance of oral health and the need to maintain it. One of the notable findings of this study was that both education and income level were not associated with HLL and periodontal status. Several studies have indicated that these characteristics are significantly positively correlated with HL.[4,11,12] About 50% of pregnant women in our population had more than higher education, and 70% had a balanced income. While a higher level of education is believed to make people more competent at gathering and processing information in any subject, the small sample size of this pilot study may have contributed to this difference. For this reason, it can be seen as an indication that education alone is not sufficient to gain knowledge in a particular area, such as health, but other aspects are also involved.

As our findings show, HLL did not have an effect on periodontal parameters. Oral health care habits are generally expected to be more common in individuals with a high HLL. However, our study

Table 3. Correlation Analysis Among Health Literacy Levels, Clinical Parameters, and Pregnancy Outcomes

Pregnant women (N = 104)	PI	GI	PD	BoP	CAL	HLL	Birthweight	Birth week
PI	-	.738**	.610**	.672**	.624**	−.271	.441**	.538**
GI	.738**	-	.212	.879**	.218	−.315	.399*	.587**
PD	.610**	.212	-	.173	.999**	.299	.687**	.412**
BoP	.672**	.879**	.173	-	.187	−.243	.415**	.388*
CAL	.624**	.218	.999**	.187	-	.277	.675**	.400*
HLL	−.271	−.315	.299	−.243	.277	-	.465**	.133
Birthweight	−.441**	−.399*	−.687**	−.415**	−.675**	−.465**	-	−.835**
Birth week	−.538**	−.587**	−.412**	−.388*	−.400*	−.133	−.835**	-
All (N = 216)	PI	GI	PD	BoP	CAL	HLL		
PI	-	.620**	.407**	.495**	.512**	.182		
GI	.620**	-	.308**	.876**	.302**	.191		
PD	.407**	.308**	-	.271*	.918**	.174		
BoP	.495**	.876**	.271*	-	.266*	.190		
CAL	.512**	.302**	.918**	.266*	-	.023		
HLL	.182	.191	.174	.190	.023	-		

Correlation coefficient values by Spearman's correlation test.
BoP, bleeding on probing; CAL, clinical attachment level; GI, gingival index; HLL, health literacy level; N, count; PD, probing depth; PI, plaque index.
*P <.05. **P <.001.

showed that high HLL did not influence the oral health care habits of pregnant women.

As an objective indicator of the level of oral hygiene, the PI scores were similar in both groups, which is another finding supporting the above result. Consequently, our findings showed that GI and BoP were higher in pregnant women, reflecting increased periodontal inflammation, although PI scores were similar in both groups. The excessive periodontal inflammatory response to local factors in pregnant women can be explained by physiological hormonal changes specific to this period. These findings suggest that oral health in pregnant women is still considered a separate component of general health. Because oral health is part of overall health, the implementation of oral health programs can increase awareness among pregnant women before and during pregnancy. Close collaboration between health care providers, educators, policymakers, the commercial sector, and women is essential to raise awareness of oral health. In addition to the HLL, additional appropriate scales must be developed to highlight the association between oral health and health literacy.

The positive relationship between HLL and birthweight further demonstrates the importance of HLL because, as mentioned above, the motor and cognitive functions of preterm and LBW newborns are slower than those of infants of the same age. As a result, HLL in pregnant women is a phenomenon that affects the postpartum period, as well as the prenatal and perinatal periods. A negative correlation between periodontal parameters and birthweight and week of delivery suggests that maternal periodontal health is essential for an uncomplicated pregnancy.

The most noticeable result of this study was that there were significant positive differences in the access, understanding, and use of relevant information for disease prevention and health promotion among pregnant women. However, this improvement did not change the processing of information. There are many speculative reasons why women may not receive and interpret health information during pregnancy. Since pregnancy only covers the last 9 months of a woman's life, it is reasonable to assume that this is a short period during which detailed medical information can be processed. As pregnant women become more attached to themselves and their unborn child and become more accessible, these educational programs become increasingly crucial. It is important to plan these programs during puberty. Therefore, these assumptions require further research to clarify the process.

A significant limitation of this study is the small sample size of the population. More research should be carried out with a large number of pregnant women. Pregnant women are important role models for their children in forming habits at a certain age. Education, information sessions, and follow-up initiatives to improve oral health awareness among pregnant women are critical for influencing and shaping their children's oral health.

Given the limitations of this study, our findings revealed that pregnancy had a positive impact on HLL. Interestingly, while such beneficial improvements reduced the prevalence of adverse pregnancy outcomes, they still had no impact on the periodontal health of pregnant women. Additionally, findings of this study underscore the importance of educational initiatives to promote awareness of better oral health-care practices and to preserve periodontal health in pregnant women. These findings highlight the significance of developing novel and practical strategies to improve general and oral health care during pregnancy.

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Frequency of Direct Composite Restorations to Anterior Teeth After Orthodontic Treatment: A Retrospective Study

Ortodontik Tedavi Sonrası Anterior Dişlere Direkt Kompozit Restorasyon Uygulama Sıklığı: Retrospektif Bir Çalışma

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ABSTRACT

Objective: The aim of this study was to evaluate the frequency rate of applied direct composite restorations to the upper anterior teeth of patients to improve the aesthetic appearance after orthodontic treatment.

Methods: Records of 1080 patients whose orthodontic treatment was completed in the last 5 years were examined. In total, 104 patients with direct composite restorations of their upper anterior teeth because of a tooth-size discrepancy, tooth-shape malformation, missing lateral incisors, missing central incisors, black triangles, and transposition after orthodontic treatment were identified. Information such as gender, age, Angle classification, and which tooth or teeth were restored and for what reason were recorded. Mean ± standard deviation or n (%) was used for the descriptive variables and the chi-square test was used for the categorical variables. Statistical significance was accepted as $P < .05$.

Results: In the present study, the frequency rate of direct composite restoration to the upper anterior teeth was found to be 9.6% among all patients whose orthodontic treatment was completed. When the reasons for restoration were evaluated, the most common reasons were determined as tooth-size discrepancy (60.6%), malformation (18.3%), and missing lateral incisors (14.4%). In patients with direct composite restorations, the most common reason for restoration in the right (65.2%) and left canine (66.7%) teeth were missing lateral incisors; in the right (80.6%) and left (74.3%) central and right (77.8%) and left (78.7%) lateral teeth, the tooth-size discrepancy was detected.

Conclusion: In some orthodontic cases, direct composite restorations are needed for an appropriate aesthetic appearance.

Keywords: Anterior diastema, direct composite restoration, orthodontic treatment

ÖZ

Amaç: Bu çalışmanın amacı, ortodontik tedavi sonrası estetik görünümü iyileştirmek için hastaların üst ön dişlerine uygulanan direkt kompozit restorasyonların sıklığını değerlendirmektir.

Yöntemler: Son beş yıl içinde ortodontik tedavisi tamamlanan 1080 hastanın tüm kayıtları incelendi. Ortodontik tedavi sonrası diş–boyut uyuşmazlığı, diş–şekil bozukluğu, lateral diş eksikliği, santral diş eksikliği, siyah üçgen oluşumu ve transpozisyon nedeniyle üst anterior dişlerine direkt kompozit restorasyon yapılan 104 hasta tespit edildi. Cinsiyet, yaş, Angle sınıflandırması, hangi diş veya dişlerin ne sebeple restore edildiği gibi bilgiler kaydedildi. Tanımlayıcı değişkenler için ortalama ± standart sapma veya n (%), kategorik değişkenler için ki-kare testi kullanıldı. İstatistiksel anlamlılık $P < ,05$ olarak kabul edildi.

Bulgular: Bu çalışmada ortodontik tedavisi tamamlanan tüm hastalar arasında, üst ön dişlerine direkt kompozit restorasyon yapılma sıklığı %9,6 olarak bulundu. Restorasyon nedenleri değerlendirildiğinde, en sık olarak diş-boyut uyuşmazlığı (%60,6), diş-şekil bozukluğu (%18,3) ve lateral diş

eksikliği (%14,4) belirlendi. Direkt kompozit restorasyon yapılan hastalarda, sağ (%65,2) ve sol kanin (%66,7) dişlerde en sık restorasyon uygulama sebebi lateral diş eksikliği; sağ (%80,6) – sol (%74,3) santral ve sağ (%77,8) – sol (%78,7) lateral dişlerde ise diş – boyut uyuşmazlığı tespit edildi.

Sonuç: Bazı ortodontik vakalarda, uygun estetik görünümü sağlamak için direkt kompozit restorasyonlara ihtiyaç duyulmaktadır.

Anahtar Kelimeler: Anterior diastema, direkt kompozit restorasyon, ortodontik tedavi

INTRODUCTION

The main purpose of orthodontic treatment is to restore the health of teeth and periodontium by eliminating malocclusion and improving the dentofacial appearance.[1] To eliminate malocclusion and to provide an ideal occlusion, it is necessary to restore the tubercle–fissure relationship and overjet–overbite of the dental arches. To accomplish this, the mesiodistal size discrepancies of teeth between the lower and upper dental arches should also be eliminated. This tooth-size discrepancies are determined with conventional and digital calipers or digital scanning of 3-dimensional models of the mesiodistal widths of the teeth.[2] To achieve the goals of orthodontic treatments in patients with tooth-size discrepancies, either removing material from the teeth in the same arch (interdental stripping) or adding material (composite restorations or porcelain veneers) to the teeth in the opposite arch may be required.

Due to tooth size/shape anomalies, tight contact between the front teeth cannot always be achieved after orthodontic treatments. When such situations are detected, a restorative intervention may be required to optimize results.[3] In minor intervention, direct composite restorations are often preferred because of the high success rate. In a recent study,[4] the annual failure rate of anterior direct composite restorations applied after orthodontic treatment was found to be 2.59%. Material chipping and wear were the most common reasons for failure and most of them were classified as repairable. Direct composite restorations are simple, fast, and cost-effective and do not require extensive preparations that could damage healthy tooth structures.[5]

A multidisciplinary approach should be followed to correct the malformation in the anterior region after orthodontic treatment. For best results, it is important to include a restorative dentist on the team.[6] However, it is not known to what extent patients need treatment with a multidisciplinary approach with a restorative dentist. To know this, it is important to know the frequency of direct composite application in an orthodontic clinic.

Guidelines for obtaining informed consent for orthodontic treatment require patients to obtain adequate information about the proposed treatment.[7] As part of the process, patients should be informed of the need for restorative treatment and the potential risks/benefits of treatment. Therefore, knowing the reasons for direct composite application in the orthodontic clinic after the treatment is also important to inform patients.

Although case series and success rates have been evaluated in the studies, no study on the frequency rate of direct composite application has been found in the literature. Determining the need for restorative treatment after orthodontic treatments provides guidance to the clinician in planning the final stage of orthodontic treatment. The aim of this study was to evaluate the frequency rate of direct composite restorations applied to the upper anterior teeth of patients to improve the aesthetic appearance after orthodontic treatment. Determining the applied reasons for the restorations was a secondary purpose. The null hypothesis was that there is no requirement for orthodontics and restorative dentistry collaboration in orthodontic treatment management.

MATERIAL AND METHODS

Photographs and panoramic x-rays of 1080 patients, whose orthodontic treatment was completed in the last 5 years (between January 2015 and January 2020) in the Orthodontic Clinic of the Çukurova University, Faculty of Dentistry, were examined. Ethical approval of the study was obtained from Çukurova University Faculty of Medicine Clinical Research Ethics Committee (Date: 10.01.2020, Number: 95th Meeting, 44th Decision). The present study was a retrospective archive study. The files of the patients whose orthodontic treatment was completed but who were referred to restorative dental treatment to achieve the appropriate esthetic appearance were selected from the archive. Of these patients, those with direct composite restorations to their upper anterior teeth were determined. The exclusion criteria from this study were as follows:

- Patients with cleft lip and palate,
- Patients with craniofacial anomalies,
- Patients with oligodontia.

As a result, 104 patients out of 1080 patients were included in the present study. Reasons for applied direct composite restorations were determined as follows (Figure 1):

- Tooth-size discrepancy (Fig. 1A)
- Tooth-shape malformation (Fig. 1B)
- Missing lateral incisors (Fig. 1C)
- Missing central incisors (Fig. 1D)
- Black triangle formation (Fig. 1E)
- Transposition (Fig. 1F)

The gender, age, Angle classification (Class I, II, III), which teeth from the anterior 6 teeth were filled, the reason for filling, and who the patient's orthodontist was were recorded.

Statistical Analysis

The IBM Statistical Package for the Social Sciences 22.0 software package (IBM Corp.; Armonk, NY, USA) was used for data analysis. Age was presented as mean ± standard deviation and statistics of descriptive variables as n (%). The chi-square test was used to analyze categorical variables. Statistical significance for all analyses was accepted as $P < .05$.

RESULTS

All post-treatment records of the 1080 patients, whose orthodontic treatment was completed, were examined. It was observed

Figure 1. Reasons for direct composite restoration after orthodontic treatment. Intraoral view before orthodontic treatment on the left, during orthodontic treatment in the middle, and after composite restorations on the right. Why direct composite restoration was performed in each patient was explained: (A) Tooth-size discrepancy; because of diastema in the upper lateral and central teeth after orthodontic treatment. (B) Tooth-shape malformation; due to upper lateral teeth with narrow mesiodistal width. (C) Missing lateral incisor; due to congenital upper lateral tooth deficiency. (D) Missing central incisor. (E) Black triangle formation; due to loss of papillae between the upper central teeth. (F) Transposition; due to the transposition of the left canine and lateral.

that 104 patients (9.6%) had direct composite restorations done to their upper anterior teeth. Of these patients, 66 (63.5%) were female and 38 (36.5%) were male. The mean age of these patients was 20.4 ± 4.6 years. It was observed that 20 (19.2%) patients were under the age of 18.79 (76.0%) were aged 18-28, and 5 (4.8%) patients had the age of 29 and above. Table 1 presents the reasons for the direct composite restorations.

The evaluation in terms of gender showed that the Angle classification and the reasons for restoration were similar for men and women (Table 2). There was no gender difference regarding the teeth (Table 3).

Restorations regarding tooth-size discrepancies were similar ($P=.402$) for all Angle classifications (Class I, II, III): 66% for Angle Class I, 54% for Class II, and 71.4% for Class III. Missing lateral incisors were the only statistically significant reason for the

Table 1. Reasons for Applying Direct Composite Restorations

	n	%
Tooth-size discrepancy	63	60.6
Tooth-shape malformation	19	18.3
Missing lateral incisor	15	14.4
Missing central incisor	3	2.9
Black triangle formation	2	1.9
Transposition	2	1.9

Table 2. Evaluation of Potential Risk Factors by Gender

	Female		Male		
	n	%	n	%	P
Age groups					
Below 18	12	18.2	8	21.1	.707
From 18 to 28	50	75.8	29	76.3	
Above 28	4	6.1	1	2.6	
Angle classification					
Class I	30	45.5	17	44.7	.937
Class II	32	48.5	18	47.4	
Class III	4	6.1	3	7.9	
Tooth-size discrepancy	38	57.6	25	65.8	.409
Tooth-shape malformation	12	18.2	7	18.4	.976
Missing lateral incisor	11	16.7	4	10.5	.391
Missing central incisor	2	3.0	1	2.6	.907
Black tirangle formation	2	3.0	0	0.0	.279
Transposition	1	1.5	1	2.6	.690

Table 3. Distribution of Teeth with Direct Composite Restoration by Gender

| | Female | | Male | | |
	n	%	n	%	P
Right canine	16	24.2	7	18.4	.491
Right lateral	38	57.6	25	65.8	.409
Right central	21	31.8	10	26.3	.555
Left central	24	36.4	11	28.9	.441
Left lateral	36	54.5	25	65.8	.262
Left canine	15	22.7	6	15.8	.396

composite restoration. In addition, it was observed that the percentage of composite restorations was higher in Angle Class II patients (24.0%) compared to Class I (4.3%), due to missing lateral incisors (P=.022).

The number of direct composite restorations after orthodontic treatment was similar (P=.951) among clinicians (13 different clinicians in total). In addition, the medians of the number of teeth were equal (a maximum of 2 teeth out of 6 in 1 patient).

In patients with direct composite restoration, the most common reason for applications in the right and left canine teeth were missing lateral incisors (Table 4). Composite materials were used for recontouring the teeth.

DISCUSSION

Anterior direct composite treatments are frequently used for tooth enlargement, gap closure, and reshaping of teeth. In this study, the clinical frequency and application indications of patients who were treated with anterior tooth composites after orthodontic treatment were evaluated. According to the results of this study, the null hypothesis was rejected. This study showed that restorative treatment is needed to provide an appropriate esthetic appearance, especially in the maxillary anterior region.

In the present study, patients were classified as cases of tooth-size discrepancy (Bolton discrepancy), tooth-shape malformation (peg-shaped or narrow lateral incisors), missing lateral incisors or central incisor teeth, transposition cases, and cases with a black triangle. The study determined that Bolton discrepancy was a primary reason for composite applications, with 60.6% of the total composite restorations being applied after orthodontic treatment. This is consistent with studies that mention a 5% tooth-size discrepancy in the general population.[8] Evaluating the 1080 orthodontic treatment patients, it was observed that composite resin was applied to 63 patients, which agrees with the literature. However, it should be noted that composite restoration is not performed in every case of Bolton discrepancy. Other options for Bolton discrepancy in orthodontic practice are interproximal reduction (IPR), tooth extraction decision, angulation-inclination changes in teeth, or maxillary molar rotation.

In various studies, differences in the intermaxillary teeth ratios were investigated in ethnic,[9,10] gender,[11,12] and malocclusion groups.[13-16] Some studies found maxillary tooth material excess

in Class II malocclusions[13] and mandibular tooth material excess in Class III malocclusions, while other studies found no significant difference.[17,18] This study also investigated whether there was a relationship between the first Angle classification and tooth-size discrepancy, no significant difference was found.

According to this study, the second reason for the application of direct composite restorations is tooth-shape malformation (18.3%). The peg-shaped lateral tooth is one of the leading tooth-shape malformations. In the present study, this percentage was 1.75% in patients whose treatment was completed. According to a meta-analysis,[19] the prevalence of peg-shaped lateral incisor in the general population is 1.8%, while it was 2.7% in orthodontic treatment patients, and it is 1.35 times more common in women. In our study, peg-shaped lateral incisor rates were also 1.71 times higher in women. It is stated that the percentage of unilateral (0.8%) or bilateral peg-shaped lateral incisor is approximately equal, which is similar to the percentage observed in our study. No relationship was observed between the peg-shaped laterals with the gender or the Angle classification.

In the present study, missing lateral incisors were the third-highest cause for applying direct composite restoration (14.4%). In the case of missing lateral incisors, there are 2 types of treatments in orthodontics: opening or closing the gap.[20] If the gap is closed in the case of congenitally missing lateral incisors, repositioning the canines into the lateral incisor space may well produce an esthetical unsatisfactory result, therefore composite restoration is applied.

If the gap of the missing lateral incisor is closed with mesialization of the canine, the posterior teeth are also located mesially, and a Class II relationship is established. Space closure is indicated in cases of the mesial eruption of the canines or mesial drift within the supporting zone. This may be the reason why the percentage of composite restorations due to the lack of lateral incisors is higher in Class II. On the contrary, orthodontic space opening is preferred in cases of Class I malocclusion, where extractions in the lower arch are not indicated, and in patients with Class III malocclusion, retrognathic profile.

Another finding of the study concerns space closure in patients with missing central incisors. Replacing the central incisor with a lateral incisor, to close the gap due to the smaller mesiodistal width, requires the use of composite materials.

The other indication for composite restorations after orthodontics is black triangles. A black triangle is a gap seen at the cervical embrasure below the contact point of some teeth where the papilla is missing (Figure 1). When teeth are crowded and overlapped, the papilla is not able to grow in the contact area between them. After aligning teeth by orthodontic treatment, this lack of papillae between the teeth becomes visible as a black triangular space. This usually occurs due to root deviation of adjacent teeth either naturally or due to improper orthodontic treatment.[21,22]

Table 4. Reasons for Application in Teeth with Direct Composite Restoration

	Right Canine	Right Lateral	Right Central	Left Central	Left Lateral	Left Canine
Tooth-size discrepancy	5 (21.7)	49 (77.8)	25 (80.6)	26 (74.3)	48 (78.7)	6 (28.6)
Tooth-shape malformation	0	12 (19.0)	4 (12.9)	6 (17.1)	13 (21.3)	0
Missing lateral incisor	15 (65.2)	0	0	0	0	14 (66.7)
Missing central incisor	2 (8.7)	2 (3.2)	0	1 (2.9)	0	0
Black triangle formation	0	0	2 (6.5)	2 (5.7)	0	0
Transposition	1 (4.3)	0	0	0	0	1 (4.8)
Total	23 (100)	63 (100)	31 (100)	35 (100)	61 (100)	21 (100)

The results are presented as n (%) in the table.

Triangular-shaped incisor crowns[23] and long, narrow teeth[24] are all etiological factors for black triangles. In the case where the crowns are triangular-shaped, IPR of enamel between the triangular crowns will broaden the contact area. Changing the contact point gingivally leads to reduced open gingival embrasures. Typically, 0.5-0.75 mm of enamel is removed with IPR to correct black triangles.[25]

Other low-percentage composite restorations were transposition cases. Tooth transposition is defined as the positional interchange of two adjacent teeth within the same quadrant. Its incidence is approximately 0.4%,[26] which is similar to the incidence in our orthodontic population. It occurs more commonly in the maxilla than the mandible.[26,27] The maxillary permanent canine has been reported as the tooth most frequently involved in transposition.[26,28]

The evaluation in terms of gender concluded that the reasons for direct composites and Angle classification were similar for men and women. In cases of missing lateral incisors, the percentage of composite restorations is higher in Angle Class II patients compared to Class I. The lack of difference in other groups might be the low number of patients selected for this study. The percentage of clinicians who made a restorative treatment decision after orthodontic treatment was similar. It is seen that different orthodontists in the same clinic provide 9.6% of their patients with composite restorations after orthodontic treatment. The reason for this might be that, because of their interactions in the same clinic, the physicians have a similar opinion regarding the ideal orthodontic treatment, and the opinions of the consulted restorative dentists are also related.

Direct composite restorations made to the anterior teeth require regular control of the patient. There may be breaks, ruptures, discoloration, or complete falls on the edges of the composite fill. However, today, the success of direct composite restorations is increasing at a level that cannot be ignored. This is caused by both the improved adhesive systems and the color and physical properties of composite fillings that better reflect the properties of the teeth. Compared to prosthodontic treatment, the advantage of contemporary dental composites as a minimally invasive procedure for tooth shape corrections is the minimum loss of dental hard tissue.[29] In a previous study,[30] the failure rate after 5 years of reshaping the anterior teeth and closing diastemas with direct composite restorations was 84.6%. More than 90% of the restorations were clinically categorized as excellent or good. Moreover, failed restorations were successfully repaired, and 100% functional endurance was achieved. Another study[31] reported that restorations placed after orthodontic treatment showed a 93% success rate after a 4-year follow-up. Therefore, the treatment with direct composite restorations is considered an appropriate alternative to indirect restorations.

The percentage of direct composite restorations in patients whose orthodontic treatment was completed was 9.6%. Direct composite restorations after orthodontic treatment are widely used as an option with minimal invasive effects, providing anterior teeth with an esthetic smile, and achieving the ideal arch size and stability. This reveals the importance of a multidisciplinary approach in orthodontic treatment.

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Disinfection Effect of Gaseous Ozone on *Candida albicans* and *Enterococcus faecalis*: A Randomized Clinical Trial in Infected Primary Molars

Gaz Halindeki Ozonun *Candida albicans* ve *Enterococcus faecalis* Üzerindeki Dezenfekte Edici Etkisi: Enfekte Süt Azı Dişlerinde Randomize Bir Klinik Çalışma

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ABSTRACT

Objective: The current clinical randomized study's primary purpose was to investigate the antimicrobial efficiency of gaseous ozone on primary teeth root canals.

Methods: The included teeth were randomly divided into three groups, and in each group, the root canal therapies of 12 primary teeth were done. In group 1, 2.5% sodium hypochlorite was applied as an irrigation agent. In group 2, 0.9% sterile saline solution was combined with 80 seconds OzonyTronX® application. In group 3, 2.5% sodium hypochlorite was applied as an intracanal medicament in combination with 80 seconds OzonyTronX®. Microbial analyses assessed the colonization of *Candida albicans* and *Enterococcus faecalis* before and after the procedure.

Results: Thirty-six primary molars of 36 completely healthy patients (aged 5-10) were included in the study. The results revealed that the percentage decrease in the number of *C. albicans* was higher in group 3 (99.3%). This decrease was statistically higher than group 1 (96.1%) and group 2 (94.2%). Group 1 showed better results in eliminating the viable *C. albicans* versus group 2 ($P = .033$). The decrease in the number of *E. faecalis* was higher in group 3 (99.4%) compared to group 1 (99.1%) and group 2 (98.7%) ($P = .006$). Although the percentage of the unviable microorganisms was higher in group 1, there was no statistical difference versus group 2 ($P > .05$).

Conclusion: Using gaseous ozone alone or in combination with sodium hypochlorite may enhance the success of the antimicrobial stage of primary root canal therapies. It could be an alternative to toxic chemical agents such as highly concentrated sodium hypochlorite.

Keywords: Dentistry, disinfection agents, ozone, pediatric dentistry, primary teeth, root canal treatment

ÖZ

Amaç: Bu çalışmada ozon gazının süt dişi kök kanalları üzerindeki antimikrobiyal etkinliğinin incelenmesi amaçlanmıştır.

Yöntemler: Dahil edilen dişler rastgele three gruba ayrıldı ve her grupta 12 süt dişinin kanal tedavisi yapıldı. Grup 1'de irrigasyon ajanı olarak %2,5 NaOCl uygulandı. Grup 2'de %0,9 steril salin solüsyonu 80 saniye OzonyTronX® uygulaması ile kombine edildi. Grup 3'te %2,5 NaOCl kanal içi ilaç olarak 80 saniye OzonyTronX® ile kombinasyon halinde uygulandı. Mikrobiyal analizler ile işlemden önce ve sonra *C. albicans* ve *E. faecalis*'in kolonizasyonu değerlendirdi.

Bulgular: Tamamen sağlıklı 36 hastanın (5-10 yaş arası) 36 süt azı dişi çalışmaya dahil edildi. Sonuçlar, *Candida albicans* sayısındaki azalmanın Grup 3'te (%99,3) daha yüksek olduğunu ortaya koydu. Bu azalma Grup 1 (%96,1) ve Grup 2'ye (%94,2) göre istatistiksel olarak daha yüksekti. Grup 1'in Candida Albicans üzerindeki antimikrobiyal etkisi Grup 2'ye kıyasla daha yüksek bulundu ($P = ,033$). *Enterococcus faecalis* sayısındaki azalma Grup 3'te (%99,4) Grup 1 (%99,1) ve Grup 2'ye

(%98,7) göre daha fazlaydı (*P* = ,006). Canlı olmayan mikroorganizmaların yüzdesi Grup 1'de daha yüksek olmasına rağmen, Grup 2'ye göre istatistiksel olarak anlamlı bir fark tespit edilemedi (*P* > ,05).

Sonuç: Ozone gazının yalnız ya da sodyum hipoklorit ile kombine kullanımının süt dişi kanal tedavilerinin antimikrobiyal etkinliğini arttırabileceği ve bu uygulamanın toksik kimyasal kanal içi dezenfektanlara alternatif olabileceği düşünülmektedir.

Anahtar Kelimeler: Diş hekimliği, dezenfekte edici ajanlar, ozon, çocuk diş hekimliği, süt dişleri, kök kanal tedavisi

INTRODUCTION

Tooth caries in primary teeth may occur rapidly, and the progressive character of the lesions reveals pulpal damage in a shorter time compared to permanent teeth. Once the pulp is infected, removing the pulp tissue to avoid disseminating the infection through the surrounding tissue and mainly to the germ of the permanent tooth in the neighborhood is the preferable choice in appropriate cases.[1,2] This treatment, named root canal therapies in primary teeth, reveals differences compared to permanent dentition due to the root canal anatomies, larger and enhanced dentinal tubules, accessory canals, and root tip bifurcation. Furthermore, these differences make it impossible to disinfect the root canal of a primary tooth through instrumentation.[3] The root resorption degrees and the germ in the neighborhood of the periapical area are also challenging parts of primary root canal treatments.[4]

Numerous types of infectious agents can colonize in root canals, and the studies assessing primary root canal microbiota revealed that anaerobic strains form the main microorganism population of primary teeth with necrotic pulp.[3,5] Accordingly, *Enterococcus faecalis* (*E. faecalis*) and *Candida albicans* (*C. albicans*) are the main strains isolated from the infected root canals.[6,7] An appropriate disinfection procedure should be applied to achieve a successful root canal treatment, and this protocol consists of 2 main components: mechanical preparation and chemical irrigation.[8,9] In primary teeth, the presence of the lateral and accessory canals and the complexity of root canal anatomy make it impossible to reach all the microbial residuals and remove them by mechanical approaches.[3] By this means, chemical irrigants take a significant part of the root canal disinfection procedure in the primary dentition.[4,7,10,11] Various disinfection and irrigation agents have been used, and sodium hypochlorite (NaOCl) has been preferred as a gold standard in this area.[12-15] Though this agent shows an effective antimicrobial activity, it still has some disadvantages that restrict its use in pediatric patients. The excessive use of NaOCl causes cytotoxic effects and inflammatory responses such as edema, severe pain, ecchymosis, and paresthesia.[3,16] Hence, the search for ideal root canal disinfection agents remains to be a necessity in root canal treatment of primary teeth.[3,6,17]

Ozone is an alternative non-invasive antibacterial, antiviral, and antifungal agent preferred in reducing the number of caries-causing bacteria. Ozone reveals the antimicrobial effect by effectively oxidizing the bacterial cell wall and cytoplasmic membrane.[18-22] Accordingly, it has been used in medicine and dentistry in various areas such as wound healing, caries management, cavity disinfection, root canal therapies, tooth hypersensitivity therapies, temporomandibular joint disorders, and oral diseases.[23]

In literature searches, studies investigating the antimicrobial effect of gaseous, aqueous, and oiled forms of ozone versus NaOCl, and various disinfection agents have been detected.[2-4,24] However, these studies were mainly held on ex vivo conditions, and the application was held on permanent teeth.[17,25-29] In the literature review, no study was detected to assess the antimicrobial effect of gaseous ozone and combined use of it with NaOCl versus the use of NaOCl alone in primary teeth, in vivo. The main purpose of the current study was to investigate the antimicrobial effect of gaseous ozone and the combined use of ozone gas with NaOCl in the disinfection of primary root canals, in vivo, and to find a safe and effective alternative to NaOCl disinfection agents used in deciduous root canal therapies. The study hypothesized that the antimicrobial efficiency of gaseous ozone would be higher than the other groups compared.

MATERIAL AND METHODS

Ethical Approval

The study protocol was approved by Ethical Committee of Ankara University Faculty of Dentistry (Date: 26.10.2010, Number: 3/6). The research was conducted in full accordance with the World Medical Association Declaration of Helsinki, with all amendments. The study was designed in accordance with STROBE guidelines. The legal representatives of the participants and the patients were informed of the study design, and informed consent was obtained from them. All treatment procedures were completed for each patient admitted to our clinics, whether they were a part of the study or not. All the participants were informed that they were free to leave the study if they did not want to attempt the treatment sessions at any time interval.

Case Selection

The study population was detected by G*Power Software based on an effect size of 0.5, an alpha significance level of 5% (0.05), and a beta of 20% (0.20) to achieve an 80%.[30] Accordingly, a total of 36 mandibular second primary molars of 36 children aged between 5 and 10, with no systemic illnesses [American Society of Anesthesiologists -I] were included in the study. Including criteria were as follows: pediatric patients with no use of an antimicrobial agent in the last 3 months, teeth with positive responses to percussion and palpation, no sinus tract and intra-oral, extra-oral swelling, teeth with no pathological and physiological mobility, and restorable with stainless steel crown. Additionally, in radiographical examinations, the selected teeth needed to show the Res(i) and Res (1/4) scores according to the root resorption scoring system (Figure 1).[31] No radiolucency in the peri-radicular tissue and no internal–external root resorption were also among the including criteria. However, the teeth with lesions only in 1/3 percent of the bifurcation area were also included in the study

The patients who are not compatible with including criteria, who cannot adopt the dental treatments, and with whom rubber-dam isolation was not possible were excluded from the study.

The included teeth were randomly divided into three groups, and in each group, the root canal therapies of 12 primary teeth were done. The flowchart of the study design is described in Figure 2.
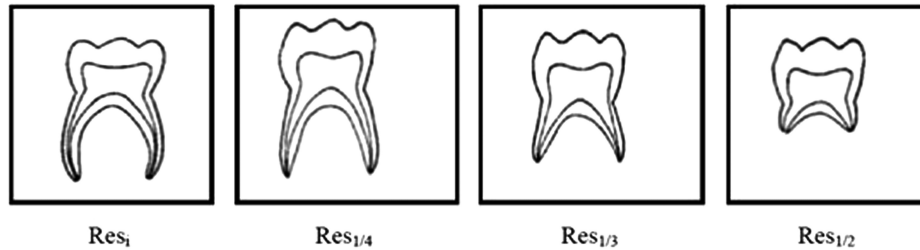
Figure 1. The root resorption degrees for mandibular deciduous molars.
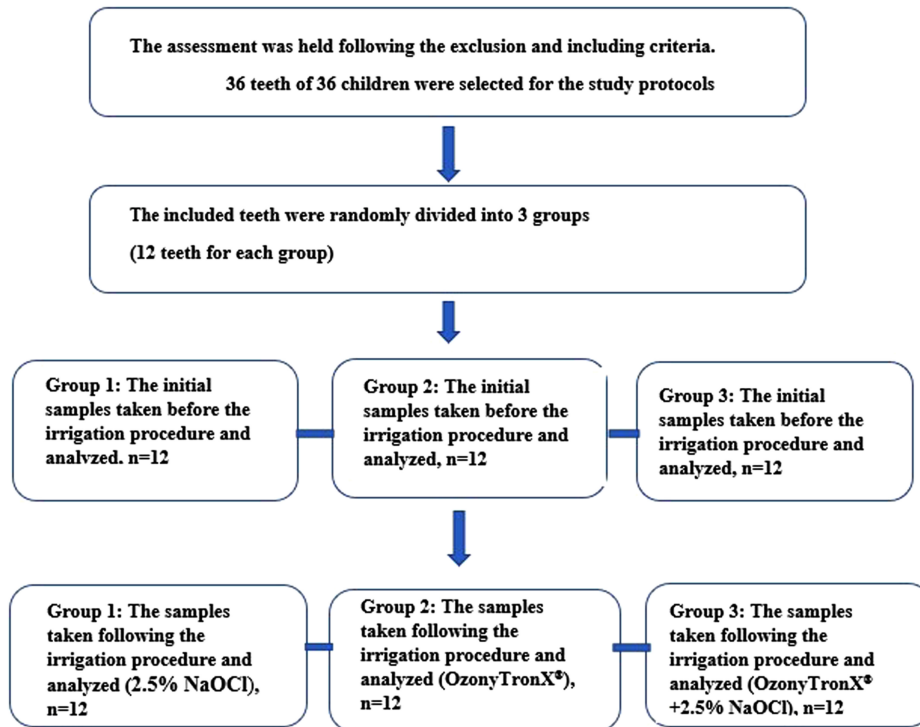
Figure 2. Flowchart of study design.

In group 1 (control group), 2.5% NaOCl was applied as an irrigation agent.

In group 2 (study group), 0.9% sterile saline solution was combined with 80 seconds OzonyTronX® application.

In group 3 (study group), 2.5% NaOCl was applied as an intracanal medicament in combination with 80 seconds OzonyTronX®.

Ozone System
OzonyTronX®, developed in 2005 in Germany, was formed by a central unit, a plasma probe, and an applicator. High-frequency impulses are sent from the central unit to the applicator via a connector. OzonyTronX® is not a generator that produces gaseous ozone. The oxygen molecules (O_2) in the atmosphere are divided into atomic oxygen when the probe contacts the application area. This atomic oxygen combines with O_2 and forms O_3, a highly effective disinfection agent.[32] OzonyTronX® has different probes that differ by application areas. The probe used in narrow (2 cm^3) and curved areas such as root canals and periodontal defects was preferred in the study. According to company recommendations, ozone at a concentration of 100 µg/mL (level 5, 40 seconds) was used with a blue probe for disinfection procedures of root canals. The use of gaseous ozone for 20-120 seconds in dental practices

was approved by Medical Device Authority (MDA) and Technical Inspection Association (TUV). Accordingly, in the current study, the application was made twice (80 seconds) to obtain the maximum disinfection effect.

Clinical Procedures
The root canal length was assessed with a phosphor plaque sensory system using a standard parallel technique (Digora® Soredex, Soredex Medical Systems, Helsinki, Finland) (Figure 3). Regional alveolar inferior block anesthesia was applied, and rubber-dam isolation was done. The plaque and other bacterial accumulations were cleaned off with pumice and a micro-brush. The external surfaces of the teeth, clamps, and rubber liner were also wiped using 0.12% chlorhexidine (CHX; Klorhex™, Drogsan, Ankara, Turkey), 3% H_2O_2 (60 seconds) (Carlo Erba, Emmendingen, Germany), 5.25% NaOCl (60 seconds) (Wizard™, İstanbul, Turkey). The remedies of NaOCl were removed using 5% sodium thiosulfate (HT1005, Sigma-Aldrich Chemie GmbH, Taufkirchen, Germany), and sterile saline solution was used to wash the operation place. The coronal cavity access was performed using a sterile diamond bur (Meisinger 801-16, Germany). The first samples of microorganisms were taken by sterile paper points placed 2 mm shorter than the root canal length for 60 seconds. The samples

Figure 3. Determining the root length using standard parallel technique (Digora® Soredex, Soredex Medical Systems, Helsinki, Finland).

were taken from the largest (distal) canal of the tooth, and meanwhile, the other canal orifices were closed by sterile cotton pellets. The paper points were placed in sterile tubes containing 2 mL reduced transport fluid and transported to Gazi University Faculty of Pharmacy Department of Pharmaceutical Microbiology laboratories. After the first samples were obtained, the mechanical preparation was done with ISO 30 K files (Golden Star Medical, Guangdong). The chemical applications were performed after the mechanical applications were made in both study and control groups.

In Group 1, 10 mL 2.5% NaOCl application followed the mechanical preparation. After 2 mL 0.9% saline application, the second samples were taken by placing a sterile cone in the largest canal of the tooth (distal canal for 60 seconds). The mesiobuccal and distobuccal canals were closed with a sterile cotton pellet while the samples were taken. After the application, the root canal filling was completed with a calcium hydroxide-containing paste (Tg-Pex™, London, England), glass ionomer cement (Ionofil U, Voco, Cuxhaven, Germany) was placed, and the teeth were restored with a Stainless-Steel Crown (3M ESPE, Seefeld, Germany).

In Group 2, the canals were irrigated with 10 mL 0.9% sterile saline. Ozone treatment (OzonyTronX with CA probe) was applied for 80 seconds, and 2 mL 0.9% saline application was performed. Finally, the second samples were taken by the method described in group 1, and the canal treatment was completed the same as mentioned in group 1.

In Group 3, the disinfection of root canals was done using 10 mL, 2.5% NaOCl, and ozone treatment for 80 seconds, and 2 mL 0.9% saline application was performed. Finally, the second samples

were taken by the method described in group 1, and the canal treatment was completed in the same manner as mentioned in group 1. The materials used in the study are listed in Table 1. The clinical procedures are shown in Figure 4.

The Microbial Analyses

The microbial samples were obtained by using a sterile paper point. After the coronal cavity was prepared and the disinfection agents were applied, the initial and the last root canal microbiota was obtained by placing a paper point in the root canals for 60 seconds. These paper points were immediately placed in sterile tubes containing RTF and transported to the pharmaceutical microbiology laboratories.

The colonization of *C. albicans* and *E. faecalis* was assessed by 10 times diluting the samples in PBS (Phosphate buffered saline) and inoculating the samples in MacConkey agar in 3 parallel lines. The identification of microorganisms was made by API (microorganism identification) kits (Biomerieux, Marcy-l'Étoile, France), and the values of alive microorganisms were assessed macroscopically in colony-forming unit (CFU)/mL, in a microaerophilic atmosphere (Anaerocult C), 37°C, following the incubation of 48 hours (Arendorf & Walker 1979).

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 21.0 for Windows (IBM Corp.; Armonk, NY, USA) was used to analyze the study results. Whether the distribution of continuous-measure variables was close to normal was investigated using the Shapiro–Wilk test, and the homogeneity of variances was investigated with the Levene test. Descriptive statistics are shown as mean (standard deviation). The effectiveness of the irrigation agent was evaluated with the "Wilcoxon Sequential Sign Test" using pre-post-irrigation data for in-group comparison. The difference between the groups was also evaluated by performing the "Kruskal–Wallis test" separately on the microbiological data obtained before and after the application. If there was a significant difference due to the Kruskal–Wallis test, the groups causing the difference were determined by Conover's non-parametric multiple comparison test.

RESULTS

In Table 2, the results of the descriptive statistical analyses of the values of *C. albicans* and *E. faecalis* prior to the application and following the applications were shown in Log CFU. According to the study results, the number of viable microorganisms was significantly reduced compared to the initial samples in all groups ($P < .05$).

However, according to the Kruskal–Wallis analyses in which the initial microorganism values versus the values obtained following

Table 1. The Materials and Chemical Agents Used in the Study

| Material	Ingredients	Producer Firm
Xylocaine 10% spray	Lidocain 10%	AstraZeneca, Switzerland
Ultracain D-S ampul	40 mg articain hydrochloride, 0.006 mg epinephrine hydrochloride, 0. 5 mg sodium metabisulfite, 1 mg sodium chloride, 0.3162 mg 0.1 N hydrochloric acid, and 1 mL water for injection	Aventis Farma, Turkey
Saline solution	0.9% isotonic sodium chloride, 0.9 g sodium chloride (154 mEq/L sodium and 154 mEq/L chloride), 100 mL water for injection	İ.E Ulagay, Istanbul, Turkey
Sodium hypochlorite (NaOCl)	5% NaOCl and sterile saline	Wizard, Rehber Kimya San. ve Tic, Istanbul, Turkey
Ca(OH)$_2$ paste	30% Ca(OH)$_2$, 40.4% iodoform, 22.4% silicon oil	Tg-Pex™, London, England
Glass ionomer cement	Florosilicate glass, polyacrylic acid, PHB esters	Ionofil U, Voco GmbH, Cuxhaven, Germany
Gaseous ozone		OzonyTronX®, Mymed, Germany
Stainless steel crown	72% iron, 18% crom, 10 % nickel manganese, silicon, and carbon	3M ESPE, Seefeld, Germany
Reduce transport fluid	NaCl, (NH$_4$)$_2$SO$_4$, KH$_2$PO$_4$, KHPO$_4$, Mg$_2$SO$_4$, NaEDTA, L-cysteine	Merck, Turkey
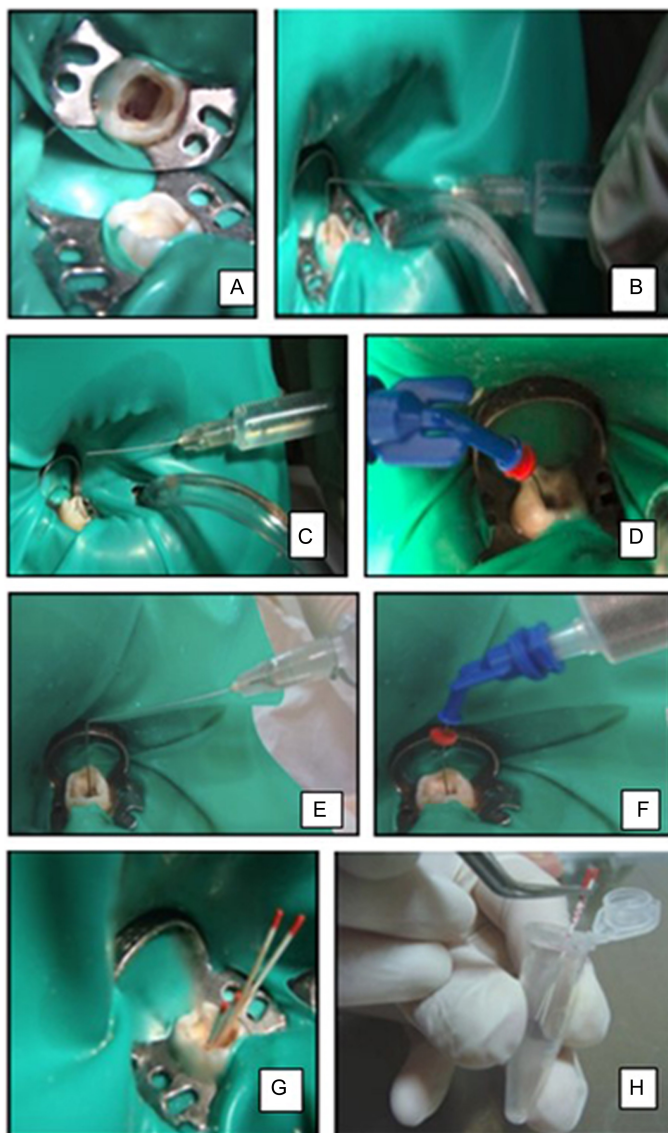
Figure 4. The clinical procedures of different disinfection agents' applications. (A) The coronal access cavity was performed under rubber dam isolation. (B) A patient from Group 1—NaOCl irrigation was performed. (C) A sample from Group 2—saline application. (D). Group 2—ozone application. (E) Group 3—NaOCl application. (F) Group 3—ozone application. (G) The microbial samples were taken by sterile cotton pellets. (H) The microbial samples were placed into RTF-containing tubes and transferred to laboratories.

Table 2. The Mean Values of the Microorganisms Obtained Before/After the Irrigation/Disinfection Procedures (Log CFU)

Before Irrigation	n	(Log CFU) Mean (Standard Deviation)	After Irrigation	n	(Log CFU) Mean (Standard Deviation)
C. albicans			*C. albicans*		
Group 1	12	3.6675 (0.41784)	Group 1	12	.014417 (0.0036546)
Group 2	12	3.4892 (0.54773)	Group 2	12	.022167 (.0156253)
Group 3	12	4.4514 (0.08507)	Group 3	12	.014917 (.014917)
E. faecalis			*E. faecalis*		
Group 1	12	4.1350 (0.63110)	Group 1	12	.015333 (.0025346)
Group 2	12	4.3233 (0.89024)	Group 2	12	.028667 (.0338213)
Group 3	12	4.5417 (0.02488)	Group 3	12	.013500 (.0018340)

Table 3. Decrease in the Amount of *C. albicans* and *E. faecalis* in Percentage Following Irrigation/Disinfection Procedures

Groups	*C. albicans*	*E. faecalis*	P
Group 1	96.1 (5.15)[A]	99.1 (1.06)[D]	.008*
Group 2	94.2 (7.40)[B]	98.7 (1.21)[D]	.015*
Group 3	99.3 (0.82)[C]	99.4 (0.63)[E]	.002*
P	.033*	.006*	

*P < .05.**Same upperletters means no statistical difference

the antimicrobial treatment applications were compared, the number of viable microorganisms revealed higher values in the ozone group (Table 3, Figures 5 and 6).

The Wilcoxon signed-rank test determined the decrease of the microorganisms in root canals in percentage to compare the effect of irrigation procedures (*E. faecalis* and *C. albicans)* (inter-group comparisons-between the groups).

Group 1 showed better results in eliminating the viable *C. albicans* versus group 2 (*P* = .033). The percentage decrease in the number of *C. albicans* was higher in group 3 (99.3%). This decrease was statistically higher than group 1 (96.1%) and group 2 (94.2%).

The decrease in the number of *E. faecalis* was higher in group 3 (99.4%) compared to group 1 (99.1%) and group 2 (98.7%)

(*P* = .006). Although the percent of the unviable microorganisms was higher in group 1, there was no statistical difference versus group 2 (*P* > .05).

Groups 1, 2, and 3 revealed better results in eliminating the viable *E. faecalis* versus eliminating the viable *C. albicans* (*P* = .008, *P* = .015, *P* = .002).

DISCUSSION

In the current study, in which the antibacterial activity of ozone application on *E. faecalis* and *C. albicans* in infected primary tooth's root canals was compared with NaOCl, all agents revealed an antimicrobial activity on both *E. faecalis* and *C. albicans* colonization and the number of the viable microorganism decreased in all groups compared after the applications of irrigation agents. Ozone's combined use with NaOCl was found to be superior to NaOCl alone and the hypothesis of the study was rejected.

For *E. faecalis*, ozone gas application (98.7%) provides a numerically lower effect than the application of NaOCl alone (99.1%); the difference is not statistically significant. However, the effect in the group (99.4%) in which NaOCl and ozone were applied together was significantly higher than the other groups. For *C. albicans*, although the application of ozone gas (94.2%) provides a numerically lower effect than the application of NaOCl alone (96.1%), the difference is not statistically significant. However, the effect seen in the group (99.3%) in which NaOCl and ozone were applied together was significantly higher than the other groups.

In the literature review, according to previous in vitro and in vivo studies, the antimicrobial effect of NaOCl showed better results versus the various antimicrobial agents used (e.g., ozone, saline, laser applications, green tea).[2,3,5] Kapdan et al[2] held a similar study, aimed to assess the effect of different irrigation procedures on the viability of *E. faecalis* colonized in primary incisors' roots (n = 60), in vitro. Gaseous ozone (150 seconds), NaOCl, KTP (potassium titanyl phosphate) laser, and saline solution were used as disinfection agents and techniques. Results of the study showed that NaOCl was superior to all groups compared. The results of the study were similar to the current study we conducted. Öter et al[4] studied the antimicrobial effects of Endosafe, PAD (photo-activated disinfection), diode laser, ozone, and NaOCl on microbial colonization on 100 extracted human primary molars. According
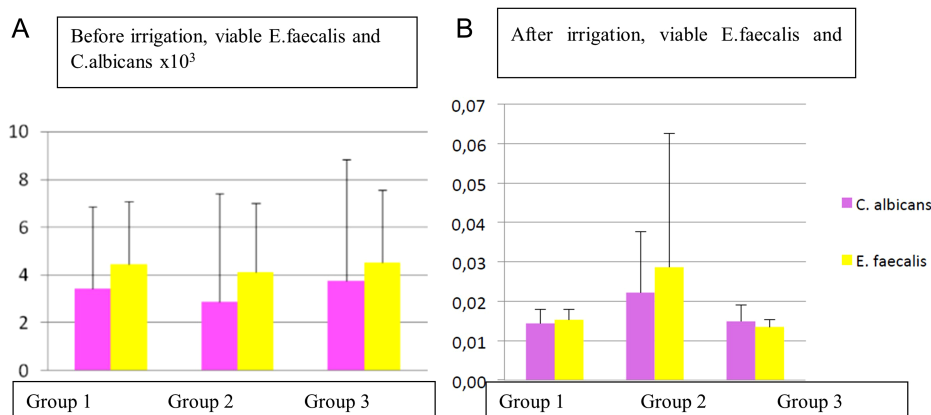
Figure 5. (A) *C. albicans* and *E. faecalis* amounts isolated from root canals before irrigation. (B) *C. albicans* and *E. faecalis* amounts isolated from root canals after irrigation.
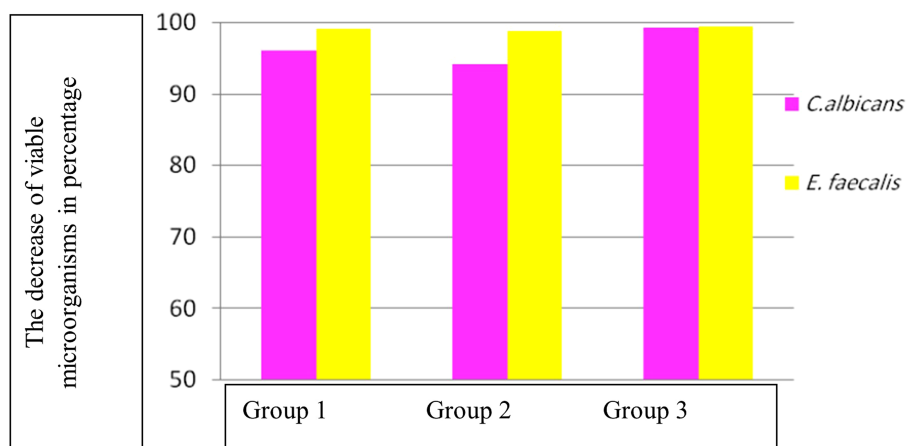
Figure 6. The decrease of viable microorganisms in percentage after the final irrigation compared to before irrigation.

to the results, NaOCl revealed better results than diode laser application. Diode laser was superior to ozone, Endosafe, and PAD groups. The efficiency of ozone was similar to the Endosafe and PAD applications. This study has also revealed that NaOCl application was superior to ozone application by means of root canal disinfection efficiencies.

However, in an in vivo study, Ajeti et al[24] (2018) assessed the disinfection efficiencies of 0.9% NaCl, 2.5% NaOCl, and 2% CHX combined with gaseous ozone. The last group (2% CHX combined with gaseous ozone) revealed superior results compared to the groups studied. The results of this study were different from our findings. However, Ajeti et al[24] studied the effect of the combined use of CHX and ozone versus NaOCl. The additional antimicrobial effect of CHX may enhance the efficiency of ozone gas, and the success of ozone-CHX versus NaOCl could be attributed to the effect of CHX use.

In another previous study, Agarwal et al[3] (2020) compared the antimicrobial efficiency of ozone, green tea, and saline in 60 primary teeth with a single root, in vivo. The microbial samples were taken before treatment, after the irrigation, and on the third day after the treatment. The results showed that the antimicrobial effect of ozone application was superior to green tea and saline treatments. The result of this study was different from the findings of the current study we held. This difference might be attributed to the fact that, in the study

by Agarwal et al,[3] the antimicrobial effect of ozone was compared to saline and green tea. The comparison between ozone and NaOCl was not made in this study, and the results might be changed if the study groups were enlarged, including the application of NaOCl.

The study was held on clinical conditions; although clinical studies are more respectable than in vitro studies, environmental and biological factors may affect the study results. The findings might differ if the study was supported with an in vitro trial stage. Repeating the treatment in a larger patient population may enhance the reliability of the study. Furthermore, only the gaseous form of ozone was obtained and used in the current study. However, different ozone forms, such as oiled ozone and ozonated water, could affect the study results. These could be mentioned as the limitations of the current study

Based on our findings, ozone gas could be an alternative agent in pediatric patients with fear and anxiety, thanks to the disinfection effect with short application time in infected root canals. Furthermore, ozone gas could be an aid to NaOCl in endodontic treatment, thanks to its enhanced antibacterial efficiency when used following mechanical instrumentation. However, long-term follow-up clinical studies are needed to assess the effect of ozone gas application on the success rate of endodontic treatment of primary teeth with periapical/furcation lesions

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The Effect of Tea Tree Oil as a Denture Cleanser on the Surface Roughness of an Acrylic Resin

Protez Temizleyici Olarak Çay Ağacı Yağının Akrilik Rezinin Yüzey Pürüzlülüğü Üzerindeki Etkisi

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ABSTRACT

Objective: This study aims to evaluate the effect of using tea tree oil and chemical agents in denture cleaning on the surface roughness of acrylic resin dentures.

Methods: A total number of 40 acrylic resin samples (65 mm × 10 mm × 3 mm) were prepared for the study. After the samples were enumerated, their roughness values were determined and they were randomly divided into groups (n = 10) and kept in Protefix, Corega, tea tree oil, and distilled water. The time period for the immersion in the solutions was established as 20 minutes. The roughness values were measured again after 720 immersions. The data thus obtained were evaluated using two-way analysis varinace and post hoc Tukey's test.

Results: As a result of the variance analysis, it was determined that the liquid used and the immersion time were not statistically significant ($P > .05$).

Conclusions: It is exciting that natural oils have an important place in people's lives in all aspects and that we can use them in denture cleansing. The surface roughness of base materials is important for both aesthetics and microbiology. Dentists have to consider the effects of tea tree oil on the surface roughness of base material.

Keywords: Acrylic resin, denture cleaners, surface roughness, tea tree oil

ÖZ

Amaç: Bu çalışma, protez temizliğinde çay ağacı yağı ve kimyasal ajanların kullanılmasının akrilik rezinin yüzey pürüzlülüğüne etkisini değerlendirmeyi amaçlamaktadır.

Yöntemler: Çalışma için toplam 40 adet akrilik rezin (65 mm x 10 mm x 3 mm) hazırlandı. Numuneler numaralandırıldıktan sonra pürüzlülük değerleri belirlenmiş ve rastgele gruplara (n=10) ayrılarak Protefix, Corega, çay ağacı yağı, distile suda bekletilmiştir. Çözeltilere daldırma süresi 20 dakika olarak belirlendi. 720 daldırma işleminden sonra pürüzlülük değerleri tekrar ölçülmüştür. Elde edilen veriler, iki yönlü ANOVA ve post-hoc Tukey testi kullanılarak değerlendirildi.

Bulgular: Varyans analizi sonucunda kullanılan sıvının ve daldırma süresinin istatistiksel olarak anlamlı olmadığı belirlendi ($P > ,05$).

Sonuç: Doğal yağların insanların hayatında her yönden önemli bir yere sahip olması ve bunları protez temizliğinde kullanabilmemiz heyecan verici. Temel malzemelerin yüzey pürüzlülüğü hem estetik hem de mikrobiyoloji için önemlidir. Diş hekimleri, çay ağacı yağının temel materyalin yüzey pürüzlülüğü üzerindeki etkilerini dikkate almalıdır.

Anahtar Kelimeler: Akrilik rezin, protez temizleyiciler, yüzey pürüzlülüğü, çay ağacı yağı

INTRODUCTION

In the oral environment, tartar, plaque, and stain formation are observed on dentures as well as on teeth.[1] Conditions that can vary from patient to patient such as the surface properties of dentures, duration of use, oral hygiene, dietary habits, and saliva components point out to possible variations in

the resulting deposits on dentures.[2] Individuals that fail to maintain denture hygiene may, as a result, develop halitosis, denture stomatitis, and other mucosal infections.[3]

Denture stomatitis refers to inflammatory and erythematous formations in the oral mucosa in contact with the base. This condition, dominated by Candida Albicans fungi, was reported to feature colonizations mostly on the inner surface of the base plate.[4]

Denture cleaning can be achieved by mechanical or chemical methods employed individually or in combination.[5] Brushing, ultrasonic cleaners, and microwave ovens can be used for this purpose as mechanical methods. Chemically, denture cleaning can be performed with the use of disinfectants, enzymes, diluted acids, alkaline peroxides, and alkaline hypochlorites.[6]

These chemical agents should not cause any chemical, physical, or mechanical changes on the dentures.[7] Since the dentures will need to be cleaned numerous times with such agents during their period of effective use, it is important that they should offer good efficacy and not damaged dentures.[7]

Given the fact that the users of dentures are mostly of advanced age, it should be foreseen that they will not be able to achieve sufficient denture cleaning through mechanical means. In addition, the microbiological efficiency of mechanical cleaning can be ranked rather low. For these reasons, it is often recommended to hold dentures in chemical solutions, as they offer a method to facilitate denture cleaning. Effervescent tablets are the most commonly recommended chemical agents.[7] Users are urged to keep their dentures in solutions prepared with agents in tablet or powder form. This method can also be stated to complement chemical cleaning with micro-mechanical cleaning owing to the release of oxygen in the solution containing such a tablet or powder.[6]

These products, when used regularly, can remove lightly attached food residues and mucin, but their efficacy falls short in removing settled, thickened plaque.[4]

Tea tree oil was reported as an ideal disinfectant for topical applications as it can easily penetrate the skin and offer antimicrobial efficacy against a wide range of microorganisms without causing irritation.[8] This substance is found in numerous products such as toothpaste, mouthwash, soap, facial cleansers, shampoo, and moisturizer in different concentrations or without dilution.[9]

Plants belonging to the genera *Leptospermum*, *Melaleuca*, and *Kunzea* from the Myrtaceae family are known as "tea tree." These plants do not share any similarities with the true tea plant (*Camelia sinensis*) in terms of taste, smell, and composition.[10] The essential oils present in the leaves of these plants are called "tea tree oil." The plants known as "tea tree" and the essential oils obtained are denominated as follows:[11,12] *M. cajuputi* (swamp tea tree, paperbark tea tree), Cajuput oil, *Kunzea ericoides*, Kanuka oil, *Melaleuca quinquenervia* (broad-leaved tea tree, broad-leaved paperbark), Niaouli oil, *Leptospermum scoparium*, Manuka oil, *Melaleuca Alternifolia* (Australian tea tree), and Australian tea tree oil (ATTO).[11,12]

Australian tea tree oil produced from *Melaleuca alternifolia* stands out as the prominent, thoroughly researched oil of medical and economic value.[12]

Patients using toothpaste containing tea tree oil were observed to enjoy improvements in hygiene and the condition of periodontium.[13]

Good surface properties are required in the materials to be utilized in dental treatments to prevent plaque retention and stain formation, as well as to provide an aesthetic appearance. These materials should be shiny and smooth.[14] Plaque retention was reported in the presence of surface roughness greater than 0.2 μm.[14,15]

Although there are a large number of studies examining the effects of denture cleaning solutions on the mechanical and physical properties of acrylic resins, the literature does not offer any studies conducted with the aim of investigating the effects of antibacterial solutions prepared with tea tree oil on the surface roughness of acrylic resins. Our study aimed to evaluate the effect of the use of tea tree oil solutions on the surface roughness of acrylic resin dentures. The hypothesis of the study is that the use of denture cleaners prepared with tea tree oil will change the surface roughness values of acrylic resins at a lesser degree than the common denture cleaners currently available in the market.

MATERIAL AND METHODS

Ethics committee approval was received for this study from Atatürk University Faculty of Dentistry (Date: 21.04.2022, Number: 51).

About 40 acrylic resin samples were prepared in dimensions of 65 mm x 10 mm x 3 mm in accordance with ISO:1567.[14] The present study employed heat-polymerized acrylic resin (Meliodent, Heraeus Kulzer, Hanau, Germany). In order to prepare standard-sized samples, a wax model (Cavex Set Up Regular, Cavex Holland BV, Haarlem, The Netherlands) was put into a muffle with common methods and this step was followed by wax removal. Heat-polymerized acrylic resin (Meliodent, Heraeus Kulzer) was prepared in line with the manufacturer's recommendations, placed in a muffle, and polymerized. Information on the manufacturer and place of manufacture of the materials used in this procedure is given in Table 1.

After polymerization, any excess around the samples was removed and the samples were polished appropriately. In order to remove residual monomer, the samples were kept in distilled water at 37°C for 48 hours. The samples were randomly divided into 4 different groups according to the solution used (n = 10).

The initial and 10-day roughness values of the samples were measured with a profilometer (Surtronic 25; Taylor Hobson, Leicester, UK). In this study, the measurement length was set at 2.5 mm and the cutoff value at 0.25 mm.[16] The surface roughness value of each sample was calculated by averaging out measurements repeated in 3 different areas on the surfaces of the sample.

The chemical denture cleaning agents used in the study were Corega (Glaxo Smith Kline, Ireland) and Protefix (Helago-Pharma

Table 1. Information on Manufacturers of Denture Cleaners and Acrylic Resins Used in the Study

Material	Manufacturer	Place of Manufacture
Meliodent	HeraeusKulzer	Germany
Protefix	Helago-Pharma GmbH An der Schleifmühle 2	Germany
Corega	Glaxo Smith Kline	Ireland
Tea tree oil	Toroslar Doğal ve Kozmetik Ürünler A.Ş.	Turkey

Table 2. Breakdown of Obtained Values (n = 10)

	Time							
	At the Start				10 Days Later			
Solution of Immersion	Minimum	Maximum	X	SD	Minimum	Maximum	X	SD
Protefix	0.300	1.19	0.852	0.261	0.500	1.61	1.05	0.348
Corega	0.490	1.56	0.802	0.320	0.320	1.42	0.849	0.303
Tea tree oil	0.430	1.13	0.770	0.242	0.380	1.12	0.701	0.198
Distilled water	0.460	1.23	0.907	0.242	0.360	1.12	0.684	0.205

Table 3. Comparison of Solutions by Surface Roughness Values

Solution		Difference Between Averages	SE	df	t	Ptukey
Protefix	Corega	0.1235	0.105	36.0	1.179	0.644
	Tea tree oil	0.2135	0.105	36.0	2.038	0.193
	Distilled water	0.1535	0.105	36.0	1.465	0.468
Corega	Tea tree oil	0.0900	0.105	36.0	0.859	0.826
	Distilled water	0.0300	0.105	36.0	0.286	0.992
Tea tree oil	Distilled water	−0.0600	0.105	36.0	−0.573	0.940

GmbH An der Schleifmühle 2, Germany), which are easily accessible in our country and belong to the alkaline peroxide group. These denture cleaning agents are available in the market in the form of effervescent tablets. While Corega and Protefix effervescent tablets were prepared with 1 tablet each placed in 200 mL lukewarm water in line with the recommendations of the manufacturer, tea tree oil was used in its pure form as obtained through herbal distillation (Taurus Natural & Cosmetics Inc., Turkey). About 15 mL of tea tree oil was added to 85 mL of water. This concentration was used in the present study due to the significant efficacy reported for a tea tree oil concentration of 15%.[17] The samples in the control group were kept in the distilled water.

In the literature, the immersion times employed in similar studies for solutions vary from 5 minutes to 8 hours.[18,19] In order to compare the results accurately, all the solutions used were kept for an equal period of time.[18,20,21] Acrylic resin samples and solutions were kept in 100 mL capped plastic containers.

As the solutions are to be renewed once every 8 hours[18] and 72 immersions of 20 minutes each will be completed in 1 day, the samples were immersed in the solutions for a period of 10 days to simulate 720 individual uses.[18] Baseline measurements and 10th-day measurements were evaluated using two-way analysis variance (ANOVA) and post hoc Tukey's test (α = ,05).

Statistical Analysis

The data obtained in this study were evaluated with two-way ANOVA and Tukey's post hoc comparisons at a significance level of $P < .05$ Statistical Package for Social Sciences (SPSS) version 20.0 software (IBM Corp.; Armonk, NY, USA).

RESULTS

An examination of the results of the analysis of variance employed for the evaluation of collected data statistically indicated that the liquid used and immersion time were not significant ($P > .05$), while the interaction between the liquid used and immersion time was significant ($P < .05$).

The minimum, maximum, and average levels and standard deviation results of the values obtained are shown in Table 2.

The surface roughness values were observed to have increased the most after 10 days in the samples immersed in Protefix, followed by samples immersed in Corega, and to have changed on a decreasing trend in samples kept in tea tree oil.

Table 4. Comparison of Surface Roughness Values by Time

Time	Difference Between Averages	SE	df	t	Ptukey
Initial Measurement—10th-day measurement	0.0127	0.0423	36.0	0.301	0.765

An evaluation of the results of the post hoc Tukey multiple comparison test assessing the roughness values by individual solution (Table 3) and immersion time (Table 4) established that the difference between the surface roughness values was not statistically significant ($P > .05$).

DISCUSSION

A decrease was found in the surface roughness values of acrylic resins kept in tea tree solution, which can be used as a denture cleaner, but the hypothesis of the study was rejected because this decrease was not found to be statically significant.

Efforts to eliminate plaque and ensure hygiene surely play an important role in the longevity of removable dentures. Tablets used for these purposes generally do not contain abrasives and they achieve the cleaning effect with surfactant and antimicrobial activity with hydrogen peroxide, alkaline peroxide, radical oxygen, and peracetic acid.[22] It has been reported that the activity that occurs in the solution of alkaline or hydrogen peroxides in water causes dissolution in the organic matrix in the polymer structure.[23] It has also been reported that the roughness of the acrylic base increases with the use of chemical cleaning tablets.[24] In the present study, it was determined that the chemical cleaning agents are used to increase the surface roughness values of acrylic, which may be due to the dissolution they create in the acrylic structure.

In this study, a significant increase was observed in the roughness values following the exposure of heat-polymerized base to denture cleaners;[25] but in another study, it has been reported that heat-polymerized resins exposed to chemical cleaning agents have less surface roughness changes than injection-molded thermoplastic resins.[26] The fact that the change in the roughness values was not statistically significant in the present study may be attributed to the use of heat-polymerized acrylic.

Even though studies employing cleaners available in the market as effervescent tablets indicate a significant increase in the roughness values of polymethyl methacrylate resins,[27] there are also studies that conclude that surface roughness does not vary with the use of Corega tablets.[19,27] In the present study, although

surface roughness increased in the Corega group, such increase was not statistically significant.

The present study measured surface roughness with a profilometer as in numerous other evaluations of resin roughness.[28] What we express as "Ra" refers to the surface roughness parameter. The use of this device is significant in that it secures the comparability of the results with those of the other studies. In addition, its ease of measurement and calculation can be considered as an advantage.[23] However, there is a perceived disadvantage in the two-dimensional nature of the resulting measurement.

Higher surface roughness increases microorganism retention. It has been reported that the microorganism colonization on the base decreases when Ra is below 0.2 μm.[25] In the present study, it was found that tea tree oil, unlike chemical agents, reduced surface roughness. Such reduction may be attributed to oil adherence on already rough surfaces. On the other hand, the decrease in the control group suggests water absorption. Any decrease in roughness leads to a decrease in colonization.

The majority of the patients using dentures are of advanced age. Accordingly, chemical agents are often preferred for geriatric patients with neuromuscular dysfunction and lack of manual dexterity, who cannot physically perform denture cleaning.[29] Although these chemical cleaners offer strong antimicrobial efficacy, microorganisms developing resistance has heightened the need for the use of natural plant extracts.[29,30] Vegetable oils with antimicrobial and antifungal effects are added to toothpaste and mouthwash.[29]

A study conducted to investigate the effect of a paste containing tea tree oil on oral microflora and periodontal health reported improvements in hygiene and the condition of the periodontium among patients using the paste.[13]

Positive results have been obtained in terms of antifungal activity with the addition of tea tree oil to Viscogel-GC soft lining material.[31]

In a study comparing the antimicrobial efficacy of tea tree oil with that of chlorhexidine gluconate and fluconazole on acrylic resin, it was reported that tea tree oil was equally effective on Candida with chlorhexidine and superior to fluconazole.[32] The critical value of the present study lies in its estimation that the decrease in surface roughness values and the reduction of bacterial colonization in acrylic samples exposed to tea tree oil solution. Its effect of reducing surface roughness also suggested that its antimicrobial superiority might be maintained without any loss.

In a study evaluating the effect of the incorporation of tea tree oil in soft linings on the proliferation of *Candida albicans*, 1-, 30-, and 60-day checks were carried out and it was reported that the preparation offered significant efficacy for up to 60 days.[33]

In another study, it was stated that the antifungal activity of 15% tea tree oil was significant in heat-polymerized acrylic resin.[17,33] The present study also employed the same concentration.

It is known that the surface roughness of the materials used in dentistry affects the free surface energy.[14] This implies that the formation of bacterial plaque is directly proportional to the increase in roughness.[34] Surface roughness is also important in the occurrence of stomatitis due to the dentures. In this case, it becomes easier for *C. albicans* to adhere to the rough surface.[14,35]

One relevant study reported that thyme essential oil was superior to certain chemical agents in maintaining the surface roughness values of the base material compared to denture cleaners.[30] However, although the antifungal efficacy of tea tree oil has been investigated in comparison to chemical agents before, our study will offer guidance to the preference of tea tree oil in scientific research, since no such study has been undertaken on the evaluation of resulting changes in surface roughness.

In the present study, it was observed that, among cleaning solutions, Protefix and Corega increased while tea tree oil decreased the roughness.

It is important for the patients using dentures to be guided by their physicians in denture cleaning. They should know about the materials that can increase surface roughness. While informing the patients, we should prioritize cleaning agents that change the surface properties of dentures either slightly or none at all, offer the best antifungal and antibacterial efficacy, and contain the least amount of chemicals or are entirely made up of herbal content. Within the limits of this study, it was observed that tea tree oil reduced prosthetic surface roughness, while chemical agents were found to increase surface roughness in the 10-day evaluation. The present study will be a guide for physicians to recommend tea tree oil more commonly as a substance that we found to reduce the surface roughness value when compared to chemical agents.

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Coronavirus Disease 2019 Pandemic Management Performance of 4 Different Orthodontic Health-Care Institutions Held by Public, Private, and Foundation Systems in Turkey: A Preliminary Study

Türkiye'de Kamu, Özel ve Vakıf Sistemi Tarafından Yönetilen 4 Farklı Ortodontik Tedavi Hizmeti Sunan Kurumun Coronavirus 19 Pandemi Yönetim Performansı: Bir Ön Çalışma

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ABSTRACT

Objective: This article presents a comparison of the coronavirus disease 2019 pandemic management activities between different health-care institutions providing orthodontic treatment services.

Methods: Patients from 1 public university, 1 oral and dental health center affiliated to the Ministry of Health, 1 foundation university, and 2 private dental practices in Bursa and Bolu were asked to complete a questionnaire about the problems they experienced with their ongoing treatments during the coronavirus disease 2019 quarantine process. Descriptive statistics with percentages were performed, and the institutions were compared in terms of their performance in managing the pandemic process based on the answers.

Results: The questionnaire was answered by 1108 people. The comparisons between institutions revealed the superiority of private practices in appointment arrangement frequency by having appointments within 1 month by 19.8%, in communication skills with 4.04 mean value, and in anxiety management by 3.08 mean value of anxiety frequency about treatment elongation when evaluated with a 5-point Likert scale. The rate of not being informed about pandemic management was highest in foundation universities.

Conclusion: The quarantine and coronavirus disease 2019 pandemic showed to have an impact on orthodontic treatments. In private practices, the patient–doctor interaction was more effective. Private practices have the lowest anxiety levels. Only private practices used video calls for communication. Doctors in filiation applications had an important role in the overall welfare of the people. However, this operation had a deteriousle impact on orthodontic appointments and treatment options.

Keywords: COVID-19, delivery of health care, orthodontics

ÖZ

Amaç: Bu makale, ortodontik tedavi hizmeti veren farklı sağlık kurumları arasındaki COVID-19 pandemi yönetimi faaliyetlerinin bir karşılaştırmasını sunmaktadır.

Yöntemler: 1 devlet üniversitesi, Sağlık Bakanlığı'na bağlı 1 ağız ve diş sağlığı merkezi (ADSM), 1 vakıf üniversitesi ve Bursa ve Bolu'daki 2 özel ortodontist muayenehanesinde tedavi gören hastalardan COVID-19 karantina sürecinde devam eden tedavilerinde yaşadıkları sorunlar hakkında bir anket doldurmaları istendi. Deskriptif istatistikler yapıldı ve kurumlar, verilen yanıtlara göre pandemi sürecini yönetmedeki performansları açısından karşılaştırıldı.

Bulgular: Anket 1108 kişi tarafından yanıtlandı. Kurumlar arası karşılaştırmalar, özel muayenehanelerin rutin aylık kontrolleri gerçekleştirebilme oranının %19,8 olduğunu; 5'li Likert ölçeğine göre iletişim becerilerinde 4,04, tedavinin sürecinin uzamasına yönelik kaygı yönetimi başarısında 3,08 ortalama değeri ile üstünlüğünü ortaya koydu. Pandemi yönetimi konusunda bilgilendirilmeme oranı vakıf üniversitelerinde en yüksek bulundu.

Sonuç: Karantina ve COVID-19 pandemisinin ortodontik tedavileri etkilediği gösterildi. Özel muayenehanelerin hasta-doktor etkileşiminde daha etkin olduğu, özel kliniklerde tedavi gören hastaların en düşük kaygı düzeyine sahip olduğu ortaya çıktı . Görüntülü iletişim yolunu yalnızca özel muayenehaneler kullandı. Filiasyon uygulamalarında doktorlar, halkın genel refahında önemli bir role sahipti. Ancak bu uygulamanın ortodontik randevuları ve tedavi seçeneklerini olumsuz etkilediği ortaya kondu.

Anahtar Kelimeler: COVID-19, sağlık hizmeti, ortodonti

INTRODUCTION

Coronavirus disease 2019 (COVID-19) pandemic is a worldwide public health crisis, and dental proficiency is one of the highest risk areas for COVID-19 contamination, considering the hazards associated with aerosol-generating procedures.[1] At the beginning of the pandemic, orthodontists struggled to balance their own safety with their duty to their patients.[2] Turkey's first case of COVID-19 has been confirmed on March 11, 2020.[3] In Turkey, as a first response to the pandemic, the Ministry of Health regulatory authorities has ordered an obligatory postponement of all nonemergent procedures with the inclusion of orthodontic treatments on March 27 and updated the regulations on April 1. According to the COVID-19 advisory guideline of the Ministry of Health, emergent treatment services for orthodontics are defined as "cutting or removing the brackets and the archwire causing ulcerations of the oral mucosa and/or infections" and "application of feeding plate to newborns with cleft lip and palate."[4]

In Turkey, orthodontic health-care services are maintained by public and private providers. While public orthodontic care service is provided through the government by national health-care systems in public university hospitals and oral and dental health centers (ODHC), private health care is maintained by private hospitals or self-employed practitioners and private nonprofit foundation universities.

In Turkey, orthodontic patients were treated by both postgraduate orthodontic specialists and postgraduate students. A graduate dentist who wants to be a specialist can continue their postgraduate education via 2 programs: specialization and doctorate program. However, while graduate students who continue specialization education program are entitled as research assistants and paid by the government, doctorate (Ph.D.) students are not. In Turkey's universities, orthodontic treatment service is generally maintained by Ph.D. students and research assistants under the supervision of an authorized faculty member. On March 13, the Republic of Turkey Council of Higher Education Board stated the universities would be closed within the scope of COVID-19 measures, and these regulations would be valid for Ph.D. students as well. These restrictions were not inclusive for authorized academic staff and research assistants. Also, on March 20, most specialists working for ODHC were assigned within the scope of the filiation applications to find and determine the source of the COVID-19 cases and protect the well-being of positive cases, including people who have had contact with the positive patients.[5,6] Thus, these specialists could not provide orthodontic treatment services for a long time. During this period, all institutions used circumstance-specific protocols. While some closed down completely, some continued to provide emergency services only, and some provided a combination of treatments at the practice and remote sessions. Hereby, patients who received orthodontic treatment services from different institutions were also affected at different rates.

Health institutions aim to provide equal, fair, and high-quality services to all parts of society. Measurements for efficiency, quality, and satisfaction that are made during an emergency will reveal the current condition and possible solution methods.

Accordingly, the current study aims to evaluate the public and private sector performances preliminarily, under the light of the questionnaire results obtained from four different institutions across the key domains of management of the pandemic. The null hypothesis is "There was no difference between the institutions in terms of pandemic management activities."

MATERIAL AND METHODS

This study was approved by the Biruni University Ethics Committee (Date: 28.05.2020, Number: 40-28).

During the quarantine measures, a questionnaire form consisting of 11 questions, 3 of them (Q1, 2, 3) were demographic and 8 of them (Q4-Q11) were related to the pandemic process, on the basis of systematic literature review and through discussions with clinicians to be answered by the orthodontic patients (Table 1).

A Google Forms questionnaire (Google LLC, Mountain View, Calif, USA) was sent to 2200 patients who were being treated at 1 public university, 1 oral and dental health center affiliated to the Ministry of Health (ODHC), 1 foundation university, and 2 private dental practices in Bursa and Bolu in Turkey. Patients being sent the form were not considered whether they were treated by a faculty member or Ph.D. students or research assistants. However, all patients in ODHC and private practices were treated by a specialist. The link for the questionnaire was sent by WhatsApp Messenger (WhatsApp Inc., Menlo Park, Calif, USA). Consent was obtained from the families of the patients who were under 18 years of age.

Participators were asked about demographic information, whether or not their orthodontist informed them about pandemic management and their ongoing orthodontic treatment, and if they have gotten in contact with their doctor in case of a problem with their treatments—if yes—which communication tool they have used, whether or not the orthodontist has managed to solve their problem remotely, and how long it took to get an appointment at the practice. Also, participants were asked if they have consulted another orthodontist in case of an

Table 1. Questionnaire Applied to Orthodontic Patients

Q1: What is your gender?
( ) Male
( ) Female
Q2: How old are you?
( ) 6-12 years
( ) 12-18 years
( ) 18-36 years
( ) 36 years and above
Q3: In which institution does your orthodontic treatment continue?
( ) Public university
( ) Foundation university
( ) Private clinic
( ) Oral and dental health centers affiliated to the Ministry of Health
Q4: How long did you not get an appointment during the COVID-19 pandemic?
( ) 0-1 month
( ) 1-1.5 months
( ) 1.5-2 months
( ) 2-2.5 months
( ) 2.5-3 months
( ) 3 months and above
Q5: During the COVID-19 pandemic process, did you go to a health institution for urgent treatment?
( ) Yes
( ) No
Q6: Have you been able to contact your doctor when you needed it?
( ) I did not find any need to contact my doctor
( ) Never
( ) Rarely
( ) Sometimes
( ) Often
( ) Always
Q7: If you were able to contact your doctor, was your doctor able to solve your problem? (If you did not find any need to contact your doctor at all, please skip this question.)
( ) No answer
( ) Never
( ) Rarely
( ) Sometimes
( ) Often
( ) Always
Q8: How did you mostly contact your doctor during the COVID-19 pandemic process? (If you did not find any need to contact your doctor, you can skip this question.)
( ) No answer
( ) I have not managed to contact my doctor
( ) SMS
( ) WhatsApp
( ) Social media
( ) Videoconference
Q9: Have you gotten help from another orthodontist/dentist to solve your problem apart from your own doctor during the COVID-19 pandemic? (If you did not need any help, please skip this question.)
( ) Yes
( ) No
Q10: Did your doctor inform you about pandemic management?
( ) Yes
( ) No
Q11: Have you ever worried about the prolongation of your treatment process?
( ) Never
( ) Rarely
( ) Sometimes
( ) Often
( ) Always

COVID-19, coronavirus disease 2019; SMS, short message service.

emergency and how worried they were about the elongation of their treatments. The questionnaire was available to complete from June 1 to July 1, until the beginning of "back to work policy." A 5-point Likert scale was performed for the sixth, seventh, and 11th questions.

Statistical Analysis

Responses were obtained and tabulated in Microsoft Excel (Microsoft, Redmond, Wash, USA) for statistical analysis. Descriptive

statistics were performed for Q1, 2, 3. The Shapiro–Wilk test was applied to test the normality of distribution and P was found to be >.05. Thus, nonparametric tests were performed.

The comparison of behaviors between 4 institutions were analyzed with Fisher's exact test for Q4 and 5 and Q8, 9, 10 and Kruskal–Wallis and Mann–Whitney U-test were used for Q6, 7, and 11. Statistical analysis was performed with MedCalc statistical software, Version 12.7.7. A value of $P < ,05$ was considered statistically significant. Post hoc power analysis was performed using the online ClinCalc post hoc power calculator.

RESULTS

Among the 2200 patients who were sent the questionnaire, 1108 people answered the questionnaire. The response rate was 50.36%. 5.4% of participants' ages were between 6 and 12 years, that of 37.5% were between 12 and 18 years, that of 50.4% were between 18 and 36 years, and that of 6.7% were 36 years and over (Q1). Most of the patients were female (Q2). The distribution of patients' treatment institutions was as follows: 464 in private practices (41.9%), 397 in public university (35.8%), 199 in foundation university (18%), and 48 in ODCH (4.3%) (Q3) (Table 2).

When comparative statistics were evaluated, there was a statistically significant difference in terms of the distribution of all parameters according to the institution providing treatment service (Table 3).

The comparison between institutions revealed that private practices were the easiest to create appointments, and they had significantly higher rates of making an appointment for emergencies within 1 month. Similarly, they had the smallest rate of postponing appointments for more than 3 months (Q4). 10.75% of all participants reported going for an emergency appointment during quarantine measures. The rate of patients requiring an emergency appointment was lower in private practices (Q5). The rate of those who could not contact their doctor during quarantine measures was highest in foundation university when compared with private practices and public university (Table 3). The percentage of those who stated that they could contact their doctor was not significantly different between the rest (Q6) (Table 4). When asked if the treatment provider was able to solve the problem that was faced, the answers revealed similar results of satisfaction for all institutions, with a significantly lower rate in the foundation university (Table 4). The most chosen answer was "My problem was always solved" option, with a significantly important dominance among all possible answers (Q7). While the most frequently used tool was telephone (38.1%) and WhatsApp (28.8%), social media (0.5%) and videoconference (0.6%) were the most rarely used methods to communicate (data not shown on tables). The use of WhatsApp was high at the foundation university, while the public university,

Table 2. Demographics of Respondents

		N	%
Gender	Male	330	29.8%
	Female	778	70.2%
Age	6-12 years	60	5.4%
	12-18 years	416	37.5%
	18-36 years	558	50.4%
	36 years and above	74	6.7%
Institution	Public university	397	35.8%
	Oral and dental health center affiliated to Ministry of Health	48	4.3%
	Foundation university	199	18.0%
	Private practice	464	41.9%

Table 3. A Comparative Analysis of National COVID-19 Pandemic Management Performance in Turkey

		Public University		Oral and Dental Health Center Affiliated to Ministry of Health		Foundation University		Private Practice		P
		N	%	N	%	N	%	N	%	
How long did you not get an appointment during the COVID-19 pandemic? (Q4)	0-1 month	7	1.8%	2	4.2%	6	3.0	92	19.8%	<001
	1-1.5 months	14	3.5%	5	10.4%	1	0.5	29	6.3%	
	1.5-2 months	23	5.8%	5	10.4%	5	2.5	93	20.0%	
	2-2.5 months	39	9.8%	6	12.5%	23	11.6	101	21.8%	
	2.5- 3 months	116	29.2%	8	16.7%	67	33.7	81	17.5%	
	3 months and more	198	49.9%	22	45.8%	97	48.7	68	14.7%	
During the COVID-19 pandemic process, did you go to a health institution for urgent treatment? (Q5)	Yes	51	12.8%	5	10.4%	16	8.0%	31	6.7%	.019
	No	346	87.2%	43	89.6%	183	92.0%	433	93.3%	
Have you been able to contact your doctor when you needed it? (Q6)	I did not find any need to contact my doctor	34	8.6%	7	14.6%	29	14.6%	56	12.1%	<.001
	Never	173	43.6%	23	47.9%	53	26.6%	188	40.5%	
	Rarely	30	7.6%	4	8.3%	30	15.1%	21	4.5%	
	Sometimes	34	8.6%	2	4.2%	15	7.5%	43	9.3%	
	Often	41	10.3%	2	4.2%	26	13.1%	27	5.8%	
	Always	85	21.4%	10	20.8%	46	23.1%	129	27.8%	
		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		Mean ± SS Med. (Min-Max)		Mean ± SD Med. (Min-Max)		P*
		3.89 ± 1.43 5 (1-5)		4 ± 1.4 5 (1-5)		3.22 ± 1.5 3 (1-5)		4.04 ± 1.3 5 (1-5)		<.001
If you were able to contact your doctor, was your doctor able to solve your problem? (If you did not find any need to contact your doctor at all, please skip this question.) (Q7)	Not replied	214	53.9%	22	45.8%	113	56.8%	302	65.1%	.001
	Never	18	9.8%	2	7.7%	11	12.8%	17	10.5%	
	Rarely	13	7.1%	0	0.0%	5	5.8%	6	3.7%	
	Sometimes	13	7.1%	1	3.8%	12	13.9%	9	5.5%	
	Often	20	10.9%	3	11.5%	21	24.4%	27	16.6%	
	Always	119	65.0%	20	76.9%	37	43.0%	103	63.6%	
		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		P*
		4.14 ± 1.37 5 (1-5)		4.5 ± 1.14 5 (1-5)		3.79 ± 1.39 4 (1-5)		4.19 ± 1.32 5 (1-5)		.004
How did you mostly contact your doctor during the COVID-19 pandemic process? (If you did not find any need to contact your doctor, you can skip this question.) (Q8)	Not replied	65	16.4%	9	18.8%	66	33.2%	115	24.8%	<.001
	I have not managed to contact my doctor	0	0%	0	0%	0	0%	0	0%	
	SMS	62	15.6%	1	2.1%	11	5.5%	25	5.4%	
	Social media	3	0.8%	1	2.1%	1	0.5%	1	0.2%	
	Phone call	156	39.3%	21	43.8%	49	24.6%	196	42.2%	
	Videoconference	0	0.0%	0	0.0%	0	0.0%	7	1.5%	
	WhatsApp	111	28.0%	16	33.3%	72	36.2%	120	25.9%	
Have you gotten help from another orthodontist/dentist to solve your problem apart from your own doctor during the COVID-19 pandemic? (If you did not need any help, please skip this question.) (Q9)	Not replied	147	37.0%	26	54.2%	80	40.2%	214	46.1%	.005
	Yes	20	5.0%	2	4.2%	13	6.5%	9	1.9%	
	No	230	57.9%	20	41.7%	106	53.3%	241	51.9%	
Did your doctor inform you about pandemic management? (Q10)	Yes	270	68.0%	33	68.8%	89	44.7%	302	65.1%	<.001
	No	127	32.0%	15	31.3%	110	55.3%	162	34.9%	
Have you ever worried about the prolongation of your treatment process? (Q11)	Never	56	14.1%	8	16.7%	18	9.0%	105	22.6%	<.001
	Rarely	38	9.6%	10	20.8%	13	6.5%	82	17.7%	
	Sometimes	98	24.7%	12	25.0%	48	24.1%	119	25.6%	
	Often	92	23.2%	4	8.3%	48	24.1%	74	15.9%	
	Always	113	28.5%	14	29.2%	72	36.2%	84	18.1%	
		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		Mean ± SD Med. (Min-Max)		P*
		3.57 ± 1.35 4 (1-5)		3.42 ± 1.52 3 (1-5)		3.84 ± 1.22 4 (1-5)		3.08 ± 1.47 3 (1-5)		<.001

$P < .05$ Fisher's exact test.
COVID-19, coronavirus disease 2019; Med., median; Min-Max, minimum–maximum; SMS, short message service; SS, sum of squares.
* $P < .05$ Kruskal–Wallis test.

private practices, and ODHC contacted patients mostly by phone. Videoconferencing was not used for communication purposes in any institution other than private practices (Q8). The rate of patients stating that they got help from another orthodontist/dentist to solve their problem—because they needed help—was the highest with patients receiving treatment at the foundation university and lowest in private practices. Participants stating that they have not gotten any help from another dentist/orthodontist was highest at the public university (Q9). During the COVID-19 pandemic, the rate of not being informed about pandemic management was highest in the foundation university (Q10). With this questionnaire, the level of anxiety of the respondents was also evaluated. When the anxiety levels about the delay of ongoing treatment of all participants were checked overall, the anxiety levels were listed as follows: 25.5%: always present; 19.7%: frequently present; 20.3%: sometimes present; 7.7%: rarely present; and 16.9% never present (data not shown on tables). Foundation university patients had the highest and private practice

Table 4. Post Hoc Comparison of Q6-Q7 and Q11

	P		
Post Hoc Pairwise Comparisons	**Q6**	**Q7**	**Q11**
Public university vs. private practice	.356	.993	**<.001**
Public university vs. oral and dental health center affiliated to Ministry of Health	.600	.202	.641
Public university vs. foundation university	**<.001**	**.005**	.035
Private practice vs. oral and dental health center affiliated to Ministry of Health	.899	.191	.172
Private practice vs. foundation university	**<.001**	**.004**	**<.001**
Oral and dental health center affiliated to Ministry of Health vs. foundation university	**.005**	**.005**	.152

P <.008 Mann–Whitney *U*-test (Bonferroni correction).

patients had the lowest rate of anxiety about elongation of their treatment duration (Q11).

The calculated power for this study according to post hoc pairwise comparisons in terms of Q6 and Q7 of ODHC was found to vary between 92.7% and 95.9%. The calculated power being greater than 80% indicated that the sample size is sufficient for the study.

DISCUSSION

In Turkey, orthodontics is a recognized dental specialty, and orthodontic treatments are primarily held by these specialists. According to the latest published data, there are 52 public universities, 661 ODHC, 14 foundation universities, and 10 775 private practices.[7-9] Even if all institutions tried to follow the restrictions and guidance as precisely as possible, differences in action to some extent are inevitable. Thus, this present study aims to shed light on this subject. It is the first detailed survey study comparing pandemic management activities of different health-care institutions providing orthodontic treatment services. At an unprecedented time such as a worldwide pandemic, an online web-based survey is beneficial in terms of producing large amounts of data in a relatively short period of time for a fairly low cost. Thus, it provides a wide view of how things are at a specific era.[10] Using this advantage, our study managed to reach a large sample size, collected data from various regions of the country, and had a homogeneous age and gender distribution.

When the comparative differences between different institutions were examined, there were results worth addressing. According to Hancock et al's study,[11] there was a significant difference between private and public care in terms of the speed of getting an appointment. Our study showed parallel results. Private practice patients were able to arrange emergency appointments more easily compared to others. The first reason for the private practices being more accessible may be due to the Ph.D. students' responsibility of providing treatment was not active because of the regulations. Secondly, this may be related to the disadvantage the ODHC had. Since the treatment providers at the ODHCs were assigned to work for "COVID-19 filiation applications," they were not able to provide treatment service to their continuing orthodontic patients.

The study about the impact of the COVID-19 pandemic on appointments revealed that 25.1% of patients would attend an appointment only in case of emergency. The percentage of patients who required an emergency appointment in our study was lower than that reported in Cotrin et al's[12] results. In addition, the present study allowed for a comparison between institutions and showed the rate of patients requiring emergency appointments were significantly lower in private practices. The significant difference of

shorter intervals between appointments in private practices can be the reason for this result as continuing to have regular visits will decrease the necessity for emergency appointments.

The systematic review by Basu et al[12] on the comparative performance of private and public health-care systems concluded that the private sector is not superior to the public sector in terms of efficiency. However, the public sector appears frequently to lack timeliness and hospitality toward patients. Our findings indicated that the inability of participants to reach their doctors was notably more prevalent at Foundation University, while the differences in this aspect between other institutions were not statistically significant. This observation provides partial corroboration to the earlier mentioned systematic review. The variation in communication frequency can be attributed to the regulations applied on Ph.D. students in foundation universities, which restrict them from serving healthcare services and canalize them to pursue their education online. Actually, the same situation was valid for the Ph.D. students in public universities, as well. However, in contrast to foundation universities, most of the Ph.D. students in public universities are appointed as academic staff. Government regulations required the academic staff to work without any permission to have a leave of absence or to quit because of these particular circumstances of COVID-19. Contrary to all these factors, the highest rate of not being informed about pandemic management shows that this specific university could not manage this situation well. It is not appropriate to generalize this finding to all foundation universities. The next aspect was highly related to the previous one. We were curious about the ability to solve the encountered problems if a communication was possible to be made. Findings showed us similarity between differences in institutions in terms of availability and creating contact. After contact, patients considered their problems to be solved in all institutions except in the foundation university, with a significantly lower rate of solutions to problems. Still, it should be noted that even though there was a significant difference in the comparison between institutions, the ability to solve problems was high in foundation the university, as well. These two findings support each other. Both suggest that communication is a key domain and doctor–patient relationship is the most essential contributing factor to patient fulfillment.[13]

Not only communication but also the communication method is also significant. Remote communication methods prevent spread of the virus by reducing the physical contact between doctors and patients.[14] In this perspective, the utilization of innovative communication tools including phone calls, videoconferencing, messaging via WhatsApp or social media, and e-mails to maintain long-distance care draws attention as an effective opportunity for face-to-face service.[15,16] Petruzzi et al[18] confirmed the use of WhatsApp as a good option for teledentistry. Guidice et al[19] reported that using WhatsApp for monitoring patients limits human contact and decreases the risk of virus dissemination. Currently, WhatsApp is the most commonly used application.[20] Consistent with these reports, in the present study, the most used communication tools during the quarantine measures were the phone and WhatsApp. Videoconferencing was used only by private practices and was the least preferred tool among all the communication utilities. This may be due to the poor resolution of imaging.

As our data revealed, the patients being treated at the foundation university had the highest rate of getting help from outside

institutions. This may be due to the previously mentioned restrictions in Q7. This situation contributes to our understanding of the reason for the rate of getting help from other institutions being the lowest at the public university. The second reason may be economical. The study about the utilization of dental services suggests that the Turkish health insurance system is mainly based on government plans, and this prevents people from using relatively expensive private dental services.[21] We believe that the possibility of public university patients hesitating to seek help from other institutions may be due to their economic status. Finally, the rate of those who got help from another orthodontist/dentist to solve their problem—because they needed help—being lowest at private practices may be due to private practices being able to maintain their routine appointment schedules.

A study that compares public and private hospital care service quality in Turkey shows a lack of communication between the patients and the hospital personnel in Turkish public hospitals.[22] Consistently, this present study showed that doctors in private practices informed patients about pandemic management more than in other institutions. This higher rate of communication could be justified by the private sector being keen on providing a better quality service to be able to compete with the market.[22]

According to a study about the factors affecting duration of orthodontic treatment, every missed appointment tends to elongate the treatment by 1.09 months.[23] This is a predictable outcome and patients usually are able to make this assumption and get worried about the prolongation of treatment process. Peleso et al[23] reported that 48.7% of orthodontic patients worried about delays in their treatment. When the proportion of participants stating "always and often experiencing anxiety about the delay in treatment" were evaluated together, our results were 45.2%. Thus, they are compatible with the aforementioned study. Furthermore, the present study compared anxiety levels among patients between institutions. Foundation university patients had the highest anxiety rate about elongation of treatment duration. Also, as previously discussed, the foundation university had the lowest rate of adequately informing patients. We believe these two findings may be associated with each other and lack of communication may have resulted with the high rate of anxiety.

Evaluating overall, the null hypothesis was rejected, and findings showed that there were differences between pandemic management activities between institutions. Also, our study was not free of problems: First, the participants whose treatments were continuing in different institutions were not represented in equal numbers, and this caused a weakness in homogeneity. If participation to the survey were similar from each health care institution, different findings could have been obtained. Secondly, although the sample size of the study is not small, the number of institutions where the patients received treatment is not enough to make a general assumption. Advantages and disadvantages may be specific to the institutions where the research was conducted. However, despite the limited data, this work provides a preliminary snapshot of the pandemic management activities of different health-care institutions in Turkey by being the study with the largest sample size on the matter so far. Still, for more comprehensive results, further studies are needed.

The quarantine measurements have had an impact on treatment-providing institutions and patients. The research presented here confirms that the relationship between patient and doctor in private practices was more dynamic in terms of communication about pandemic management. In addition to that, the slightest anxiety level was identified in private practices as well. Communication by video calls was only existent in private practices. Although orthodontic procedures were influenced contrarily by filiation applications, specialists in this methodology served a valuable role in the prosperity of general society overall. Ease of communication and having regular appointments stand out as a critical dimension in service quality. There was a negative correlation between pandemic management by adequately informing patients and anxiety levels. A continuum of periodic appointments showed to decrease anxiety. In view of all that has been mentioned so far, one way supposes that creating safe ways to continue patients' treatments under every possible circumstance is important.

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**Current Research in
Dental Sciences**

Craniofacial Growth Differences in Individuals with Skeletal Class III and Class I During Different Growth Periods

İskeletsel Sınıf III ve Sınıf I bireylerin Farklı Büyüme Dönemlerindeki Kraniofasiyal Büyüme Farklılıklari

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ABSTRACT

Objective: The purpose of this study is to compare the craniofacial growth of individuals with skeletal class III and class I structure at different stages of growth periods.

Methods: The study includes 266 untreated individuals with class I and class III malocclusion admitted for orthodontic treatment. The individuals were divided according to their genders— male and female—and growth periods based on the hand–wrist films. The differences between the growth periods and sex groups of class I and class III individuals were statistically evaluated.

Results: In the study, there was no difference between class I and class III in terms of anterior and posterior cranial base length. The cranial base angle was shown to be lower in class III individuals than in class I individuals. Effective maxillary length (Co-A) is significantly lower in class III patients than in class I individuals. Mandibular growth dimensions of the class III and class I groups are similar in the early period however, differences between the two groups increase in later periods. Craniofacial and mandibular sizes were larger in class I and class III males than females. We found that protrusion of the maxillary incisor and retrusion of the mandibular incisor become increasingly evident as development progresses.

Conclusion: In class III and class I individuals, the amount of maxillary and mandibular growth is similar in the early stages of development, whereas in class III individuals the skeletal discrepancy is intensified in the later stages of development.

Keywords: Malocclusion, Angle class III, cephalometry, pubertal growth

ÖZ

Amaç: Bu çalışmanın amacı, iskeletsel sınıf III ve sınıf I yapıya sahip bireylerin farklı büyüme dönemlerindeki kraniyofasiyal büyümelerini karşılaştırmaktır.

Yöntemler: Çalışmaya ortodontik tedavi için başvuran sınıf I ve sınıf III maloklüzyona sahip 266 tedavi edilmemiş hasta dahil edilmiştir. Bireyler cinsiyetlerine (kadın ve erkek) ve el-bilek filmlerine göre büyüme dönemlerine göre ayrılmıştır. Sınıf I ve sınıf III hastaların büyüme dönemleri ve cinsiyet grupları arasındaki farklar istatistiksel olarak değerlendirilmiştir.

Bulgular: Çalışmada ön ve arka kranial kaide uzunluğu açısından sınıf I ve sınıf III arasında fark bulunamamıştır. Kranial kaide açısının sınıf III hastalarda sınıf I hastalara göre daha düşük olduğu gösterilmiştir. Efektif maksiller uzunluk (Co-A) sınıf III bireylerde sınıf I bireylere göre anlamlı derecede düşüktür. Sınıf III ve sınıf I gruplarının mandibular büyüme miktarları erken dönemde benzerdir, ancak daha sonraki dönemlerde iki grup arasındaki farklar artmaktadır. Kraniyofasiyal ve mandibular boyutlar sınıf I ve sınıf III erkeklerde kadınlara göre daha büyük bulunmuştur. Gelişim ilerledikçe maksiller kesici dişin protrüzyonunun ve mandibular kesici dişin retrüzyonunun giderek belirginleştiği bulunmuştur.

Sonuç: Sınıf III ve sınıf I bireylerde maksilla ve mandibulanın büyüme miktarları gelişimin erken safhalarında benzerken sınıf III bireylerde gelişimin ilerleyen safhalarında iskeletsel uyumsuzluk şiddetlenmektedir.

Anahtar Kelimeler: Maloklüzyon, Angle sınıf III, sefalometri, pubertal büyüme

INTRODUCTION

Class III anomalies may arise from the interrelationships of dentoalveolar and craniofacial structures and their combinations.[1,2] Spalj et al reported that 43% of class III individuals had a mandibular protrusion, 19.6% had maxillary retrusion, and 4.7% had both protrusion and retrusion.[3] Although the prevalence of class III anomalies varies based on ethnicity, it is around 12% in the Asian population [4] and approximately 1% in the European American population.[5]

Genetics, congenital, and environmental factors are among the factors that cause class III anomalies.[6] Class III anomalies may also occur due to environmental factors such as congenital anatomical defects, syndromes, nasal congestion (nasal obstruction), sinusitis, septum deviation, mouth breathing due to hypertrophic tonsils and adenoids, tongue size, and position, and forced anterior positioning of the mandible due to premature contacts.[7,8]

Class III cases typically have a negative ANB (A point, nasion, B point) angle,[2,9] increased posterior cranial base (S-Ba) length, decreased anterior cranial base (SN) length[2,10] and cranial base angle (SNBa),[10,11] increased face height, increased mandibular length (Co-Gn), corpus (Go-Gn) and ramus (Ar-Go) size,[2] a glenoid fossa more anteriorly located,[9,12] protrusive maxillary incisors, and retrusive mandibular incisors.[2,10,13,14] In individuals with class III skeletal structure, Wits values decrease over time, and there is an increase in maxillomandibular difference and lower face height.[15]

The growth and development characteristics of craniofacial structures may show different trends in different malocclusions. In studies with class III individuals, the SNBa is smaller, S-Ba increased, maxillary SNA and Co-A dimensions decreased, whereas mandibular dimensions (Co-Gn), gonial angle, and lower face height increased, with protruded maxillary incisors and retrusive mandibular incisors.[2,14,16]

The cranial base, especially the anterior skull base, which forms the ethmoid–maxillary complex with the upper midface, has great importance in craniofacial growth and development. It is said that a disorder in SN growth will often be coupled by midfacial insufficiency.[17] In individuals with class III malocclusions, the posterior cranial base (S-Ba) horizontal growth is insufficient due to early fused synostosis, and thus the condyles and glenoid fossa are located more anteriorly with a smaller SNBa angle.[12,17,18] In the study of Reyes et al, the SNBa angle was reported to be smaller in class III individuals, while the lower anterior face height was found to be higher in advanced stages of development.[11]

According to Ochoa and Nanda,[19] changes in growth and development in boys take approximately 2 years longer than in girls. Maxillary growth slows down after 12 years of age in girls, and mandibular growth slows down after 14 years of age. In males, growth continues until the age of 16 years.[19] Mitani et al[20] compared class III individuals with prognathic mandibles with class I individuals, and their growth rates were found to be similar until puberty but changed in later periods.

In class III individuals, growth potential and shape are important in the decision and success of orthodontic treatment. Considering that the majority of orthodontic treatments are performed during the growth period, identification of the craniofacial growth behavior will be helpful in choosing the right mechanics and timing of treatment in class III patients, especially in terms of the intermaxillary relationship.[21] The H0 hypothesis of this study was determined that there is no difference in the dimensional and angular values of craniofacial structures between class I and class III individuals and genders at different growth periods. This study aims to compare the craniofacial growth of individuals with skeletal class III and class I at different growth periods.

MATERIAL AND METHODS

This retrospective and cross-sectional study was conducted on lateral cephalometric and hand–wrist films of 266 applicants for orthodontic treatment. Individuals were chosen from the orthodontics department's archive using the patient registration program (FileMaker Pro11). This study was approved by Gazi University Clinical Research and Ethics Committee (Date: 26.10.2011, Number: 318).

The following criteria were taken into account in the selection of individuals included in the study, who have not received orthodontic treatment, have no congenital tooth deficiency, skeletal class I (ANB: 0-4°) and class III (ANB < 0°)[22] have an anomaly class I individuals with a balanced facial structure and class III individuals with concave facial structure, individuals without any syndrome, craniofacial anomaly, and cleft lip–palate.

In this study, the individuals were first divided into 2 main groups, skeletal class III (n = 133) and class I (n = 133). Then, these groups were also classified according to their genders as male and female. These groups were divided into 4 subgroups based on the growth periods (prepubertal, pubertal, postpubertal, and adult) determined based on the hand–wrist films[23] (Table 1). The Δ values are the amount of the difference values between the 2 periods (Δ1: difference value between pubertal and prepubertal periods, Δ2: difference value between postpubertal and pubertal periods, Δ3: difference value between adult and postpubertal periods).

The lateral cephalometric and hand–wrist films belonging to the groups were taken in x-ray machines (MORITA, J. Morita MFG. CORP., Kyoto, Japan) under standard conditions with a magnification difference of 1.1 mm. Lateral cephalometric films were first scanned with a scanner (EPSON Scanner PerfectionV700) at 300 dpi resolution and transferred to the computer. Later the measurements were done with the digital cephalometric analysis program of Dolphin Imaging Software (version 11.0, Dolphin Imaging and Management Solutions, Calif, USA). 188 lateral cephalometric radiographs belonging to 96 individuals randomly selected from both groups were measured using intraclass correlation coefficient (ICC) for a second time after 3 weeks from the completion of the measurements, to evaluate individual error control and intraexaminer reliability.

In this study, 25 cephalometric parameters, 13 angular, 11 linear, and 1 proportional, were evaluated. SN, S-Ba, Wits, Co-A, Co-Gn, N-ANS, ANS-Me, N-Me, S-Go, U1-NA, L1-NB length measurements, BaSN, NSAr, SArGo, ArGoMe, SNArGoMe, SNA, SNB, ANB, SN/GoGn, U1/SN, U1/NA, IMPA, L1/NB angular measurements, and SGo/NMe proportional measurements were carried out (Figure 1).

Statistical Analysis

The Statistical Package for the Social Sciences version 15.0 software (SPSS Inc.; Chicago, IL, USA) was used to analyze the study's data. The NCSS PASS 2008 software program was used to do a power analysis on the study's sample size was analyzed. For this purpose, information about the variables of interest (SNB, ANB) from other similar studies was used as a reference.[11] As a result

Table 1. Chronological and Skeletal Age Range and SD Values According to Growth Period and Genders

			n	Chronological Age				Skeletal Age			
				Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum
Class III	M	Prepubertal	18	10.40	1.42	8.08	12.83	9.98	1.62	7.00	12.50
		Pubertal	16	12.84	1.32	11.00	16.25	13.47	0.43	13.00	14.00
		Postpubertal	16	15.53	1.00	14.08	17.17	16.06	0.98	14.25	17.00
		Adult	16	20.65	3.40	16.00	30.00	18.69	0.48	18.00	19.00
	F	Prepubertal	16	9.64	1.33	7.33	11.50	9.30	1.34	6.83	11.00
		Pubertal	17	12.04	0.81	10.25	13.25	12.47	0.80	11.00	13.00
		Postpubertal	16	13.64	0.86	12.42	15.25	14.69	0.75	13.50	16.00
		Adult	16	17.59	2.24	13.50	21.83	17.56	0.73	16.00	18.00
Class I	M	Prepubertal	16	10.96	1.51	8.08	13.25	10.67	1.82	7.83	12.67
		Pubertal	19	13.76	0.94	12.17	15.33	13.61	0.43	13.00	14.00
		Postpubertal	16	15.70	1.19	14.00	18.25	15.97	1.87	10.00	17.00
		Adult	16	17.98	1.59	15.92	20.67	18.31	0.48	18.00	19.00
	F	Prepubertal	17	9.42	1.52	7.08	12.42	8.85	1.27	6.83	10.00
		Pubertal	16	11.98	0.81	10.42	13.50	12.06	0.85	11.00	13.00
		Postpubertal	16	13.31	0.98	11.50	14.75	14.66	0.72	13.50	16.00
		Adult	19	17.57	4.39	14.17	31.33	17.21	0.71	16.00	18.00

F, female; M, male.
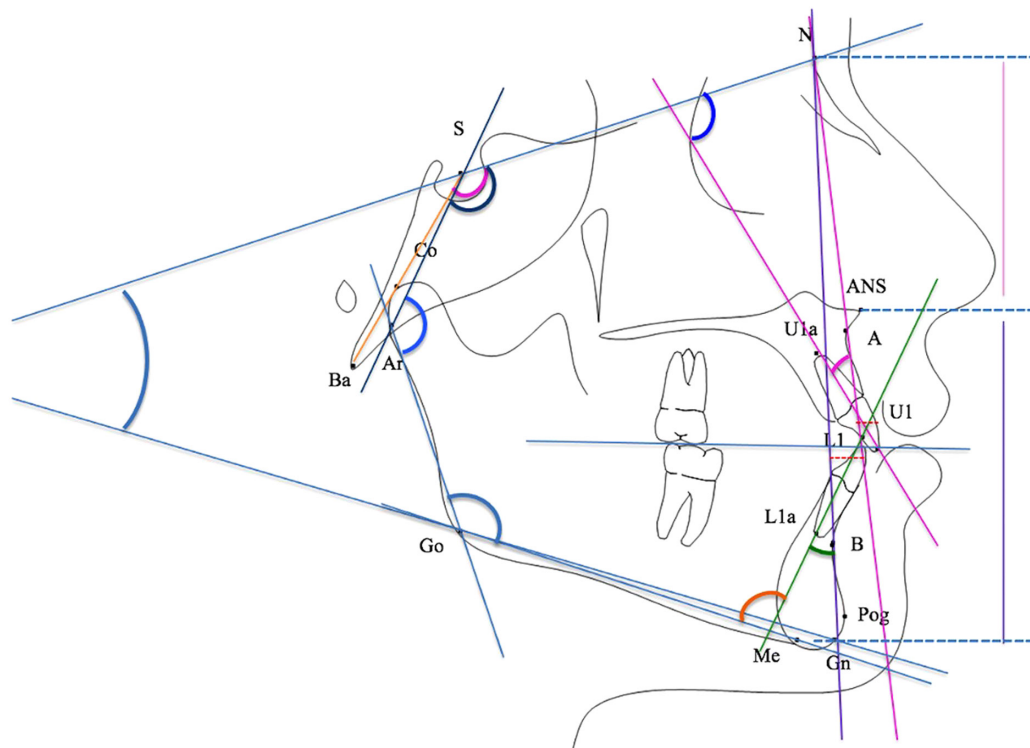
Sella (S): Geometric midpoint of the sella turcica, *Nasion (N):* The most anterior point of the frontonasal suture, *Ba (Ba):* The lowest and most posterior point in norma lateralis at the junction of the endocranial surfaces of the basis occipitalis, *Point A (Subspinal point) (A):* The deepest point of the concavity on the middle contour of the alveolar process, between the spinal nasalis anterior and the prosthion, *B point (Supramental point) (B):* Deep point on the alveolar process between the infradentale and pogonion in the mandibular symphysis, *Spina Nazalis Anterior (ANS):* The most extreme point of the maxillary bony prominence at the anterior base of the nose, *Condyle (Co):* The highest and most posterior point of the mandibular condyle, *Articulare (Ar):* The point where the posterior border of the mandibular condyle intersects with the skull base bone base image, *Gonion (Go):* The point where the bisector of the angle between the mandibular and ramal planes intersects the mandible, *Menton (Me):* The lowest point of the lower border of the mandibular symphysis, *Gnathion (Gn):* Midpoint of Menton and pogonion points, *Pogonion (Pg):* The most anterior point of the mandibular symphysis in the sagittal direction, *U1:* The apex of the cutting edge of the upper most anterior central incisor, *U1a:* Root tip of the upper most anterior central incisor, *L1:* The apex of the cutting edge of the lower most anterior central incisor, *L1a:* Root tip of mandibular most anterior central incisor

Figure 1. Reference points and measurements used in cephalometric analysis.

Table 2. The Significance of the Differences Between the Measurement Values Belonging to the Class I, Class III Groups and Genders

		Prepubertal					Pubertal					Postpubertal					Adult				
		Class III n=34		Class I n=33		P	Class III n=33		Class I n=35		P	Class III n=32		Class I n=32		P	Class III n=32		Class I n=35		P
		X̄	SD	X̄	SD		X̄	SD	X̄	SD		X̄	SD	X̄	SD		X̄	SD	X̄	SD	
S-N (mm)	M	68.9	2.8	71.2	3.9	.056a	71.6	3.1	73.1	4.8	.302a	74.7	3.6	75.8	3.7	.395a	74.0	3.8	73.5	4.8	.724a
	F	67.0	3.0	68.7	3.6	.160b	69.3	3.3	69.8	2.4	.643a	69.7	4.0	71.2	3.0	.127b	70.4	3.3	71.7	3.3	.263a
	P	.061a		.031b			.046a		.018a			.000a		.000a			.007a		.190a		
S-Ba (mm)	M	44.8	2.6	45.4	3.8	.576a	48.4	3.2	48.5	4.1	.956a	48.7	3.6	48.7	3.6	.954a	50.1	2.9	47.5	3.8	.033a
	F	43.5	3.2	44.3	3.3	.496	43.9	3.8	46.1	2.9	.077a	46.8	2.9	47.5	3.5	.539a	45.9	3.5	45.6	3.2	.804a
	P	.219a		.380a			.001a		.059a			.110a		.315a			.001a		.132a		
BaSN (°)	M	125.6	4.5	129.9	3.9	.005a	127.7	6.0	130.6	6.0	.171a	126.6	6.5	127.6	5.9	.676a	125.2	6.4	128.1	7.7	.269a
	F	127.0	3.7	129.8	3.9	.042	129.1	5.0	130.7	4.7	.347a	128.6	3.1	130.8	5.5	.181a	130.2	6.2	131.0	4.7	.666a
	P	.319a		.944a			.484a		.952a			.272a		.119a			.036a		.182a		
NSAr (°)	M	120.2	5.3	123.8	4.6	.040a	122.1	5.3	126.2	5.8	.040a	122.4	6.4	122.3	5.1	.865a	119.9	6.2	123.8	8.3	.144a
	F	119.5	4.6	124.1	4.1	.018a	122.7	5.2	124.2	3.9	.352a	122.0	4.3	124.5	5.3	.157a	122.1	7.1	126.0	4.5	.058a
	P	.783b		.860a			.775a		.246a			.831a		.359a			.361a		.321a		
SArGo (°)	M	147.8	8.2	144.1	5.8	.139a	142.3	5.8	142.1	7.8	.909a	144.0	6.5	148.1	7.6	.111a	144.7	5.0	143.5	9.4	.654
	F	143.4	6.5	142.0	7.4	.587a	144.4	6.3	142.0	3.8	.023b	143.8	4.0	143.8	8.1	.440b	141.5	6.9	143.5	5.4	.351a
	P	.090a		.388a			.242a		.986a			.915a		.127a			.147a		.997a		
ArGoMe (°)	M	128.1	6.4	128.0	6.2	.943a	131.9	5.6	128.5	6.3	.102b	127.3	7.6	124.5	6.2	.257a	127.7	7.7	125.9	7.8	.516a
	F	130.1	5.2	130.5	6.3	.845a	130.4	6.8	130.5	5.7	.948a	129.2	6.1	126.2	6.6	.201a	133.1	7.6	126.0	5.7	.003a
	P	.340a		.261a			.497a		.319a			.463a		.458a			.054a		.977a		
SNArGoMe (°)	M	396.1	4.8	395.9	4.6	.891a	396.4	3.6	396.7	5.8	.819a	393.8	6.0	395.4	6.5	.467a	392.3	4.5	393.2	7.3	.683a
	F	393.0	4.5	396.6	4.5	.028a	397.4	5.0	396.7	4.9	.693a	395.0	4.6	394.5	4.9	.775a	396.8	5.1	395.5	5.3	.475a
	P	.060a		.656a			.488a		.998a			.536a		.652a			.014a		.296a		
SNA (°)	M	78.2	2.6	79.6	2.8	.166a	78.9	3.7	80.3	2.9	.217a	78.3	3.3	80.0	4.5	.233a	81.5	4.5	81.2	4.5	.888a
	F	80.5	2.6	79.3	3.5	.254a	78.0	4.4	80.1	3.5	.145a	80.0	3.8	81.5	3.1	.232a	79.1	4.1	80.7	1.9	.133a
	P	.014a		.812a			.525a		.820a			.210a		.302a			.128a		.631a		
SNB (°)	M	80.4	2.9	77.2	2.9	.004a	81.3	3.1	77.9	2.9	.002a	80.4	3.4	77.9	4.4	.076a	85.0	4.3	78.6	4.2	.000a
	F	82.8	3.2	76.9	4.2	.000a	80.1	3.8	77.9	4.0	.114a	82.0	4.4	79.1	3.6	.052a	82.8	3.9	78.1	1.9	.000a
	P	.029a		.782a			.325a		.993a			.275a		.404a			.147a		.646a		
ANB (°)	M	-2.1	1.8	2.3	1.3	.000a	-2.4	1.6	2.4	0.9	.000a	-2.1	1.5	2.1	1.0	.000a	-3.5	2.8	2.6	1.3	.000a
	F	-2.3	1.6	2.4	1.4	.000a	-2.1	1.8	2.2	1.2	.000a	-2.0	1.5	2.4	1.1	.000a	-3.7	2.4	2.6	1.2	.000a
	P	.717b		.588b			.387b		.581a			.910b		.459a			.792a		.753a		
Wits (mm)	M	-6.8	2.6	-1.6	2.9	.000a	-8.3	3.1	-0.1	3.2	.000a	-6.1	3.1	0.5	3.4	.000a	-10.1	5.4	0.3	2.0	.000a
	F	-7.5	2.6	-1.3	3.1	.000a	-7.6	2.8	-2.0	3.0	.000a	-7.6	3.6	-1.5	2.9	.000a	-10.5	4.7	-0.6	2.4	.000a
	P	.398a		.784a			.519a		.053b			.193b		.080b			.838a		.265a		
Co-A (mm)	M	78.7	3.1	83.7	4.6	.002b	84.9	4.9	89.7	5.5	.011a	86.1	4.9	90.2	5.6	.034a	88.1	4.1	89.1	6.2	.564a
	F	77.8	4.3	81.1	5.2	.060a	79.9	4.6	83.3	3.0	.020a	83.2	5.3	87.3	4.1	.020a	83.2	3.1	88.7	5.8	.002a
	P	.482a		.155b			.005a		.000a			.110a		.080a			.001a		.846a		
Co-Gn (mm)	M	110.4	4.6	110.3	5.9	.944a	120.8	6.1	121.2	7.1	.868a	125.0	5.9	125.5	7.5	.831a	132.3	6.3	121.2	7.4	.000a
	F	106.8	5.0	106.0	6.0	.704a	114.1	5.6	110.0	5.6	.043a	118.7	6.9	115.6	5.7	.168a	125.3	5.9	118.3	6.0	.002a
	P	.032a		.046a			.002a		.000a			.010a		.000a			.003a		.079b		
SN/GoGn (°)	M	34.1	5.0	33.9	4.5	.902a	34.2	3.8	34.4	5.5	.883a	31.3	6.3	32.9	7.0	.507a	30.1	4.7	30.9	7.7	.742a
	F	31.2	4.4	35.0	4.6	.023a	35.2	4.8	34.8	5.0	.848a	32.8	4.5	32.4	5.2	.845a	34.5	5.0	33.2	5.5	.470a
	P	.089a		.492a			.528a		.827a			.447a		.845a			.017a		.311a		
N-ANS (mm)	M	52.5	2.7	53.0	3.7	.661a	55.5	3.1	56.2	3.0	.506a	56.8	4.6	58.6	3.3	.212a	59.7	4.3	57.6	4.5	.188
	F	49.5	2.1	49.9	3.8	.708a	52.8	3.0	52.6	3.5	.897a	54.9	2.6	55.3	3.5	.653a	55.3	3.3	56.7	3.9	.389b
	P	.001a		.024a			.015a		.003a			.149a		.011a			.003a		.185b		
ANS-Me (mm)	M	62.5	5.3	65.5	4.8	.096a	69.7	6.5	72.8	5.8	.148a	74.3	5.4	76.5	5.7	.256a	75.1	7.6	72.4	8.1	.347a
	F	57.4	4.8	63.0	3.9	.001a	66.2	4.5	66.1	4.2	.929a	67.6	5.4	66.6	3.6	.525a	71.7	6.7	68.9	5.2	.167a
	P	.006a		.100a			.078a		.000a			.002a		.000a			.190a		.127a		
N-Me (mm)	M	114.5	5.7	117.2	7.6	.252a	124.7	8.5	127.7	7.7	.276a	130.7	7.0	134.2	7.7	.105b	134.3	7.8	128.7	11.0	.105a
	F	106.2	5.9	111.7	5.8	.011a	118.4	6.6	117.2	5.1	.563a	121.9	6.2	120.3	5.0	.450a	126.7	8.0	124.3	6.9	.340a
	P	.000a		.024a			.023a		.000a			.001a		.000a			.011b		.160a		
S-Go (mm)	M	71.0	4.0	74.1	5.4	.068a	78.9	7.0	80.4	6.2	.515a	86.7	6.8	86.4	6.3	.906a	90.5	7.2	86.9	8.0	.200a
	F	68.5	3.9	69.9	5.5	.412a	73.7	4.6	73.8	4.9	.944a	78.8	5.0	77.8	5.4	.591a	79.9	4.0	79.5	5.0	.824a
	P	.068a		.033a			.016a		.002a			.001a		.000a			.002a		.002a		

(Continued)

Table 2. The Significance of the Differences Between the Measurement Values Belonging to the Class I, Class III Groups and Genders (Continued)

| | | Prepubertal | | | | | Pubertal | | | | | Postpubertal | | | | | Adult | | | | |
| | | Class III n=34 | | Class I n=33 | | | Class III n=33 | | Class I n=35 | | | Class III n=32 | | Class I n=32 | | | Class III n=32 | | Class I n=35 | | |
		X̄	SD	X̄	SD	P	X̄	SD	X̄	SD	P	X̄	SD	X̄	SD	P	X̄	SD	X̄	SD	P
SGo/NMe (%)	M	62.1	3.4	63.2	2.9	.310[a]	63.3	3.4	63.0	4.0	.827[a]	66.4	4.3	64.5	5.0	.270[a]	67.3	3.4	67.8	5.5	.734[b]
	F	64.5	3.6	62.5	3.1	.090[a]	62.3	3.4	63.0	3.5	.572[a]	64.7	3.4	64.7	3.9	.989[a]	63.2	3.8	64.1	3.7	.495
	P	.049[a]		.509[a]			.412[a]		.990[a]			.226[a]		.926[a]			.003[b]		.053[b]		
U1/SN (°)	M	104.1	5.2	101.5	5.9	.174[a]	103.9	6.9	105.3	5.3	.500[a]	107.4	8.2	106.1	7.0	.617[a]	108.4	7.5	105.5	9.1	.334[a]
	F	106.4	5.5	104.0	7.9	.321[a]	107.3	6.8	105.2	10.1	.486[a]	106.9	6.9	102.0	5.5	.036[a]	110.1	8.2	103.1	6.8	.010[a]
	P	.224[a]		.311[a]			.163[a]		.973[a]			.836[a]		.078[a]			.543[a]		.383[a]		
U1/NA (°)	M	25.9	5.5	21.9	7.5	.085[a]	25.0	5.1	25.0	3.7	.996[b]	29.1	7.9	26.0	5.9	.985[a]	26.9	7.7	24.2	7.4	.326[a]
	F	25.8	5.0	24.7	6.8	.592[a]	29.3	8.2	25.1	7.8	.142[a]	26.9	6.1	20.5	4.2	.002[a]	30.9	6.0	22.4	6.9	.000[a]
	P	.975[a]		.275[a]			.080[b]		.951[a]			.497[b]		.000[b]			.105[a]		.449[a]		
U1-NA (mm)	M	4.0	2.1	3.4	3.1	.544[a]	5.2	2.3	5.4	2.5	.837[a]	7.5	3.2	5.5	2.4	.117[a]	6.6	3.6	5.6	2.8	.318[b]
	F	3.2	1.5	3.4	1.9	.552[b]	6.5	2.8	4.7	2.6	.069[a]	5.7	2.4	3.3	1.6	.003[a]	7.3	2.5	4.3	2.4	.001[a]
	P	.244[a]		.732[b]			.157[a]		.466[a]			.052[a]		.006[a]			.865[a]		.138[a]		
IMPA (°)	M	82.3	5.0	91.3	6.3	.000[a]	79.7	6.1	90.8	6.8	.000[a]	85.6	5.9	89.0	6.6	.130[a]	78.4	10.5	91.4	7.8	.000[a]
	F	83.6	5.7	86.1	6.4	.259[a]	83.2	5.3	87.6	6.5	.043[a]	82.6	5.4	87.7	7.4	.031[a]	78.9	10.9	90.9	8.1	.001[a]
	P	.465[a]		.023[a]			.085[a]		.362[b]			.142[a]		.606[a]			.902		.860[a]		
L1/NB (°)	M	18.8	6.5	24.5	5.6	.010[a]	17.4	5.8	25.5	6.0	.000[a]	19.8	5.3	22.3	6.2	.221[a]	15.7	8.2	23.2	7.5	.011[a]
	F	19.4	6.4	19.5	6.8	.951[a]	20.7	5.8	22.2	7.2	.515[a]	19.6	5.7	21.3	6.2	.420[a]	18.5	7.7	24.5	5.9	.012[a]
	P	.783[a]		.031[a]			.105[a]		.151[a]			.901[a]		.633[a]			.337[a]		.566[a]		
L1-NB (mm)	M	3.1	2.3	4.7	2.1	.037[a]	2.7	1.9	5.5	2.5	.001[a]	4.2	2.0	5.0	2.8	.375[a]	3.2	2.8	5.2	2.9	.056[a]
	F	2.5	1.9	3.0	2.1	.470[a]	3.6	1.9	4.1	2.5	.470[b]	3.3	1.9	3.8	1.8	.439[b]	3.3	2.1	4.6	1.8	.054[a]
	P	.429[a]		.023[a]			.183[a]		.038[b]			.201[a]		.101[b]			.895[a]		.473[a]		

P < .05, P < .01, P < .001.
F, female; M, male.
[a]Independent sample t-test; [b]Mann–Whitney U-test.

of the analysis carried out by taking alpha (α) = 0.05 and power (1 – β) = 0.90, it was calculated that there should be at least 15 individuals in each group, for a total sample size of 240 individuals. In the power analysis performed after the study for α = 0.05 and considering the number of individuals in each group, the power was found to be between 0.87 and 1.00 for the SNB variable and between 0.99 and 1.00 for the ANB in 4 different periods.

The conformity of the quantitative variables considered in the study to the normal distribution was examined using the Shapiro–Wilk test and graphical methods. For statistical comparison of 2 independent groups (the comparison of class III and class I in each period and in each gender group, the comparison of males and females in each period and in each class), "Independent sample t-test" was used for normally distributed variables and the "Mann–Whitney U-test" was used for non-normally distributed variables. The difference between 2 independent groups and the previous growth period and the next growth period (Δ) in each gender group in each class showing the difference between periods was evaluated with the "Independent sample t-test" for variables that normally distributed, and with the "Mann–Whitney U-test" for variables that do the non-normally distributed. For all statistical analyses, a value of $P < .05$ was accepted as the level of statistical significance.

RESULTS

A total of 266 individuals were included in this study. The growth periods, genders, chronological and skeletal age range values of the groups, and sample size of individuals in the groups are shown in Table 1. The intraexaminer reliability levels of the measurements for each selected parameter were assessed by using intraclass correlation coefficient (ICC). These values were close to the exact value of 1.00 (0.813-0.993) for the measurement repetition coefficients (r) calculated.

The S-N and S-Ba dimensions were found to be larger in class III males than females in the pubertal and adult periods, and the S-N size in the postpubertal period. S-N dimensions were found to be larger in class I males than females in the prepubertal, pubertal, and postpubertal periods. Statistically significant increases were observed in the S-N dimensions (Δ1 and Δ2) in class III males and (Δ2) in class I males, as well as in the S-Ba dimensions (Δ1 and Δ2) in class III females. Cranial base angle (BaSN) and saddle angle (NSAr) were found significantly smaller in prepubertal class III males than class I males, and in class III females compared to class I females. BaSN was observed to be significantly smaller in males in the class III group in adults than in females (Table 2 and 3, Figure 2).

The SArGo in the pubertal period, and the ArGoMe in the adult period were found to be larger in class III females than in class I females. While a significant decrease was observed in the SArGo value in the Δ1 and the ArGoMe value in the Δ2 in the class III males, a significant increase in the SArGo value in the Δ2 was observed in the class I males. The SNArGoMe was found to be smaller in prepubertal period class III females than in class I females and in adult period class III males than in females. When the amount of change between the periods was compared, a significant increase was observed in the Δ1 in class III females (Table 2 and 3, Figure 3).

The SNA angle was found to be smaller in prepubertal class III males than females. In terms of SNA, a significant decrease was observed in class III females in the Δ1, while a significant increase

was observed in the Δ3. The SNB angle for males and females in the class III group was found to be larger in the prepubertal and adult periods compared with the class I males and females. While a significant decrease was observed in class III females in the Δ1, a significant increase was observed in class III males in the Δ3.

The ANB and Wits values were found to be smaller in prepubertal, pubertal, postpubertal, and adult periods for class III females and males than for class I females and males. When the amount of change in ANB and Wits values between the periods were compared, significant decreases were observed in class III males and females in the Δ3 (Table 2 and 3, Figure 4).

The Co-A dimension was determined to be smaller in class III males and females than in class I males and females in the growth periods. A significant increase was observed for class III and class I males in the Δ1, for class I females in the Δ2. The Co-Gn dimension of the adult females and males in the class III group was found to be larger than the females and males in the class I group. Besides, it was found that Co-A and Co-Gn dimension was larger in class III males than females in all growth periods. Significant increases were observed in Co-Gn size for class III males in the Δ1, Δ3, for class III girls in the Δ1, Δ2, Δ3, and for class I males and class I females in Δ1 and Δ2 (Table 2 and 3, Figure 4).

Table 3. Changes of Measurements According to Class I, Class III Groups and Genders Between Growth Periods

		Δ 1 (Pubertal–Prepubertal)		Δ2 (Postpubertal–Pubertal)		Δ3 (Adult–Postpubertal)	
		Class III	Class I	Class III	Class I	Class III	Class I
		$\bar{D}$	$\bar{D}$	$\bar{D}$	$\bar{D}$	$\bar{D}$	$\bar{D}$
S-N (mm)	M	**2.7***	1.9	**3.1***	**2.8***	−0.7	−2.3
	F	2.3	1.1	0.4	1.4	0.6	0.5
S-Ba (mm)	M	**3.6****	**3.0****	0.3	0.3	1.5	−1.3
	F	0.4	1.7	**2.8***	1.4	−0.8	−1.8
BaSN (°)	M	2.1	0.7	−1.1	−3.0	−1.4	0.5
	F	2.1	0.9	−0.5	0.1	1.5	0.2
NSAr (°)	M	2.0	2.4	0.3	−3.4	−2.5	1.0
	F	3.2	0.1	−0.6	0.3	0.1	1.5
SArGo (°)	M	**−5.5***	−2.0	1.7	**6.1****	0.7	−4.7
	F	1.0	0.0	−0.6	1.7	−2.3	−0.3
ArGoMe (°)	M	3.7	0.5	**−4.5***	−4.0	0.4	1.4
	F	0.3	0.1	−1.2	−4.3	4.0	−0.2
SNArGoMe (°)	M	0.2	0.9	−2.6	−1.3	−1.5	−2.2
	F	**4.4****	0.1	−2.4	−2.2	1.8	1.0
SNA (°)	M	0.7	0.8	−0.6	−0.3	**3.1***	1.2
	F	**−2.5***	0.8	2.0	1.4	−0.9	−0.8
SNB (°)	M	0.9	0.7	−0.9	0.0	**4.5*****	0.7
	F	**−2.7***	1.0	1.9	1.2	0.8	−1.0
ANB (°)	M	−0.2	0.1	0.3	−0.3	**−1.4***	0.5
	F	0.2	−0.2	0.1	0.2	**−1.7****	0.2
Wits (mm)	M	−1.5	1.5	2.1	0.6	**−4.0****	−0.2
	F	0.0	−0.6	0.0	0.4	**−2.9***	0.9
Co-A (mm)	M	**6.2*****	**6.0*****	1.2	0.5	1.9	−1.1
	F	2.1	2.2	3.2	**4.0***	0.1	1.5
Co-Gn (mm)	M	**10.4*****	**10.9*****	4.2	**4.3***	**7.3****	−4.3
	F	**7.4*****	**4.0****	**4.6***	**5.6***	**6.5****	2.7
SN/GoGn (°)	M	0.1	0.6	−2.9	−1.6	−1.2	−2.0
	F	**3.9***	−0.1	−2.4	−2.4	1.7	0.8
N-ANS (mm)	M	**3.0****	**3.2****	1.4	**2.5***	**2.9***	−1.0
	F	**3.2****	**2.7***	2.1	**2.7***	0.4	1.4
ANS-Me (mm)	M	**7.2*****	**7.3*****	**4.5***	**3.7***	0.9	−4.1
	F	**8.9*****	3.1	1.4	0.5	4.1	2.3
N-Me (mm)	M	**10.1*****	**10.5*****	**6.0***	**6.5****	3.6	**−5.5***
	F	**12.2*****	**5.5***	3.5	3.2	4.8	3.9
S-Go (mm)	M	**7.9*****	**6.3*****	**7.8*****	**6.1****	3.8	0.5
	F	**5.2****	**3.9***	**5.2***	4.0	1.0	1.7
SGo/NMe (%)	M	1.2	−0.2	**3.1***	1.6	0.9	**3.2***
	F	−2.2	0.5	2.4	1.7	−1.5	−0.6
U1/SN (°)	M	−0.2	3.8	3.5	0.8	0.9	−0.6
	F	0.9	1.2	−0.5	−3.2	3.2	1.1
U1/NA (°)	M	−0.9	3.1	4.1	1.0	−2.2	−1.8
	F	3.5	0.4	−2.4	**−4.6***	4.1	1.9
U1-NA (mm)	M	1.2	**1.9***	**2.3***	0.1	−0.8	0.1
	F	**3.3*****	1.3	−0.8	−1.4	1.6	0.9
IMPA (°)	M	−2.5	−0.5	**5.8****	−1.9	**−7.1***	2.4
	F	−0.4	1.5	−0.7	0.1	−3.7	3.2
L1/NB (°)	M	−1.4	1.0	2.4	−3.2	−4.1	0.9
	F	1.4	2.7	−1.2	−1.0	−1.1	3.3
L1-NB (mm)	M	−0.4	0.8	**1.5***	−0.6	−1.0	0.3
	F	1.1	1.1	−0.3	−0.3	0.0	0.9

F, female; M, male.
*P < .05, **P < .01, ***P < .001. Δ1: difference value between pubertal-prepubertal period, Δ2: difference value between postpubertal-pubertal period, Δ3: difference value between adult-postpubertal period.
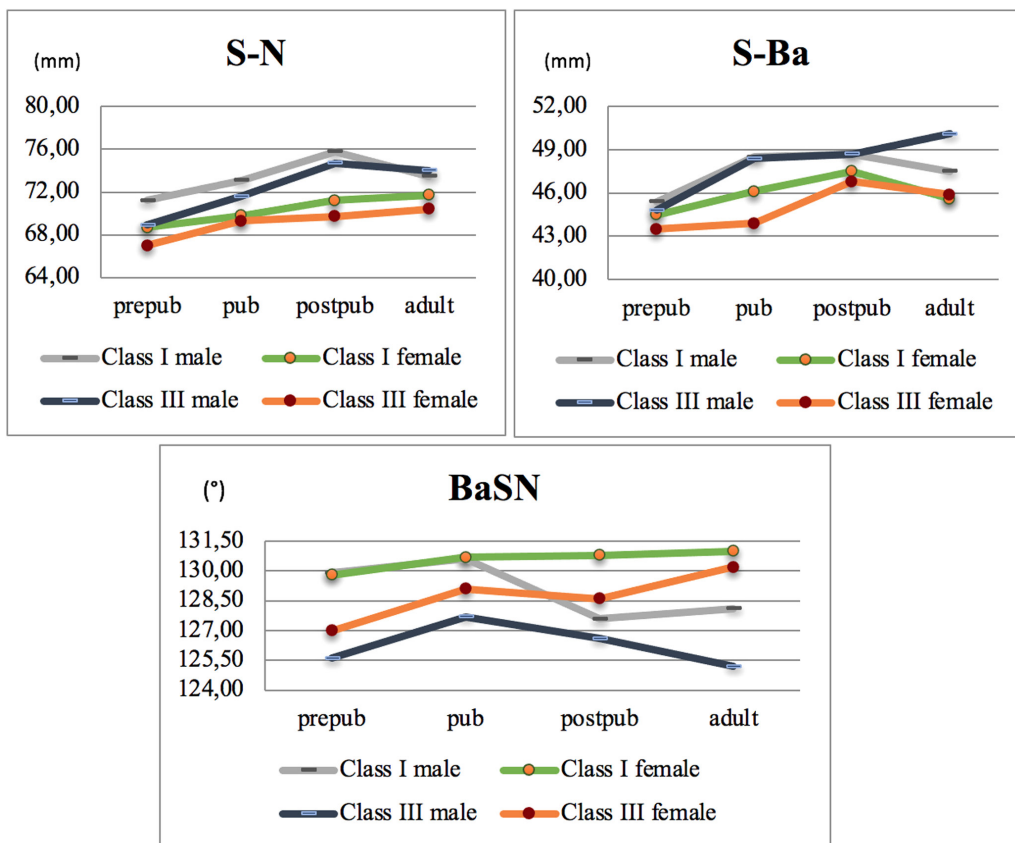
Figure 2. SN, SBa, and BaSN changes of class III and class I individuals according to growth periods.

Furthermore, the SN/GoGn angle was observed to be smaller in class III females than in class I females in the prepubertal period, and class III males were significantly smaller than females in the adult period. It was found that there was a significant increase in class III males in the Δ1. While the ratio of SGo/NMe was found to be smaller in class III males in the prepubertal period than in females, it was found to be larger in the adult period. Furthermore, there were significant increases in class III males in the Δ2 and in class I females in the Δ3.
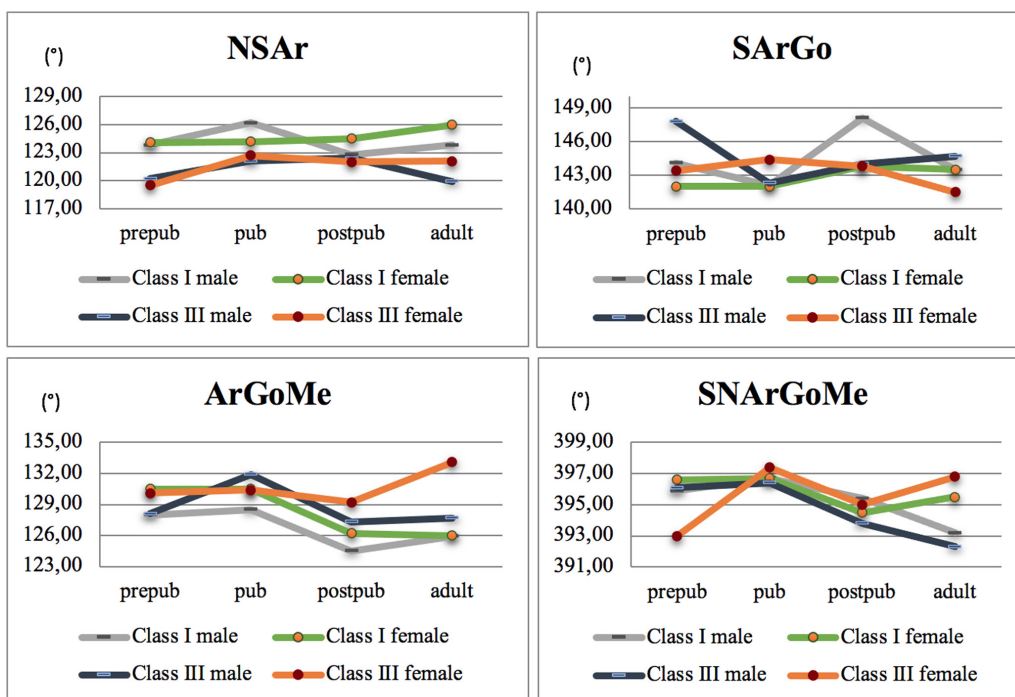
Figure 3. NSAr, SArGo, ArGoMe, SNArGoMe changes in class III and class I individuals according to growth periods.
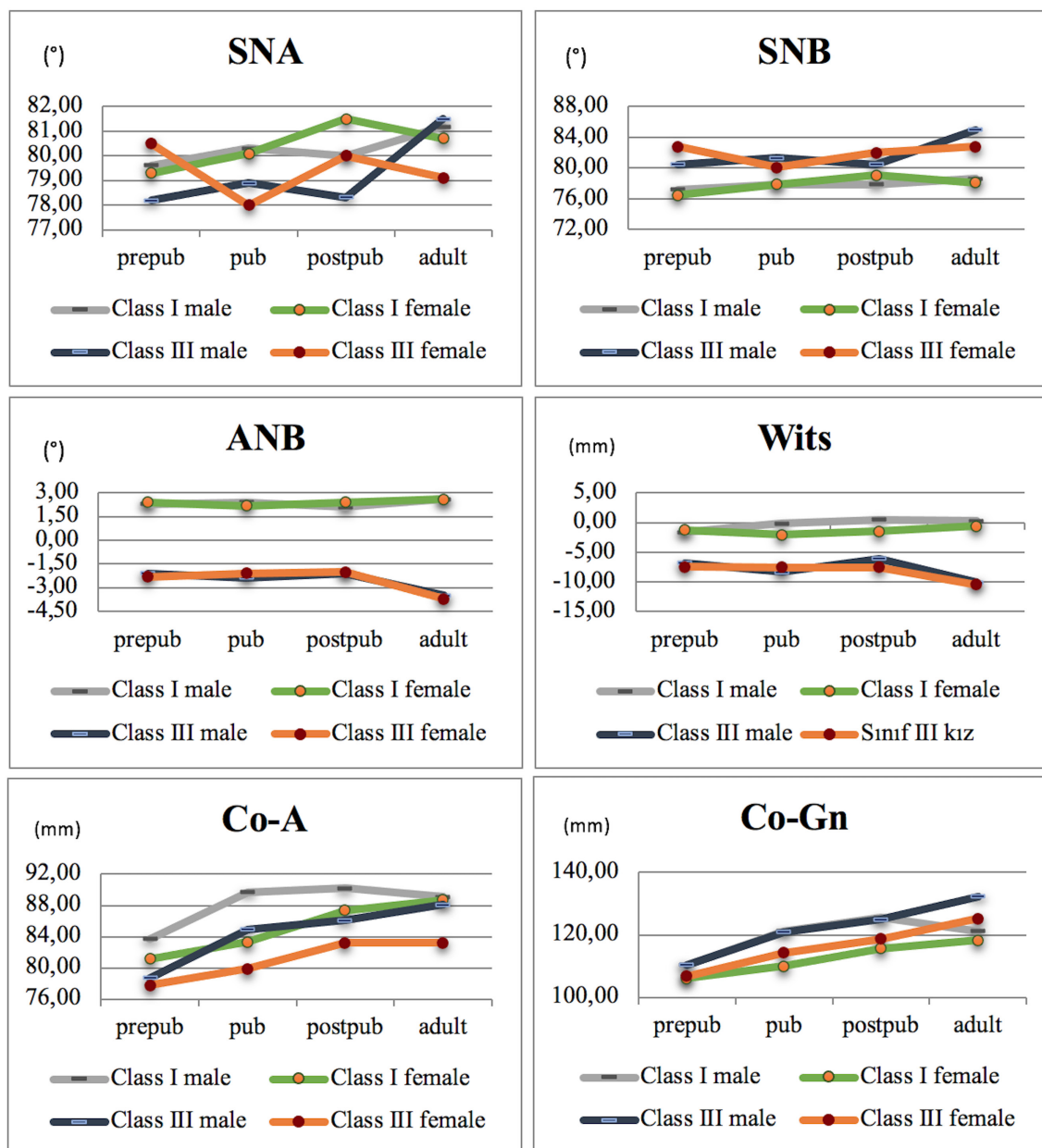
Figure 4. SNA, SNB, ANB, Wits, Co-A, and Co-Gn changes of class III and class I individuals according to their growth periods.

The N-ANS, ANS-Me and N-Me dimension was found to be greater in class III and class I males than females in the growth periods. The ANS-Me and N-Me dimensions were found to be smaller in the prepubertal period in class III females compared to class I females. Besides, there was a significant increase in class III and class I males, females in the Δ1. There was also a significant decrease in N-Me in class I females and males in the Δ1, in the class III females in the Δ2, and in the class I males in the Δ3 (Table 2 and 3, Figure 5).

The U1/SN, U1/NA angles and U1-NA length were found to be greater in class III females than in class I females in the postpubertal, and in adult periods. U1-NA length showed a significant increase in class III males in Δ2, in females in Δ1, and in class I males in Δ1. The IMPA, L1/NB angles and L1-NB length were significantly smaller in class III males than in class I males in the prepubertal, pubertal. The IMPA angle was also significantly smaller in

class III females than class I females in the pubertal, postpubertal, and adult periods, while the L1/NB angle was significantly smaller in adult periods. In addition, U1/NA angle and U1-NA length, IMPA, L1/NB angles, and L1-NB length were found to be greater in class I males than females. In terms of IMPA, a significant increase was observed in class III males in the Δ2, while there was a significant decrease in the Δ3 (Table 2 and 3, Figure 6).

DISCUSSION

Chronological or bone age is used in studies related to growth and development. While there are studies based on chronological age when creating age groups,[2,11,14,24] there are also studies based on bone age[20] or using other methods.[16] Besides the chronological ages of all individuals included in this study, maturation periods were determined by looking at the left hand–wrist radiographs and the Greulich–Pyle atlas,[25] and groups were formed according
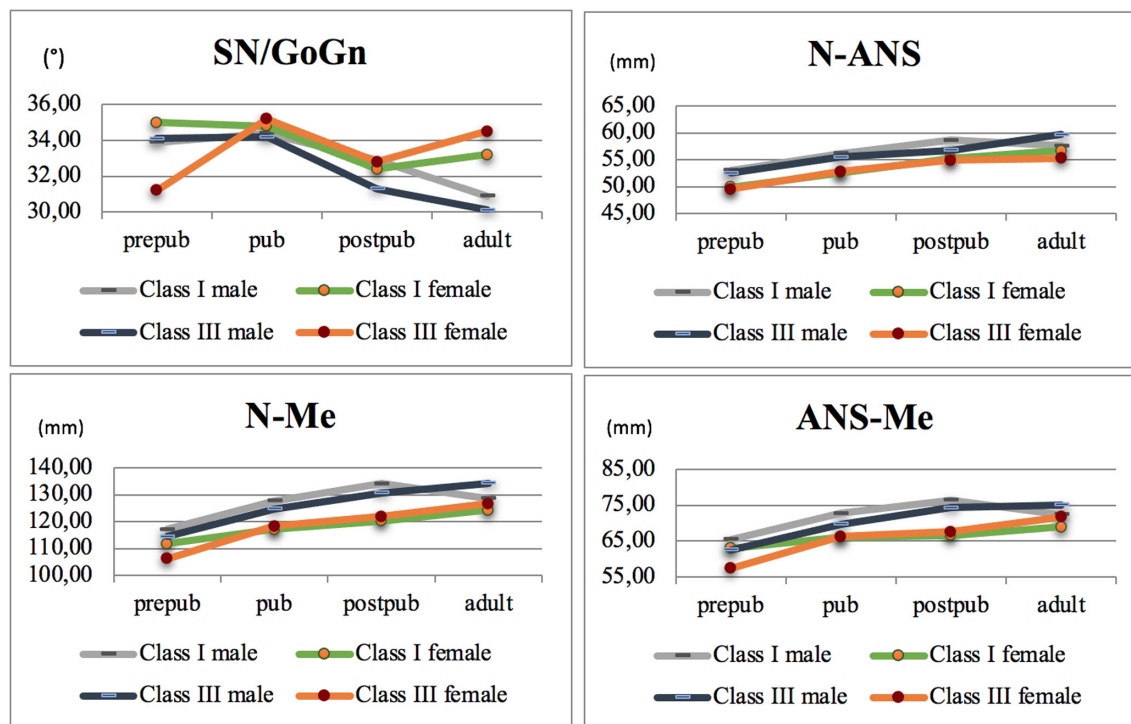
Figure 5. SN/GoGn, N-ANS, ANS-Me, N-Me changes in class III and class I individuals according to growth periods.
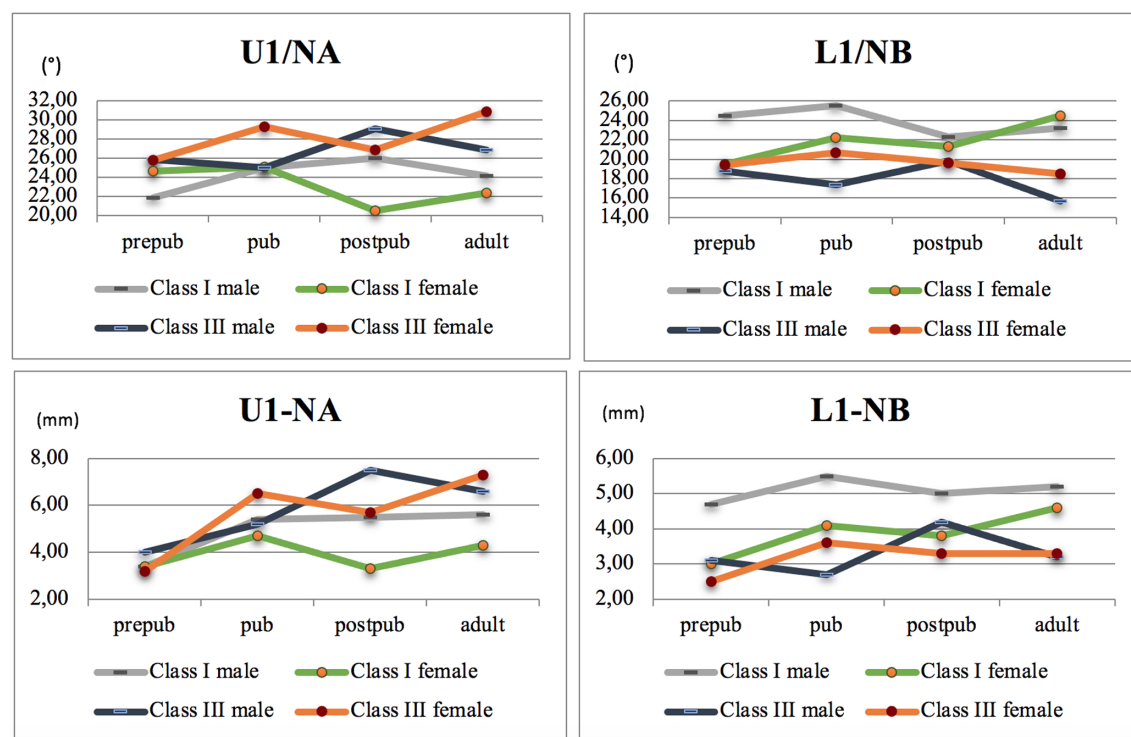

Figure 6. U1/NA, U1-NA, L1/NB, L1-NB changes in class III and class I individuals according to growth periods.

to the skeletal maturation periods as prepubertal, pubertal, post-pubertal, and adult periods.[23]

Cranial Base Relationships
Bacetti et al reported that the glenoid fossa is located more anteriorly, with a reduced BaSN in class III individuals.[12] According to Reyes et al,[11] the BaSN in class III cases is smaller than in normal individuals in all age groups. While it was observed to be between 129° and 131° in normal individuals, it was found between 121° and 124° in class III cases.[11] In this study, the BaSN was smaller in class III individuals than in class I individuals, and in males compared to females (Table 2, Figure 2). Therefore, the H0 hypothesis of this study was rejected.

While Guyer et al[2] found the value of the saddle angle to be similar between class I and class III individuals. Ellis and McNamara[1] stated that a decrease in Saddle angle is a class III cranial base feature. In this research, in accordance with other studies, the saddle angle (NSAr) was founded statistically smaller in class III group than class I group especially in the prepubertal and pubertal periods.

In Sanborn's study with class III individuals aged 16–18 years, reported that the Gonion point is located more anteriorly than the skull base and upper face, and the gonial angle (ArGoMe) is greater in class III individuals (133.6°) than in class I individuals (123°).[10] Guyer et al stated that the gonial angle is approximately 5° larger in class III than class I.[2] Wolfe et al reported that the gonial angle was higher in males than females in the class I and class III groups.[26] Although smaller values of the gonial angle were found in males than females in this study, there were no statistically significant differences. Because the vertical angular dimensions measured in this study are in the optimal angle values (SN/GoGn:30.1-35°) (Table 2, Figure 3).

Maxillary and Mandibulary Skeletal Relationships

Studies have reported that SNA angle and CoA are smaller in class III individuals.[2,14,16,20,26,27] When we compared the SNA values in this study with Steiner norms,[28] it was found that the SNA values in the class I group were smaller. In this study, SNA values were found to be 79.6°-81.2° in class I males and 79.3°-81.5° in females. This study finding indicate that there is no difference in the SNA angle between class III and class I individuals, except gender variations. Since the SNA value can be affected by the inclination of the SN plane and the degree value is smaller than mm value, no statistical difference was found.

When we compared the SNB values in this study with Steiner norms,[28] it was found that the SNB values were smaller. In this study, SNB values in the class I group were found to be 77.2°-78.6° in class I males and 76.9°-79.1° in females. Miyajima et al reported that the SNB angle in class III females increased by approximately 3° from early mixed dentition to adulthood.[16] In class III females in this study, the SNB value first decreased by 2.7° (in the Δ1) and increased in the following periods (in the Δ2 and Δ3). The highest increase was observed in class III males and in Δ3 (4.5°)(Table 3, Figure 4).

Guyer et al reported that the Co-Gn dimension was 3-6 mm longer in class III individuals than in class I individuals.[2] Reyes et al[11] reported that the amount of growth was higher in class III individuals than in class I individuals. Besides, they reported that the greatest increases in mandibular dimensions occurred in class III individuals approximately 1 year after class I individuals. In males with class III anomalies, the highest increase in Co-Gn dimension occurs between the ages of 12-13 (4.2 mm), with an average increase of 2.9 mm.[11] Similarly, in this study, the highest increase was observed in the Δ1, and this increase was 10.4 mm in males and 7.4 mm in females on average. When the Co-Gn findings of class I individuals were compared with McNamara norms[29] (105-131 mm in class I boys, 103.3-121.6 mm in girls), the Co-Gn sizes in this study were found to be smaller. Considering the Co-Gn averages of this study, it was found between 110.3-125.5 mm in class I males and 106-118.3 mm in females (Table 2, Figure 4).

Intermaxillary Relationships

Wolfe et al stated that ANB and Wits values were smaller in class III individuals and became more severe in the negative direction over time.[26] In this respect, some cases stated that growth can be better evaluated with the Wits measurement, which is measured from the occlusal plane and is not affected by vertical direction changes.[9,26] Chen et al stated that the class III structure was formed before the age of 8 years, and that more vertical and transversal changes were observed in the following period.[27] In the study of Rutili et al, a worsening over time of the skeletal characteristics (ANB, SNB angle, Wits, mandibular length) of class III malocclusion was described.[30] Compatible with these studies, this study also observed that the class III anomaly was exacerbated in both females and males in ANB and Wits measurements in the Δ3. In class 3 individuals, even if the orthodontic treatment is finished in the early growth period, the mandibula will continue to grow in later growth periods and the risk of relapse should be taken into consideration and appropriate clinical measures should be taken (Table 3, Figure 4).

Studies in the literature stated that the morphological characteristics of mandibular prognathism occur before the pubertal growth spurt, and this situation is maintained in the following period.[20,31] Zegan et al in class III individuals found statistically significant differences with several characteristics between the prepubertal (<14 years) and pubertal-postpubertal (>14 years).[31] While there is no difference in mandibular dimensions in the prepubertal and pubertal periods, there are obvious differences in the transition from postpubertal to the adult period. This should be taken into account in treatment planning. In order to prevent the possible risk of relapse due to continued growth until late periods, for example, the duration of treatment can be prolonged, or class 3 elastics can be used to control mandibular growth. Thus, the orthodontist will be able to create a more effective treatment plan by taking some clinical measures.

Vertical Facial Relationships

In the Sanborn study, SN/GoGn values were reported as 33.17° in class III individuals and 28.97° in class I individuals.[10] On the other hand, Wolfe et al stated that class III individuals have a hyperdivergent growth pattern with increased mandibular plane angle.[26] In this study, the average of SN/GoGn is 30.1°-34.2° in class III males, 31.2°-35.2° in females, 30.9°-34.4° in males in class I group, 32.4°-35° in females. It is seen that they have similar and optimum values (Table 2). According to Ochoa and Nanda, the SN/GoGn angle decreases from 6 to 14 years of age in individuals with class I occlusion.[19] In this study, decreases are observed in the Δ2 (Table 3).

Dentoalveolar Relationships

In individuals with class III malocclusion, the upper incisors are protrusive, and the lower incisors are retrusive as a result of dentoalveolar compensation.[2,10,11,14] In this study, it was observed that proclinations increased in the upper incisors in general during the 4 developmental periods, and there was significant retroclination in the lower incisors in class III cases (Table 2, Figure 6).

In conclusion, we infer the following:

- The craniofacial and especially the mandibular dimensions are larger in class I and class III males than in females.

- The cranial base angle and effective size of the maxilla (Co-A) are smaller in class III individuals than in class I individuals.
- In Class III individuals, maxillary incisors are protrusive, and mandibular incisors are retrusive.
- Although the growth rates between class III and class I individuals in the early period (Δ1) of the maxilla and mandible are similar, these differences intensify in the later periods (Δ3). It was found that the growth rate of the mandible was higher than the growth rate of the maxilla.
- The class III intermaxillary relationship worsened over time. Mandibular growth was found to continue into late growth periods, especially in males.
- In class III individuals, even if orthodontic treatment is completed in the early growth period, the mandible will continue to grow in later growth periods, and the risk of relapse should be considered, and appropriate clinical measures taken. These results reveal the importance of early diagnosis and treatment in class III individuals.

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Current Research in Dental Sciences

Evaluation of the General Level of Knowledge about COVID-19 Infection of Parents Who Visited a Pedodontics Clinic during the COVID-19 Pandemic

COVID-19 Pandemisi Esnasında Pedodonti Kliniğine Başvuran Ebeveynlerin COVID-19 Enfeksiyonu İle İlgili Genel Bilgi Düzeylerinin Değerlendirilmesi

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ABSTRACT

Objective: It is predicted that droplet-transmitted diseases will cause pandemics in the future, as they had in the past. In order to control possible pandemics, people need to be aware of diseases that can be transmitted through droplets. For these reasons, this questionnaire study aimed to assess parents' general knowledge and attitudes of pediatric patients who visited the pediatric dental clinic during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: In this study, the questionnaire was applied to 450 parents of children who visited the pediatric dental clinic for routine pediatric dental examination. The data analysis of our study was performed using the Statistical Package for the Social Sciences version 23.0 software program (SPSS Inc.; Chicago, IL, USA). Percentages and frequencies of responses to questions were obtained.

Results: Most parents were found to have adequate knowledge about the transmission routes and symptoms of COVID-19 infection. 95.1% of parents stated that dentists should use protective equipment (mask, glasses, protective clothing) during aerosol procedures. About 98.8% of parents agreed that parents and patients in dental clinics should wear their masks to cover the nose and mouth during a COVID-19 pandemic.

Conclusion: We think that participants were aware of masks, social distancing during the pandemic, and the symptoms and transmission routes of COVID-19 infection.

Keywords: COVID-19, dentistry, pandemic, protective equipment

ÖZ

Amaç: Gelecekte geçmişte olduğu gibi damlacık yolu ile bulaşan hastalıkların pandemilere sebep olacağı öngörülmektedir. Olası pandemilerin kontrol altına alınabilmesi için insanların damlacık yolu ile bulaşabilen hastalıklara karşı bilinçlenmesi önemlidir. Çalışmamızın amacı COVID-19 pandemisi sürecinde çocuk diş hekimliği kliniğine çocuklarının diş rahatsızlığı nedeniyle başvuran ebeveynlerin COVID-19 enfeksiyonu hakkındaki yaklaşımları ve bilgi düzeyleri hakkında bilgi sahibi olmaktır.

Yöntemler: Çalışmamızda çocuğunu dental muayene amacıyla çocuk diş hekimliği kliniğine getiren 450 ebeveyne anket uygulanmıştır. Elde edilen veriler SPSS versiyon 23.0 yazılım programı (SPSS Inc.; Chicago, IL, ABD). Yüzde ve frekans değerleri kullanıldı.

Bulgular: Ebeveynlerin çoğunun COVID-19 enfeksiyonunun bulaş yolları ve belirtileri hakkında bilgi düzeylerinin yeterli olduğu gözlenmiştir. Ebeveynlerin %95.1'i hekimlerin aerosollü işlemler sırasında koruyucu ekipman (maske, gözlük, koruyucu kıyafet) kullanması gerektiğini bildirmiştir. Ebeveynlerin %98.8'i COVID-19 pandemisi esnasında dental kliniklerde ziyaretçilerin ve hastaların maskelerini burnu ve ağızı kapatacak şekilde takmaları gerektiğini belirtmiştir.

Sonuç: Katılımcıların pandemi döneminde maske ve mesafe konusunda bilinçlendiğini ve COVID-19 enfeksiyonun belirtileri ve bulaş yolları konusunda bilgi sahibi olduklarını düşünmekteyiz.

Anahtar Kelimeler: COVID-19, diş hekimliği, pandemi, koruyucu ekipman

INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) announced that the coronavirus disease 2019 (COVID-19) novel coronavirus outbreak had reached a critical juncture, warranting classification as a global pandemic and a matter of international public health concern[1]

During the pandemic, many countries took various measures to try to prevent COVID-19 from spreading. Similar pandemics have occurred in the past, and many prevention have been taken in this pandemic.[2] The primary strategy has been to reduce the burden on the health-care system (especially beds and ventilators, etc.) and to find ways to slow the spread of viral pathogens. These preventions include implementing rules such as social distancing, hand hygiene, and wearing masks.

During the COVID-19 pandemic, it was observed that protective measures such as social distancing and the use of masks were generally taken. On the other hand, a group of people were observed who thought there was no need to take these protective measures, did not wear masks, and ignored social distancing. Likewise, during this pandemic period, there have also been people who avoided going to any hospital.

It is predicted that droplet-transmitted diseases will cause pandemics in the future, as they have in the past. In order to control possible pandemics, it is important to increase people's awareness of droplet-transmitted diseases.[3] Therefore, it is essential to determine the level of public knowledge about COVID-19. In addition, parents are a particular group, and their behavior is important.[4] Therefore, parents, especially parents of children with systemic diseases, need to have a high level of knowledge to protect their children from pandemics individually. Although the COVID-19 vaccine has been found and the number of cases has decreased, people with chronic and systemic diseases are still at risk of COVID-19. Coronavirus disease 2019 infection in children shows symptoms similar to adults, but symptoms may be milder.[5] This situation is of great concern to pedodontists due to aerosol exposure during dental treatment and close working.

This questionnaire study aimed to assess the general knowledge and attitudes of parents of pediatric patients who visited the Pediatric Dental Clinic during the COVID-19 pandemic.

MATERIAL AND METHODS

The present questionnaire study was approved by the local ethics committee for clinical research at Tokat Gaziosmanpaşa University (Date: 21.10.2021, Number: 83116987-863, Registration Number: 21-KAEK-222).

This prospective study was administered to the parents of pediatric patients (aged 0–-14 years) who visited the Pediatric Dental Clinic of Tokat Gaziosmanpaşa University Faculty of Dentistry for routine pediatric dental examination between 28.10.2021 and 24.12.2021. The inclusion criteria were as follows: mentally healthy parents and children, parents who could complete/understand the questionnaire, and agreed to participate in the study. Questionnaires with incomplete answers were recorded as missing data and excluded from the study.

Before inclusion in the questionnaire study, written informed consent was obtained from the parents indicating that they agreed to participate in the study. The parents completed the questionnaires in the waiting room before the dental examination of the participant's child. Privacy and confidentiality were strictly upheld, with no disclosure of individual outcomes.

A questionnaire consisting of 3 sections was prepared for this study. In the first part of the questionnaire, there are questions about socio-demographic information; in the second part, there are 10 questions about the evaluation of parents' level of knowledge about COVID-19 infection; and in the third part, there are questions that include 5 written questions in the second part translated into visual questions. The purpose of adding the third section to the questionnaire was to determine the consistency of the participants' answers while filling out the questionnaire.

The adequacy of the content of the questionnaire and the accuracy of the answers were evaluated by 2 pediatric dentists and 1 oral diagnostician before the study, taking into account the guidelines of the Ministry of Health of the Republic of Turkey[6] titled "Guidelines for working in health institutions and infection control measures" and the guidelines published by the WHO.[7] A Turkish language expert evaluated the clarity of the understanding of the questions. Based on the comments made by these experts, the questionnaire was designed with 15 questions and questions to obtain demographic data. A pilot test was conducted to assess the accuracy and clarity of the questions. Fifteen parents completed the questionnaire. After each questionnaire was completed, parents were asked if any questions needed to be understood while filling out the questionnaire. The questionnaire was finalized according to the feedback.

Power Analysis

The number of participants was calculated using the G-Power sample size calculator (Universitat Kiel, Germany). A precision of 3%, a population size of 10 600, and a 95% confidence interval were used, and the minimum required sample size was calculated as 385. The effect size was derived from the reference.[8]

Statistical Analysis

The data obtained in our study were analyzed using the Statistical Package for the Social Sciences version 23.0 software program (SPSS Inc.; Chicago, IL, USA). Percentage and frequency values of the answers to the questions were obtained.

RESULTS

A total of 485 parents participated in the study and completed the questionnaires. However, 35 questionnaires were excluded from the analysis due to missing information. Consequently, 450 questionnaires were considered for evaluation. The distribution of responses to the questionnaires is presented in Tables 1–3, showing frequencies and percentages.

About 84.2% of the participants were young adults between 20 and 44 ages. About 19.1% of the participants graduated from primary education, 53.1% from secondary education, and 27.8% from higher education (Table 1).

In our study, a high proportion of participants (88.1%) and their children (94.1%) did not have any systemic disease (Table 1).

A high rate of participants correctly answered questions about the symptoms (Q1, Q3) and transmission routes (Q2) of COVID-19 infection. Details of the data of the answers to these questions are given in Table 2.

A high proportion of participants correctly answered questions about mask use (Q4, Q5) and social distance (Q8) (Table 2).

To the question, "Q6. What mask should the dentist wear when applying aerosolized (water-scattering) procedures during the COVID-19 pandemic?" 62.9% of the parents answered as specialty masks and 35.1% as surgical masks (Table 2).

To the question, "Q7. During the COVID-19 Pandemic, do dentists need protective clothing, masks, and glasses in aerosol (water-scattering) procedures?" 95.1% of the participants answered yes (Table 2).

To the question, "Q9. Has your child's tooth brushing frequency changed during the COVID-19 Pandemic?" 51.1% of the parents answered no, it has not changed, while 40.7% answered yes, it has increased (Table 2).

Table 1. Frequency and Percentages of Sociodemographic Data of Parents

PART 1: Questions About Parents' Sociodemographic Information		n	%
Age	20-44	379	84.2
	45-54	54	12
	55-74	17	3.8
Gender	Female	279	62
	Male	171	38
Education	Primary education	86	19.1
	Secondary education	239	53.1
	Higher education	125	27.8
The gender of the child you brought to our clinic today	Female	248	55.1
	Male	202	44.9
The age of the child you brought to our clinic today	0	1	0.22
	2	1	0.22
	3	10	2.22
	4	14	3.11
	5	29	6.44
	6	50	11.11
	7	33	7.33
	8	49	10.9
	9	52	11.55
	10	53	11.8
	11	39	8.66
	12	55	12.22
	13	55	12.22
	14	9	2
The number of siblings of the child you brought to our clinic today	0	35	7.8
	1	116	25.8
	2	156	34.7
	3	99	22
	4	35	7.8
	5	5	1.1
	6	3	0.6
	7	1	0.2
Does your child have any chronic diseases diagnosed by a doctor? (More than 1 option can be selected.)	None	447	94.1
	Hypertension (high blood pressure)	1	0.2
	Diabetes	2	0.4
	Asthma/coah	12	2.5
	Cancer	0	0
	Immune system diseases	0	0
	Heart diseases	3	0.6
	Others (Specify ...)	10	2.1
Do you have any chronic diseases diagnosed by a doctor? (More than 1 option can be selected.)	None	422	88.1
	Hypertension (high blood pressure)	10	2
	Diabetes	9	1.8
	Asthma/coah	16	3.4
	Cancer	1	0.2
	Immune system diseases	2	0.4
	Heart diseases	6	1.3
	Others (Specify ...)	13	2.8

Table 2. Frequency and Percentages of Data on Parents' Level of Knowledge About COVID-19 Infection

PART 2: Questions Related to the Evaluation of Parents' Level of Knowledge About COVID-19 Infection		n	%
Q1. What are the symptoms of COVID-19 infection? (More than 1 option can be selected.)	Fever	450	13.3
	Cough	440	13
	Shortness of breath	441	13
	Diarrhea	290	8.6
	Vomiting	244	7.2
	Runny nose	219	6.5
	Sore throat	376	11.1
	Redness of the eyes	229	6.8
	It may occur without symptoms	275	8.1
	Joint or muscle pain	406	12
	I don't know	13	0.4
Q2. What are the transmission routes of COVID-19 infection? (You can choose more than 1 option.)	Inhalation of respiratory droplets during coughing, sneezing, breathing	450	19.4
	Saliva	392	17
	Eye	202	8.7
	Blood	180	7.8
	Fecal–oral route	173	7.5
	Contact with a sick person	383	16.5
	Contact with surfaces where the virus is alive	358	15.5
	Sexually transmitted	175	7.6
	I don't know	1	0.0
Q3. COVID-19 infection in children has similar symptoms to adults, but symptoms may be milder.	Yes	369	82
	No	8	1.8
	I don't know	73	16.2
Q4. Is it necessary to wear a mask during the COVID-19 pandemic?	Yes	440	97.7
	No	6	1.5
	I don't know	4	0.8
Q4.(1) If yes, which type of mask should be used?	N95	45	10.4
	FFP2	6	1.4
	Surgical mask	267	62.1
	Cloth mask	44	10.23
	I don't know	68	15.82
Q5. During the COVID-19 pandemic, are patients and visitors to dental clinics required to wear face masks that cover the mouth and nose?	Yes	445	98.8
	No	2	0.5
	I don't know	3	0.7
Q6. What mask should the dentist wear when applying aerosolized (water-scattering) procedures during the COVID-19 pandemic?	Surgical mask	158	35.1
	Specialty mask (N95–FFP2)	283	62.9
	Surgical mask and specialty mask	9	2
Q7. During the COVID-19 Pandemic, do dentists need protective clothing, masks, and glasses in aerosol (water-scattering) procedures?	Yes	428	95.1
	No	12	2.6
	I don't know	10	2.3
Q8. Should there be a social distance of at least 1 meter between seats in waiting rooms of dental clinics during the COVID-19 pandemic?	Yes	438	97.3
	No	4	0.8
	I don't know	8	1.9
Q9. Has your child's tooth brushing frequency changed during the COVID-19 pandemic?	Yes, it increased	183	40.7
	Yes, it decreased	37	8.2
	No, it has not changed	230	51.1
Q10. Has your tooth brushing frequency changed during the COVID-19 pandemic?	Yes, it increased	172	38.2
	Yes, it decreased	12	2.7
	No, it has not changed	266	59.1

COVID-19, coronavirus disease 2019.

To the question "Q10. Has your tooth brushing frequency changed during the COVID-19 pandemic?" 59.1% of the parents answered no, it has not changed, and 38.2% answered yes, it has increased (Table 2).

Visual questions (Q11-15) in the third section on masks, protective equipment, and social distancing were answered correctly at

Table 3. Comparison of the Answers Given to the Written and Visual Questions Evaluating the Level of Knowledge of Parents About COVID-19 Infection

Visual Questions	n (%)	Written Questions	n (%)
Q11. During the COVID-19 Pandemic, which picture shows how a dentist should dress for aerosol (water-splashing) procedures?	394 (87.6) / 56 (12.4)	Q7. During the COVID-19 Pandemic, do dentists need protective clothing, masks, and glasses in aerosol (water-scattering) procedures?	Yes—428 (95.1) No—12 (2.6) I don't know—10 (2.3)
Q12. During the COVID-19 Pandemic, which mask shown in the pictures should the dentist use for aerosol procedures?	382 (84.9) / 68 (15.1)	Q6. What mask should the dentist wear when applying aerosolized (water-scattering) procedures during the COVID-19 pandemic?	Surgical mask—158 (35.1) Specialty mask (N95–FFP2)—283 (62.9) Surgical mask and specialty mask—9 (2)
Q13. Which of the masks shown in the pictures did you use during the COVID-19 pandemic?	55 (12.2) / 391 (86.9) / 4 (0.9)	Q4. Is it necessary to wear a mask during the COVID-19 pandemic? Q4.(1) If yes, which type of mask should be used?	Yes—430 (95.6) No—14 (3.1) I don't know—6 (1.3) N95—45 (10.4) FFP2—6 (1.4) Surgical mask—267 (62.1) Cloth mask—44 (10.23) I don't know—68 (15.82)
Q14. Which of the given images is the correct use of the mask?	392 (87.1) / 0 (0) / 1 (0.2) / 46 (10.2) / 11 (2.5)	Q5. During the COVID-19 pandemic, are patients and visitors to dental clinics required to wear face masks that cover the mouth and nose?	Yes—445 (98.8) No—2 (0.5) I don't know—3 (0.7)
Q15. Which of the pictures is incorrect in terms of social distancing during the COVID-19 pandemic?	17 (3.8) / 387 (86) / 45 (10) / 1 (0.2)	Q8. Should there be a social distance of at least 1 meter between seats in waiting rooms of dental clinics during the COVID-19 pandemic?	Yes—438 (97.3) No—4 (0.8) I don't know—8 (1.9)

COVID-19, coronavirus disease 2019.

a high rate. Details of the data of the answers given to these questions are given in Table 3.

When the answers given to the picture questions and the written questions corresponding to these picture questions were examined, it was seen that the answers were compatible with each other (Table 3).

DISCUSSION

In our study, the general knowledge level of the parents who visited the pediatric dental clinic during the COVID-19 pandemic was evaluated about COVID-19 infection. It is seen that our participants, most of whom are healthy and young adults with an intermediate level of education, have sufficient knowledge about

COVID-19 infection and the measures to be taken to protect against this infection, and they know that COVID-19 infection shows symptoms similar to adults in children, but the symptoms may be milder.

In the study conducted by Ceyhan et al,[9] most participants stated that the symptoms of COVID-19 infection were fever, shortness of breath, and dry cough. Similarly, in our study, participants chose fever, cough, and shortness of breath as the most common symptoms of COVID-19 infection. In the study conducted by Kasemy et al,[10] participants stated that fever was the main symptom among the symptoms of COVID-19 infection. Similarly, in our study, fever was the most frequently selected symptom among the symptoms of infection.

In our study, the most frequently selected ways to transmit COVID-19 infection were coughing, sneezing, inhaling respiratory droplets during breathing, saliva, and contact with a sick person. In the study conducted by Al-Hanawi et al,[11] the majority of participants stated that the transmission of infection occurs through respiratory droplets when infected people cough and sneeze. In the same study, 43.77% of the participants stated that people should use surgical masks to prevent infection. Similarly, in the study by Bates et al,[12] 47.2% of the participants stated that ordinary citizens should wear surgical masks. In the study conducted by Önal et al,[13] 91.6% of the participants it was stated that they used their masks to cover their mouth and nose. In the present study, most participants stated that it is necessary to wear a mask to cover the mouth and nose during the pandemic and that the type of mask to wear is a surgical mask.

In the study by Ahmed et al,[14] 60% of the parents they were reported that dentists should use personal protective equipment. In the study by Sürme et al,[15] almost all participants felt safe because the physician's protective clothing could prevent COVID-19 transmission. In the study conducted by Farsi and Farsi,[16] 82.4% of the parents stated that using personal protective equipment by dentists and ancillary staff is essential, and 77.7% of the participants answered that all visitors should use masks outside the treatment. Our study also observed that the parents knew that physicians should use protective equipment and special masks during aerosolized procedures.

In the study conducted by Farsi and Farsi,[16] participants stated that paying attention to social distancing in patient waiting rooms is very important. In our study, it was observed that the parents knew that social distancing should be kept in the clinics' waiting rooms.

In the present study, it was determined that participants had a high level of knowledge about COVID-19 infection. When the answers given to the visual questions and the written questions corresponding to these visual questions were examined, it was seen that the answers were compatible with each other. Therefore, the answers given by the participants to the questions are consistent.

A study conducted by Karaarslan et al[17] observed that the frequency of tooth brushing of adults increased significantly during the pandemic. In this study, it was reported that the first reason for the increase in tooth brushing frequency during the pandemic period was that individuals thought there was a relationship between COVID-19 infection and oral hygiene and that good oral hygiene would reduce the risk of infection. The second reason was that individuals feared their oral health would deteriorate because they could not visit the dentist due to the pandemic. According to the authors, first, these findings show that tooth brushing behavior is a multidimensional phenomenon influenced by perceived risks and benefits. Second, people engaged in inappropriate precautionary behaviors not mentioned or documented in the literature as a method of infection control to cope with a new disease. Third, perceived COVID-19 risk is positively associated with a positive response to toothbrushing behavior. Fourth, individuals' toothbrushing behavior changed rapidly and dramatically during the pandemic. Fifth, oral health care has not been separated from general health care during the pandemic, and oral health should be seen as a component of general health. Sixth, the pandemic can contribute to raising awareness of the importance of oral health.[13]

In the study conducted by Campagnaro et al[18] in June 2020, when the number of cases was high in Brazil, it was reported that 83.5% of children brushed their teeth during the pandemic. In our study, it was observed that the frequency of tooth brushing of both parents and children tended to increase rather than decrease. In addition, in our study, the tooth brushing frequency of children increased slightly more than that of their parents. This may be due to parents acting as the primary practitioners or supervisors of children's daily oral care and the possibility of not receiving dental treatment during the pandemic.[19]

The main limitation of this study is its single-center design. This situation may have limited the generalizability of the results to the whole population. Despite this limitation, the results of the study show parents' general level of knowledge about COVID-19 infection provides valuable information.

The participants have become aware of masks and distancing during the pandemic and know the symptoms and transmission routes of COVID-19 infection.

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The Childhood Bruxism: Literature Review

Çocukluk Dönemi Bruksizmi: Bir Literatür Derlemesi

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ABSTRACT

Bruxism is an activity characterized by tightening or creaking of the teeth that occurs most frequently during sleep. It may occur at night or in the daytime. Patients typically clench their teeth during the day, and they grit their teeth at night. Although its etiology is not entirely understood, it can be said that factors such as stress, nutritional deficiency, allergic diseases, unhealthy behaviors, and malocclusion predispose to the presence of bruxism. The treatment of childhood sleep bruxism is a multidisciplinary approach involving pediatricians, pedodontists, and other practitioners in the healthcare field. This study summarizes childhood bruxism, its etiological causes, diagnosis, and potential current options for treatment.

Keywords: Bruxism, teeth grinding, parafunctional habits, diagnosis, treatment

ÖZ

Bruksizm; en sık uyku sırasında ortaya çıkan dişlerin sıkılması veya gıcırdatılması ile karakterize bir aktivitedir. Gece ya da gün boyunca oluşabilmektedir. Etiyolojisi tam olarak bilinmemekle birlikte stres, beslenme yetersizliği, alerjik hastalıklar, zararlı alışkanlıklar ve malokluzyon gibi faktörlerin bruksizm varlığına yatkınlık oluşturduğu söylenebilir. Çocuklarda uyku bruksizmi tedavisi; pediatristler, pedodontistler ve diğer sağlık profesyonellerini de içeren multidisipliner bir yaklaşımdır. Bu derleme çocuklarda görülen bruksizmi, etiyolojik faktörlerini, tanı ve olası güncel tedavi seçeneklerini özetlemektedir.

Anahtar Kelimeler: Bruksizm, diş gıcırdatma, parafonksiyonel alışkanlıklar tanı, tedavi

INTRODUCTION

A typical movement problem called bruxism is characterized by teeth grinding or clenching. Sleep bruxism (nocturnal bruxism) and diurnal bruxism are the 2 categories (awake bruxism). Even while diurnal and sleep bruxism appears to have different etiologies, their impact on teeth may be comparable. Although healthy children and adults routinely experience bruxism, it is also frequently documented in kids with cerebral palsy and mental retardation.[1] In children, the reported prevalence of bruxism ranges from 3.5% to 40.6%[2], while in adults, it ranges from 8% to 31.4%.[3] In the pediatric population, bruxism is seen as a typical parafunctional condition linked to alterations in teeth. Children start grinding their teeth between the ages of 4 and 8 on average.[4] Due to mixed dentition, the prevalence of bruxism is higher between the ages of 10 and 14 and then declines.[5] However, because sleep bruxism may be a result of the continuous physiological development of the central nervous system, it can be challenging to evaluate bruxism in children.[6]

Even though it is thought of as a benign and self-limiting illness in youngsters, bruxism can deteriorate orofacial features if it gets bad enough.[7] Additionally, it was believed that some bruxist patients would benefit from sleep bruxism. This mechanism improves the upper respiratory tract's airway patency[8] and acts defensively by promoting salivation, which guards against tooth erosion.[9] However, bruxism can have several adverse effects on the stomatognathic system if it is not controlled, including aberrant tooth wear, tension headaches, pain or exhaustion in the chewing muscles, and temporomandibular disorders.[10]

ETIOLOGY

Harmful Habits and Malocclusion

Harmful oral habits (pacifier use, finger sucking, and nail biting); it is thought that these behaviors help kids deal with psychological and emotional challenges such as stress, worry, and tension. In this situation, sleep bruxism might be a method for the kid to unwind at night.[11] According to Drumond et al,[12] sleep bruxism was 50% more common in kids who bit their nails and 30% more common in kids who bit objects. They added that girls had a 22% lower prevalence of sleep bruxism. In a different study, oral respiration was assessed together with gender, breastfeeding style, pacifier use, bottle or finger sucking, nail biting, and other factors. It was shown that only oral respiration was statistically associated with sleep bruxism. Children who breathe orally during sleep are 2.71 times more likely to grind their teeth at night.[13] According to several types of research, a posterior crossbite is a protective feature. As a result, it is believed that children without posterior crossbites are 2.2 times more prone than those with posterior crossbites to bruxism.[14] Bruxism is brought on by regional causes like traumatic occlusion, early contact, protruding restorations, tooth cysts, and ectopic eruption. The development of bruxism is supported by malocclusions, calculus, mobility, lip deformity, gingival hyperplasia, and other occlusal physiology-related variables.[15] According to a study, the 2 oral behaviors that sleep bruxism sufferers have in common the most are breastfeeding and bottle feeding.[16] Although at a young age, these behaviors are not hazardous. When they are kept up for a long time, they may result in malocclusions and other oral health issues.[17] In their study, Zapata et al[18] found that 12.6% of bruxist patients utilize feeding bottles and pacifiers in addition to 23.13% using solely feeding bottles. Simões-Zenari and Bitar[19] observed a relationship between bruxism and pacifier use, lip biting, and nail biting and concluded that the risk of developing bruxism in children who use pacifiers is 7 times higher and that the risk of developing lip bites is 5 times higher. These studies indicate that the presence of certain harmful habits increases the likelihood of bruxism occurring.

Psychological Factors

Repeated teeth grinding as you sleep, which is triggered by stress and worry, is thought to be the primary cause of bad sleep.[20] The most frequent emotional element in children was stress from regular restlessness and worry. These elements may hinder the development of the facial skull complex and harm the Temporomandibular Joint (TMJ), muscles, periodontium, and other structures.[21] In research, children who reported being agitated and tense during the day had a statistically greater frequency of bruxism (42.7%) than children who reported being calm (22.6%).[22] According to Manfredini et al,[23] demographic factors may have an impact on a person's mental state, which may lead to sleep bruxism. A 2017 study from Brazil found that emotional elements like stress, anxiety, and personality features have an impact on several behaviors in bruxist patients.[24] A statistically significant association between sleep bruxism and psychosocial factors, particularly between bruxism and personality traits of stress, anxiety, and tension, was discovered in a 2015 study.[25] Neuroticism, perfectionism, aggression, higher sensitivity to stress, and coping mechanisms were found to be connected with an increased chance of developing bruxism, according to Serra-Negra et al[6] and Restrepo et al[26] Children with sleep bruxism had high levels of stress linked to psychological responses, according to a case–control study involving 360 patients aged 7-10 years.[27] Another study found that maternal stress had a significant impact on children's behavior and sleep bruxism.[12] According to studies, parental stress leads to emotional and/or psychological issues in children, and anxiety symptoms can lead to bad dental habits like nail biting.[28-30]

Genetics

According to a study, the HTR2A gene polymorphism plays a significant role in the development of sleep bruxism.[31] On the other hand, a meta-analysis in 2014 by Lobbezoo et al[32] that looked at 10 studies examining the connection between genetics and bruxism concluded that bruxism is partially inherited genetically.

Parasite/Allergy

Immunoglobulin E (IgE) levels are elevated in cases of allergies and parasitic intestinal infections; hence, it was decided that oral symptoms were present. Additionally, it has been noted that eosinophilia and bruxism are closely related to IgE levels.[15] Studies show that compounds known as non-specific proteins, which have toxic effects and are released from parasites at different stages of life, are typically connected to bruxism caused by intestinal parasites.[15] However, research examining this idea has produced varying conclusions.[34] While there was no difference in the presence of intestinal parasites between patients aged 6-11 who had bruxism and those who did not, according to Brazilian researchers, Indian researchers concluded that these parasites may be the cause of the onset of bruxism in children aged 3-6 years.[35]

Nutrition/Cigarette

Adult studies have revealed that smokers experience bruxism more frequently. The impact of cigarette smoke on bruxism in children has so been researched. According to a study, children who are exposed to high amounts of smoking are more likely to develop bruxism than those who are exposed to moderate or low levels.[36] In a different study, it was hypothesized that dietary elements such as caffeine, tea, chocolate beverages, soft drinks, and smoking could lead to bruxism by stimulating the central nervous system and escalating stress and anxiety.[37,38]

Diseases

Nutritional deficiencies, parasite infestations, Down syndrome, gastrointestinal issues, allergic reactions, pharmacological side effects, mental retardation, and cerebral paralysis are some of the systemic problems connected to bruxism.[38] Patients with neurological diseases getting neuroleptic and anticonvulsant medication have shown signs of bruxism. Patients using stimulant medications including levodopa, amphetamines, and antidepressants frequently experience bruxism.[38-40]

Gastroesophageal reflux and bruxism have been linked in a 2018 study; long-term gastroesophageal reflux has been observed to induce severe tooth wear in patients with bruxism. Since dentists are the ones who usually notice tooth wear, when bruxism patients exhibit any symptoms of pathological tooth wear as a result of erosion, dentists should thoroughly assess systemic conditions like dietary practices, oral hygiene, and gastroesophageal reflux to further understand reflux symptoms. important.[41]

An investigation into the prevalence of bruxism and its associations with age, gender, intellectual handicap level, and trisomy 21 chromosomal abnormalities was conducted in 2007 among a group of Mexican children with Down syndrome. In the 57 patients (36 normal, 11 with mosaicism, and 5 with translocation) included in the study, bruxism was observed to be prevalent at a rate of 42%. According to a report, there is no appreciable

variation in bruxism prevalence between the sexes. There is no discernible difference between children with special educational needs at various levels, according to research. The various forms of trisomy 21 were discovered to significantly differ from one another, though. Five times more probable than children without mosaicism, children with Down syndrome who also have mosaicism are more likely to have bruxism.[42]

In a study including kids with autism, it was discovered that the prevalence of bad oral habits was almost twice as high in these kids (87.3%) as compared to typically developing kids (49.3%). Object biting (44.7%), mouth breathing (26.7%), and bruxism (54.7%) were the 3 behaviors that autistic kids were most likely to engage in. This is thought to enhance the likelihood of malocclusions.[43]

Diagnosis

The clinical identification and evaluation of bruxism is a difficult process. It is crucial to observe the patient or their parent or caregiver to spot bruxism. One of the reasons parents look for expert assistance is teeth grinding as they sleep.[44] This highlights the need and necessity of educating patient families more. It is advised that medical professionals speak clearly and use appropriate terminology to ensure proper communication with parents or carers during anamnesis and treatment.[45]

According to the findings of a cross-sectional study conducted on 1325 parents in 5 distinct Brazilian regions, 57.3% of respondents had no idea what sleep bruxism was and 60.0% had no idea what its causes were.[45] In rare instances, sleep bruxism may go unnoticed by parents. Examples of these circumstances include not sharing a bed, children's sleep bruxism symptoms not being severe, and the onset of tooth wear.[46]

In the clinical diagnosis of bruxism, symptoms such as occlusal and/or incisal abrasion, pulp hypersensitivity, destruction of periodontal tissues, mobility, temporomandibular joint pain and disorders, cusp-restoration fractures, masseter hypertrophy, and headache are frequently observed.[47] It may cause pseudo-class III development by accelerating the resorption of primary teeth and causing changes in the eruption time of permanent teeth.[48] Also, clinical features of sleep bruxism include masticatory muscle hypertrophy, indentations on the lip or tongue, and linea alba on the cheek.[49] However, they can also be consequences of functional promoter activity such as swallowing[50]

Sample questions directed to patients or parents in the diagnosis of bruxism are shown in Table 1.

TREATMENT

Children's sleep bruxism is treated using a multidisciplinary strategy that involves pedodontists, pediatricians, and other medical specialists.[52] Orthodontic treatments, bite aligners, and restorative operations are frequently carried out by dentists. Bite plates are used to minimize muscle activity and to relieve the patient. Therefore, in more severe situations, the occlusal surface is shielded from deterioration.[53] Occlusal alignment, orthodontic bracketing, an interdental splint, psychotherapy, and exercises are advised if bruxism has caused harm to the stomatognathic system. On the best strategy, there is still no agreement, though.[54] Rapid expansion therapy is used to treat children with bruxism in sleep apnea syndrome situations to widen the airways, enhance breathing, and lessen parafunction.[55]

For the treatment of bruxism in the adult population, studies have looked at the use of pharmacological drugs such as analgesics, anti-inflammatories, muscle relaxants, benzodiazepines, catecholamine precursors, and beta-adrenergic antagonists. There is not a single medicine that is effective and safe enough to use on kids.[56] However, both adult and pediatric populations may benefit from short-term (<6-12 weeks) medication use. Diazepam is a benzodiazepine with an intermediate and long half-life that is used to treat several some money ailments, including anxiety, muscle spasms, seizures, and sleep disturbances.[57]

In a 2019 study, the effectiveness and safety of short-term diazepam use on the management of sleep bruxism in healthy children were assessed. A total of 109 children with sleep bruxism were randomly assigned to 1 of 3 groups in this double-blind, randomized, placebo-controlled clinical experiment. These groups each received low- or moderate-dose benzodiazepines for 2 weeks or a placebo. The severity of sleep bruxism was evaluated at baseline and then again at weeks 2, 8, and 12. The long-term control of sleep bruxism in children was not observed to be improved by short-term diazepam use over a placebo. In both groups, bruxism drastically decreased after using diazepam for 2 weeks. The severity of bruxism thereafter reverted to approximately pretreatment severity in all groups; therefore, this impact is just temporary.[58]

Although the use of several pharmacological drugs has been recorded, the research by Yap and Chua[60] indicates that there are only controlled clinical studies demonstrating the effectiveness of clonidine, L-dopa, and clonazepam in the treatment of sleep bruxism.[59] The long-term use of agents in this field is constrained by side effects, which include certain psychological negative consequences and the possibility of addiction. The most widely employed benzodiazepine in this area is clonazepam.[60]

Another treatment choice is psychological counseling. Behavioral therapy procedures are part of psychological treatment and are used to treat behaviors, manage environmental factors, and lessen stress in patients.[61]

Table 1. Examples of Questions Directed to the Patient and/or Parents in the Diagnosis of Bruxism[51]

	Never	Sometimes	Generally	Don't Know
Do you grind your teeth while sleeping?				
Has anyone heard you grind your teeth while you sleep?				
Do you notice that you grit your teeth when you wake up?				
Do you have jaw pain or jaw fatigue when you wake up?				
Have you ever felt your teeth shake when you woke up?				
Do you have pain in your teeth and/or gums when you wake up?				
Do you have pain in your temples when you wake up?				
Do you have a lock in your jaw when you wake up?				
Have you ever noticed that you grind your teeth during the day?				
Have you ever noticed that you grind your teeth during the day?				

CONCLUSION

Bruxism is a complex condition with an unknown etiology that is now regularly observed in both adults and children. This condition has to be identified to be treated. The awareness of parents on this problem closely relates to their capacity to diagnose bruxism in youngsters. According to studies, parents are ignorant of bruxism. These findings imply that parents should get an education to lessen the prevalence and severity of bruxism.

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Self Adeziv Rezin Simanlar

Self-Adhesive Resin Cements

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ÖZ

Sabit protetik restorasyonlar diş hekimliğinde en çok tercih edilen restorasyonlardır. Sabit protetik restorasyonların kullanımındaki artışa bağlı olarak, restorasyon ve dişi yapıştırmak amacıyla kullanılan simanlar da önem kazanmaktadır. Klinisyenlerin tercihi, mekanik özellikleri iyi olan, kullanımı kolay, biyouyumlu ve farklı renk seçenekleri olan simanlardan yanadır. Bu amaçla self adeziv rezin simanlar geliştirilmiştir. Self adeziv rezin simanlar, geleneksel simanların uygulama kolaylığı ile kompozit rezin simanların iyi mekanik özellikleri ve estetik üstünlüklerini birleştirmeyi amaçlayan, klinik uygulama basamaklarını azaltan ve böylelikle de teknik hassasiyet kaynaklı hataları en aza indiren simanlardır. Bu derleme, self adeziv rezin simanların kullanımı, klinik prosedürleri, özellikleri ve gelişimlerini değerlendirmeyi amaçlamaktadır.

Anahtar Kelimeler: Adezyon, self adeziv rezin, siman

ABSTRACT

Fixed prosthetic restorations are most preferable restorations in dentistry. Because of that, cements used for bonding fixed restoration become popular in recent years. Clinicians prefer cements with good mechanical properties, that are easy to use, that are biocompatible, and with different color options. For this purpose, self-adhesive resin cements have been developed. Self-adhesive resin cements are cements that aim to combine the ease of application of traditional cements with the good mechanical properties and esthetic advantages of composite resin cements, reducing the clinical application steps and thus minimizing technical sensitivity-related errors. This review aims to evaluate the use, clinical procedures, characteristics, and development of self-adhesive resin cements.

Keywords: Adhesion, self adhesive resin, cement

GIRIŞ

Klinisyenlerin temel amacı; hastaya, sabit protezlere destek olan doğal dişlerin pulpa canlılığını koruyan ve kayıp fonksiyonu yeniden kazandıran bir restorasyon yapmaktır.

Dental simanlar; genellikle tek başlarına veya diğer materyallerle birlikte restorasyon maddeleri olarak veya sabit protez uygulamalarında yapıştırma maddeleri olarak kullanılırlar. Yapıştırma simanlarının temel görevi restorasyon ve diş arasındaki boşluğu doldurarak, fonksiyon sırasında restorasyonun yerinden çıkmasını önlemek amacıyla restorasyon ve diş arasında mekanik kilitlenme sağlamaktır.[1]

REZIN SIMANLAR

Rezin simanlar hem diş yapısına hem de restorasyona bağlantı sağlayabildikleri için klinik olarak popüler hale gelmiştir.[2] Rezin simanlar yüksek basınç, çekme, yapışma dayanımına sahiptirler, çözünürlükleri düşüktür ve yüksek estetik avantajına sahiptirler. Bu özellikleri yüksek retansiyon, aşınma direnci ve estetik beklentilerin yüksek olduğu vakalarda kullanılmalarına izin verir.[3]

Rezin simanlar adeziv sistemlerine göre; asitlenen ve yıkanan (etch and rinse), kendinden asitli (self etch) ve kendinden adezivli (self adeziv) rezin simanlar olarak sınıflandırılmaktadır. Asitlenen ve yıkanan rezin simanlarda, simanı dişe bağlamak için bir fosforik asit ve adeziv kullanılmaktadır. Bu sistemde bağlanma diğer sistemlere göre daha yüksektir, ancak seramik, kompozit veya metali dişe yapıştırmak için en fazla adımı gerektirir. Self etch sistemde diş yüzeyine kendinden asitli bir primer uygulanır ve karıştırılan siman primerin üzerine uygulanır. Self adeziv rezin simanlar en yeni simanlardır ve diş yüzeyine bağlanmak için asit, primer veya bonding ajan kullanımı gerektirmez.[3-6]

SELF ADEZIV REZIN SIMANLAR

Self adeziv rezin simanlar ilk kez 2002 yılında piyasaya sürülmüştür. Günümüzde diş hekimliğinde kullanımı oldukça yaygın hale gelmiştir. Self adeziv rezin simanlar geleneksel simanların uygulama kolaylığı ile kompozit rezin esaslı simanların iyi mekanik özellikleri ve estetik üstünlüklerini birleştirmeyi amaçlayan, klinik uygulama basamaklarını azaltan ve böylelikle de teknik hassasiyet kaynaklı hataları en aza indiren simanlardır. Self adeziv rezin simanlar, asitleme ve ilave bir adeziv ajan uygulama gerektirmeden diş sert dokusunu demineralize ederek diş dokusuna infiltre olabilen simanlardır.[7-10]

Self adeziv rezin simanlar asit veya primer kullanımı gerektirmezler. Multifonksiyonel asit katılarak modifiye edilmiş metakrilat monomerleri smear tabakasını çözer simanın dentin tübüllerine nüfus etmesini sağlar böylece mikromekanik bağlanma gerçekleşir. Aynı zamanda fosforik asit grupları, diş sert dokularında yer alan hidroksiapatit ile reaksiyona girer ve monomer asidik grup ile çözünmüş apatit arasında kimyasal bir etkileşim ve kimyasal bağlanma gerçekleştirir.[2,11,12] Bu simanların diş dokularına bağlanması hibrit tabaka oluşturarak değil, smear tabakasını ortadan kaldırarak diş dokularına infiltre olur bu yüzden bağlanma rezin simanlardan ziyade cam iyonomer simanlara benzerlik göstermektedir. Smear tabakasını tamamen yok etmedikleri için postoperatif hassasiyet oluşturmazlar. Fiziksel özellikleri kompozit rezin simanlarla benzerlik göstermekle beraber yük altında deformasyona karşı yüksek bir dayanıklılığa sahiptir. Self adeziv rezin simanlar kimyasal olarak, ışık ile ve hem ışık hem kimyasal olarak (dual cure) polimerize edilebilmektedirler. Genellikle inley-onley, kron ve postların simantasyonunda kullanılabilirler.[11,13-15] Günümüzde bu simanlarla ilgili birçok çalışma yapılmaktadır.

Self Adeziv Rezin Simanların Mekanik Özellikleri Üzerine Çalışmalar

Simanlar basınca karşı dayanıklı olmalıdır, siman diş ve restorasyon ara yüzündeki gerilimleri kırmadan iletebilmek için yeterli eğilme dayanımına sahip olmalıdır. Rezin simanlar hem dişe hem de restorasyona bağlandığından yüksek basınca karşı dayanıklıdır ve seramik gibi kırılgan malzemelerin dayanıklılığını artırır. Ayrıca simanın elastik modülü dentine ne kadar yakınsa, siman diş ara yüzündeki stresler o kadar az olur ve daha dayanıklı bir bağlanma oluşur.[3] Self adeziv rezin simanların mekanik özellikleri üzerine yapılan bazı çalışmalar Tablo 1'de görülmektedir.

Hattar, S. ve ark[16] çalışmalarında bağlanma dayanımı açısından self adeziv rezin simanları başarısız bulmuşlardır. Aguiar, T, R. ve ark[17] çalışmalarında self adeziv rezin simanların konvansiyonel rezin simanlara göre 2 yıllık yaşlandırma sonucunda daha yüksek bağlanma dayanımı gösterdiğini bulmuşlardır. Rodrigues ve ark[18] self rezin simanın konvansiyonel rezin siman ile benzer makaslama dayanımına sahip olduğunu fakat fosforik asit ile kombine edildiğinde en iyi sonuç alındığını belirtmişlerdir. Moghaddas, M. ve ark[19] self adeziv rezin siman ve konvansiyonel rezin siman arasında bağlanma dayanımı açısından fark bulunmadığını, mineye uygulanan asit ve primerin bağlanma dayanımını etkilemediğini ancak dentine uygulanan asit ve primerin bağlanma dayanımını azalttığını bildirmişlerdir. Pilo, R. ve ark[20] ışıkla polimerize edilen simanlardaki monomerlerin polimerlere dönüşüm derecesinin kimyasal polimerize olan simanlara göre daha yüksek olduğunu ve buna bağlı olarak mekanik özelliklerin daha iyi olduğunu bulmuşlardır. Hitz, T. ve ark[21] bütün self adeziv simanların konvansiyonel simanlara alternatif olmadığını, bazılarının daha düşük bağlanma dayanımı gösterdiğini bildirmişlerdir. Furuichi, T. ve ark[22] eğilme dayanımı en yüksek siman olarak Beauticem SA'yı (Shofu Inc, Kyoto, Japan) bulmuşlardır. Tüm simanlardaki aşınma miktarlarını benzer bulmuşlardır. Shafei ve ark[23] çalışmalarında self adeziv simanlarda mine ve dentin yüzeyinde 5 sn'lik aşındırma 15 sn'lik aşındırma kadar etkili olduğunu bu nedenle daha az süre aşındırmanı mine ve dentin yüzeyinde bağlanma dayanımını artırdığını ve daha az teknik hassasiyet gerektirdiğini bildirmişlerdir. Pathak, S. ve ark[24] Rely X U200 siman (3M ESPE, Neuss, Germany) ile yapıştırılan kronlardaki retansiyon miktarını daha yüksek bulduklarını, SmartCem2 (Caulk-Dentsply, Milford, DE, USA) ve RelyX Luting 2 (3M ESPE, St Paul, MN, USA) simanlarındaki retansiyon miktarlarında anlamlı bir farklılık olmadığını bildirmişlerdir.

Yapıştırma simanları düşük film kalınlığına sahip olmalıdır. Düşük film kalınlığı restorasyonun dişe oturmasını kolaylaştırır, marjinal uyumun iyi olmasını sağlar, bu da plak birikimini, periodontal hastalığı, simanın çözünmesini ve sekonder çürük oluşumunu azaltır. Ayrıca su emilimi ve suda çözünebilirlik simanda strese neden olur ve bunun sonucunda restorasyonun ayrılmasına veya kırılmasına neden olabilir.[3]

Petropoulou, A. ve ark[25] su emiliminin ve suda çözünebilirliğin konvansiyonel simanlarda self adeziv simanlardan daha düşük olduğunu söylemişlerdir. Pan, Y. ve ark[26] self adeziv rezin simanların konvansiyonel rezin simanlara göre daha fazla su absorbsiyonu olduğunu ve suda daha fazla çözünebildiğini bildirmişlerdir. Almeida, C, M. ve ark[27] self adeziv rezin simanların 6-12 aylık süreçte bağlanma dayanımının azaldığını, polimerizasyon profili analizine göre dönüşüm derecesini optimize etmek için ışık aktivasyonunun üreticinin önerdiğinden daha fazla olması gerektiğini öne sürmüşlerdir. Kirsten, M. ve ark[28] iCEM'de (Heraeus Kulzer, Hanau, Germany) çatlak oluşumu ve siman aralığının daha fazla arttığını gözlemişlerdir. Roedel ve ark[29] iCEM'deki higroskopik ekspansiyonu daha yüksek, iCEM'deki ph nötralizasyonunu daha düşük bulmuşlardır. Araştırmacılar simanlardaki hidrofilikliğin ve pH nötrleştirme davranışının higroskopik genleşme stresi üzerinde önemli bir etkiye sahip olduğunu söylemişlerdir.

Self Adeziv Rezin Simanın Flor Salınımı Üzerine Çalışmalar

Sekonder çürükler, restorasyonların başarısız olmasına ve değiştirilmesine neden olur.[30] Flor salınımı yapan simanlar çürük ilerlemesini önler ve bu durumdan doğacak sorunları azaltır.[31] Pellizzari, V. ve ark[32] SeT (SDI, Bayswater, Australia) ve MaxCem (Kerr, Orange, CA, USA) simanların flor salınımı cam iyonomer simana benzer olduğunu ancak cam iyonomer simanın flor salınımının daha yüksek olduğunu bulmuşlardır.

Self Adeziv Rezin Simanın Restoratif Materyallere Bağlanması Üzerine Çalışmalar

Yapıştırma ajanlarının restoratif materyale ve dişe başarılı bir şekilde bağlanması; restorasyonların uzun süre ağızda kalması ve marjinal uyum için gereklidir.[33]

Bitter ve ark[34] fiber postları self adeziv rezin siman kullanarak yapıştırmışlardır ve simanların bağlanma dayanımlarını inceledikleri çalışmalarında; başarısızlığı dentin ve yapıştırma ajanı arasındaki başarısızlık, post ve yapıştırma ajanı arasındaki başarısızlık, her ikisi kombine şekilde başarısızlık ve post içindeki koheziv başarısızlık olarak sınıflamışlardır. Araştırmacılar çalışmanın sonucunda çoğu başarısızlığın dentin ve siman arasında meydana geldiğini, dentin ve siman arasındaki bağlanma dayanımının Smart Cem ve Relyx Unicem'de daha yüksek olduğunu bildirmişlerdir. Özlek ve ark[35] 2 yeni fiber post sisteminin (FiberSite Post

Tablo 1. Self Adeziv Rezin Simanların Mekanik Özellikleri Üzerine Yapılan Bazı Çalışmalar

Araştırmacı-Yıl	Kullanılan Simanlar	Sonuç
Hitz, T. ve ark - 2012	Clearfil SA (Kuraray Dental Co.Ltd., Osaka, Japan), G-Cem(GC, Leuven, Belgium), SmartCem2 (Caulk-Dentsply, Milford, DE, USA), SpeedCEM (Ivoclar VIvadent, Schaan, Liechtenstein), RelyX Unicem (3M ESPE, Seefeld, Germany), RelyX Unicem2 (3M Deutschland, GmbH, Neuss, Germany) Panavia21 (Kuraray Dental Co.Ltd., Osaka, Japan)	Self adeziv rezin siman ve konvansiyonel rezin simanın dentine ve seramik yüzeyine bağlanma dayanımı ölçülmüştür. Self adeziv simanların konvansiyonel simanlara alternatif olmadığı, bazılarının daha düşük bağlanma dayanımı gösterdiği bildirilmiştir.
Aguiar, T, R. ve ark - 2014	RelyX Unicem (3M ESPE, Seefeld, Germany), Clearfil SA Cement (Kuraray Dental Co.Ltd., Osaka, Japan), RelyX ARC (3M ESPE, St. Paul, MN, USA) ve Clearfil Esthetic Cement (Kuraray Noritake Dental Inc, Tokyo, Japan)	Konvansiyonel rezin simanların ve self adeziv rezin simanların dentine bağlanma dayanımı ölçülmüştür. Self adeziv rezin simanların konvansiyonel simanlara göre 2 yıllık yaşlandırma sonucunda daha yüksek bağlanma dayanımı gösterdiği, 2 yılın sonunda Clearfil Esthetic Cement simanın en düşük bağlanma dayanımına sahip olduğu bildirilmiştir.
Petropoulou, A. ve ark-2015	Panavia F 2,0 (Kuraray America, Inc) Clearfil SA (Kuraray Dental Co.Ltd., Osaka, Japan), G-Cem (GC, Leuven, Belgium), Calibra Esthetic Resin Cement (Dentsply DeTrey GmbH, Germany)	Su emilimi ve suda çözünebilirlik değerlendirilmiştir. Su emiliminin ve suda çözünebilirliğin konvansiyonel simanlarda self adeziv simanlardan daha düşük olduğu, bu farklılığın nedeninin self adeziv rezin simanlarda bulunan fonksiyonel monomer olan hidrofilik asidik gruplardan kaynaklandığını söylemişlerdir.
Rodrigues ve ark-2015	RelyX U100 (3M ESPE, St. Paul, MN, USA) ve RelyX U 200 (3M ESPE,Neuss,Germany), RelyX ARC (3M ESPE, St. Paul, MN, USA)	Mine ve dentindeki makaslama dayanımı ölçülmüştür. Minede, U200 rezin simanın ARC rezin siman ile benzer makaslama dayanımına sahip olduğunu fakat fosforik asit ile kombine edildiğinde en iyi sonuç alındığını belirtmiştir. Dentinde her 3 simanın makaslama dayanımı benzer bulunmuştur.
Hattar, S. ve ark-2015	SmartCem2 (Caulk-Dentsply, Milford, DE, USA), RelyX Unicem (3M ESPE,Seefeld, Germany), seT SDI (SDI Limited, Victoria, Australia)	Simanların bağlanma dayanımı ölçülmüştür. Mine ve dentin farketmeksizin bağlanma dayanımı açısından tüm simanlar başarısız bulunmuştur.
Furuichi, T. ve ark – 2016	G-CEM (GC, Leuven, Belgium), BeautiCem SA (Shofu Inc, Kyoto, Japan), Maxcem Elite (Kerr Italia Srl,Scafati, Italy), Clearfil SA Luting(Kuraray Dental Co.Ltd., Osaka, Japan), RelyX Unicem 2 (3M ESPE Dental Products, St Paul, MN, USA), Clearfil Esthetic Cement (Kuraray Noritake Dental Inc, Tokyo, Japan)	Self adeziv rezin simanların mekanik özellikleri ve aşınma dirençleri değerlendirilmiştir. Eğilme dayanımı en yüksek siman olarak Beauticem SA bulunmuştur. Tüm simanlardaki aşınma miktarlarını benzer bulmuşlardır, simanlardaki termal ekspansiyon katsayısı Relyx Unicem'de daha düşük iken MaxCem Elite'de daha yüksek bulunmuştur.
Pathak, S. ve ark-2016	Rely X Luting 2(3M ESPE, St Paul, MN, USA), RelyX U200 (3M ESPE,Neuss,Germany), SmartCem2 (Caulk-Dentsply, Milford, DE, USA)	RelyX U200 ile yapıştırılan kronlardaki retansiyon miktarı daha yüksek bulunmuştur, SmartCem2 (self adeziv rezin siman) ve RelyX Luting 2 (RMGIC) simanlarındaki retansiyon miktarlarında anlamlı bir farklılık olmadığı bildirilmiştir.
Roedel ve ark-2016	RelyX Unicem 2 (3M Deutschland GmbH, Neuss,Germany), iCEM (Heraeus Kulzer, Hanau, Germany) , Maxcem Elite (Kerr Italia Srl,Scafati, Italy),	Self adeziv rezin simanların ph nötralizasyonu, hidrofiliklik ve higroskopik genleşme stresi araştırılmıştır. iCEM'deki higroskopik ekspansiyonu daha yüksek, iCEM'deki ph nötralizasyonunu daha düşük bulunmuştur.
Moghaddas, M.J. ve ark - 2017	RelyX ARC (3M ESPE, St. Paul, MN, USA), RelyX Unicem (3M ESPE, Seefeld, Germany), Acid etching +RelyX Unicem	Self adeziv rezin simanın mine ve dentine bağlanmasında asit ve primer uygulanmasının bağlanma dayanımına etkisi incelenmiştir. Self adeziv rezin siman ve konvansiyonel rezin siman arasında bağlanma dayanımı açısından fark bulunmadığı, mineye uygulanan asit ve primerin bağlanma dayanımını etkilemediği ancak dentine uygulanan asit ve primerin bağlanma dayanımını azalttığı bildirilmiştir.
Pilo, R. ve ark-2017	3 farklı self adeziv 1 tane self etch	Simanların fotopolimerizasyon etkinliği ve simanların mekanik özellikleri değerlendirilmiştir. Işıkla polimerize edilen simanlardaki monomerlerin polimerlere dönüşüm derecesinin daha yüksek olduğu ve buna bağlı olarak mekanik özelliklerin daha iyi olduğu bulunmuştur.
Kirsten, M. ve ark-2018	iCEM (Heraeus Kulzer, Hanau, Germany), RelyX Unicem 2 (3M Deutschland GmbH, Neuss,Germany), VariolinkEsthetic DC (Ivoclar Vivadent, Schaan, Liechtenstein)	Self adeziv rezin simanların higroskopik genleşmelerini ve bu simanlarla yapıştırılan tam seramik kronların bütünlüğü incelenmiştir. iCEM'de tüm örneklerde çatlak oluşumu ve aynı grupta siman aralığının daha çok arttığı gözlenmiştir.
Almeida, C, M. ve ark – 2018	SmartCem2 (Caulk-Dentsply, Milford, DE, USA), BisCem(Bisco, Schaumburg, USA), SeT PP (SDI, Bayswater, Australia), Relyx U100 (3M-ESPE,St. Paul, USA), YCEM (Yller Biomaterials, Pelotas, Brazil)	Uzun süreli bağlanma dayanımı ve bazı özellikleri (dentindeki demineralizasyon paternini, ph miktarını, monomerlerin polimere dönüşme oranını, eğilme dayanımı ve elastik modülünü) değerlendirilmiştir. 6-12 aylık süreçte simanların bağlanma dayanımı azalmıştır. BisCem ve SmartCem'in bağlanma dayanımının en düşük olduğu bildirilmiştir.
Pan, Y. ve ark - 2018	Multilink, Duolink (Bisco Inc., Schaumburg, USA), Nexus (Kerr, Orange, USA) Multilink Speed (Ivoclar-vivadent, Schaan, Liechtenstein), Biscem (Bisco Inc., Schaumburg, USA), Maxcem (Kerr, Orange, USA)	Yaşlandırma işleminden sonra yüzey morfolojisini ve mekanik özellikleri (mikrosertlik, su absorbsiyonu ve suda çözünebilirlik) değerlendirilmiştir. Araştırmacılar self adeziv rezin simanlarda konvansiyonel rezin simanlara göre daha fazla su absorbsiyonu olduğunu ve suda daha fazla çözünebildiğini dolayısıyla self adeziv rezin simanların mekanik özelliklerinin daha düşük olduğunu bildirmişlerdir.
Shafiei, F. ve ark 2019	Panavia SA Luting Plus (Kuraray Noritake Dental Inc, Japan), Bifix SE (Voco GmbH,Cuxhaven, Germany), %35 ortofosforik asit	Self adeziv simanlarda asitleme işleminin ve süresinin dişe bağlanma dayanımı ve diş yüzeyinin morfolojisi üzerine etkisi incelenmiştir. Çalışmada mine ve dentin yüzeyinde 5 sn'lik aşındırma 15 sn'lik aşındırma kadar etkili olduğu bu nedenle az süre aşındırmak mine ve dentin yüzeyinde bağlanma dayanımını artırdığı ve daha az teknik hassasiyet gerektirdiği bildirilmiştir.

Konu ile ilgili çalışma yapan araştırmacılar genel olarak self adeziv rezin simanların konvansiyonel simanlardan daha zayıf mekanik özellikleri olabileceğini, self adeziv simanların dentindeki adezyonunun daha düşük olabileceğini ancak analizler göz önüne alındığında klinik olarak kullanılabileceğini bildirmişlerdir.

ve Cytec Blanco Post) 2 farklı self adeziv rezin (Panavia SA ve Maxcem Elite) simanla bağlanma dayanımını inceledikleri çalışmada, Maxcem Elite (Kerr Italia Srl, Scafati, Italy), self adeziv rezin simanın, Panavia SA (Kuraray Noritake Dental Inc, Japan) self adeziv rezin simandan daha yüksek bağlanma dayanımı gösterdiğini, post tipinin bağlanma dayanımı üzerinde önemli bir etkiye sahip olmadığını bulmuşlardır. Bu çalışmanın aksine literatürdeki birçok çalışmada Panavia SA self adeziv rezin siman Maxcem Elite self adeziv rezin simandan daha yüksek bağlanma dayanımı göstermiştir.[36-38] Aktemur, T, S. ve ark[39] RelyX Unicem (3M ESPE, Seefeld, Germany) self adeziv rezin simanın, Clearfil SA (Kuraray Dental Co.Ltd., Osaka, Japan) ve G-Cem (GC, Leuven, Belgium) self adeziv rezin simana göre daha yüksek bağlanma dayanımı gösterdiğini bildirmişlerdir. Macedo ve ark[40] RelyX Unicem (3M ESPE, Seefeld,

Germany) self adeziv rezin simanın daha yüksek bağlanma dayanımına sahip olduğunu bildirmişlerdir. Lopes, A. ve ark geçici simanlar ve self adeziv rezin simanların titanyum abutmentlara retansiyonunu ölçtüğü çalışmalarında self adeziv rezin simanların daha yüksek retansiyona sahip olduğunu bildirmişlerdir.[41] Ramazanzadeh, B, A. ve ark'[42] larının ortodontik braketleri self adeziv rezin simanlarla yapıştırdığı, bağlanma dayanımını ve flor salınımı ölçtüğü çalışmada; self adeziv rezin simanların asit uygulananan simanlara göre daha düşük bağlanma dayanımı gösterdiğini, self adeziv rezin simanların uzun süreli flor salınımına sahip olduğunu bu nedenle demineralizasyonu engelleyebileceği için yapıştırma ajanı olarak kullanılabileceğini bildirmişlerdir.

Self Adeziv Rezin Simanın Marjinal Uyumu ve Renklenmesi Üzerine Çalışmalar

Hastaların doğal görünüme sahip, diş renginde restorasyonlara yönelik estetik talepleri artmaktadır. Restoratif materyaller ve yapıştırma simanları gıda alımı sıvılara ve sırasında değişen sıcaklıklardan kaynaklanan büyük etkilere maruz kalmaktadır. Bunun sonucunda su absorbsiyonu olmakta ve bu durum malzemenin şişmesine, polimer ağın zayıflamasına, doldurucu matriksin bozulmasına, sekonder çürüklerin oluşmasına ve aşırı duyarlılığa neden olmaktadır.[43] Ayrıca mekanik özelliklerin yanı sıra, renk parçacıklarının yiyeceklerden gömülmesi de renk değişikliği ile olumsuz görsel etkilere yol açabilir. Cal, E. ve ark[44] okluzal marjinlerdeki mikrosızıntının konvansiyonel rezin simanlara göre self adeziv simanlarda daha fazla olduğunu, gingival marjindeki mikrosızıntının ise benzer olduğunu belirtmişlerdir. Liebermann, A. ve ark[45] 1 yıllık takip süreci sonucunda tüm self adeziv simanlarda renklenme gözlemlememişlerdir. Çalışmanın sonunda, en az renklenen simanın Clearfil SA Cement Automix (Kuraray Dental Co.Ltd., Osaka, Japan), en çok renklenen simanın ise SmartCem2 (Caulk-Dentsply, Milford, DE, USA) olduğu açıklanmıştır. Chang, B. ve ark[46] ultrasonik scalingten sonra mikrosızıntıda bir farklılık gözlemlememişlerdir ancak mikrosızıntının yapıştırılan simana göre değişiklik gösterdiğini bildirmişlerdir. Araştırmacılar yaptıkları incelemede rezin modifiye cam iyonomer simanda daha yüksek miktarda mikrosızıntı bulunduğunu belirtmişlerdir. Tabatabaei, M, H. ve ark[47] kimyasal olarak sertleşen self adeziv rezin simanların dual cure sertleşen rezin simanlara göre daha az renk stabilitesi olduğunu bildirmişlerdir.

Çalışmalarda genel olarak self adeziv rezin simanların marjinal bütünlüğünün daha az, renklenmesinin ise konvansiyonel rezin simanlara göre daha fazla olduğu sonucuna ulaşılmıştır.

Self Adeziv Rezin Simanların Biyouyumluluğu Üzerine Çalışmalar

Self adeziv rezin simanların bileşiminde, rezin esaslı restoratif materyallerin bileşiminde bulunan metakrilat monomerlere ve düşük molekül ağırlıklı rezinlere ek olarak, pH'ı azaltmak ve diş yapısını demineralize etmek ve mikromekanik bağlanmayı sağlamak için fonksiyonel monomerler ilave edilmiştir. Rezin siman polimerize olurken monomerler polimerlere dönüşür, ideal olarak tüm monomerlerin polimerlere dönüşmesi beklenmektedir. Ancak monomerlerin tümü polimerlere dönüşemez ve dönüşümü gerçekleşmemiş monomerler dentin kanalları yoluyla pulpaya ulaşır, bu durum pulpa için toksik etki oluşturabilmektedir.[48]

Self adeziv rezin simanların biyouyumluluğu üzerine bazı çalışmalar Tablo 2'de görülmektedir.

D'Alpino ve ark[49] self adeziv rezin simanlarda hücre canlılığında önemli bir azalma olduğunu bildirmişlerdir ve flow sitometrik analizlere göre hücre ölümünün simanlara maruz kalma ve farklı sertleştirme modlarına göre değiştiğini göstermişlerdir. Ayşegül ve ark[50] çalışmadaki en yüksek artık monomer miktarının G-Cem de olduğunu belirtmişlerdir. Simanlar arasında en yüksek DNA hasarının Relyx U200 de olduğunu açıklamışlardır. Alvarez, M. M. P. ve ark[51] simanların yetersiz polimerizasyonu sonucunda kalan monomerlerin pulpal dokuyu etkileyip oksidatif strese neden olabildiğini bunun sonucunda inflamasyon oluşumuna neden olan yolun aktive olabildiğini, simanların neden olduğu gen ekspresyonu bozukluğunun hücrelerin çoğalmasını ve hücrelerin mineralizasyonunu tehlikeye atabildiğini bildirmişlerdir. Araştırmacılar MaxCem'in daha yüksek miktarda oksidatif strese neden olduğunu bulmuşlardır. Aynı zamanda MaxCem'in hücre çoğalmasını daha çok engellediğini açıklamışlardır. Şişmanoğlu ve ark[52] ekstrakt metodunda 24 saat boyunca en düşük hücre canlılığının BeautiCem' de olduğunu, dentin bariyer test metodunda BeautiCem'in apoptoza en fazla sebep olan siman olduğunu, Panavia SA'nın apoptoza en az sebep olan siman olduğunu bildirmişlerdir. Alkurt ve ark[53] cavex geçici siman en az toksik etki gösterdiğini, polikarboksilat siman en güçlü antibakteriyel etki gösterdiğini,

Tablo 2. Self adeziv rezin simanların biyouyumluluğu üzerine yapılan bazı çalışmalar

Araştırmacılar - Yıl	Kullanılan simanlar	Sonuç
D'Alpino ve ark- 2017	Maxcem Elite (Kerr Italia Srl, Scafati, Italy), Bifix SE (Voco GmbH,Cuxhaven, Germany), G-Cem LinkAce (GC, Leuven, Belgium), Clearfil SA Luting(Kuraray Dental Co.Ltd., Osaka, Japan), ve RelyX U200 (3M ESPE, Neuss, Germany)	Hücre sitotoksisitesi hücre kültüründe odontoblast hücreleri (MDPC-23) kullanarak incelenmiştir. MaxCem Elite'e maruz kalan hücrelerin ölümünde bir artış saptanmıştır. Self adeziv rezin simanlar kimyasal olarak sertleştirildiğinde toplam hücre ölümünde önemli bir artışa neden olduğu bulunmuştur.
Ayşegül ve ark-2018	G-Cem (GC, Leuven, Belgium), SpeedCEM (Ivoclar VIvadent, Schaan, Liechtenstein), RelyX U200 (3M ESPE, Neuss, Germany)	Self adeziv rezin simanlarda artık monomer salınımı ve sitotoksisite değerlendirilmiştir. En yüksek artık monomer miktarının G-Cem de olduğu, self adeziv rezin simanlardaki sitotoksisitenin kontrol grubuna göre daha yüksek olduğu ve en yüksek DNA hasarının Relyx U200 de bulunduğu bildirilmiştir.
Alvarez, M. M. P. ve ark-2019	Maxcem Elite (Kerr Italia Srl, Scafati, Italy), RelyX U200 (3M ESPE, Neuss, Germany)	Self adeziv rezin simanın neden olduğu oksidatif strese bağlı hücrelerdeki gen ekspresyonu, hücrelerin çoğalması ve hücrenin metabolizmasına etkileri incelenmiştir. MaxCem'in daha yüksek miktarda oksidatif strese neden olduğu bulunmuştur, aynı zamanda MaxCem'in hücre çoğalmasını daha çok engellediği belirtilmiştir.
Alkurt, M. ve ark. – 2019	Cam iyonomer siman (Meron) Çinko polikarboksilat siman (adhesor) Öjenollü geçici siman (Rely X temp E) Öjenolsüz geçici siman (cavex) Self adeziv rezin siman (panavia)	Hücre sitotoksisitesi hücre kültüründe incelenmiştir. Cavex geçici simanın en az toksik etki gösterdiği, polikarboksilat simanın en güçlü antibakteriyel etki gösterdiği bildirilmiştir. Çinko oksit öjenollü geçici siman ve öjenolsüz geçici simanın sınırlı antimikrobiyal etki gösterdiği bildirilmiştir.
Şişmanoğlu, S. ve ark - 2020	BeautiCem Cement (BC; Shofu Inc, Kyoto, Japan), Panavia SA Cement Plus, RelyX U200 (3M ESPE, Neuss, Germany), TheraCem (Bisco Inc, Schaumburg, IL, USA)	Hücre sitotoksisitesi hücre kültüründe fare fibroblastları (3T3) kullanılarak incelenmiştir. Ekstrakt metodunda 24 saat boyunca en düşük hücre canlılığının BeautiCem' de olduğunu, dentin bariyer test metodunda BeautiCem'in apoptoza en fazla sebep olan siman olduğunu, Panavia SA'nın apoptoza en az sebep olan siman olduğunu bildirmişlerdir.

Konu ile ilgili çalışma yapan araştırmacılar self adeziv simanlardaki biyouyumluluğun geleneksel rezin simanlara benzer olduğunu bildirmişlerdir.

Tablo 3. Self Adeziv Rezin Simanlarla Ilgili Yapılan Bazı Klinik Çalışmalar

Taschner, M. ve ark-2012	RelyX Unicem (3M ESPE, Seefeld, Germany) Syntac Classic Variolink II low (Ivoclar Vivadent AG, Schaan/Liechtenstein)	2 yıl	Posterior bölgeye yapılmış 2 farklı simanla yapıştırılmış restorasyonlar 2 yıllık süreçte değerlendirilmiştir. Hiçbir hastada postoperatif hassasiyet gözlemlenememiştir ve hastaların hepsinin restorasyonlardan memnun olduğu bildirilmiştir. Ancak Relyx Unicem ile yapıştırılan restorasyonlarda marjinal bütünlük ve diş sağlamlığı daha düşük bulunmuştur.
Marcondes, M. ve ark- 2016	RelyX ARC (3M ESPE, St. Paul, MN, USA), RelyX U100 (3M-ESPE,St. Paul, USA),	1 yıl	Bu simanlarla yapıştırılan indirek kompozit rezin restorasyonlar 1 yıllık süreçte incelenmiştir. her iki grup için yalnızca renk uyumu açısından bir farklılık gözlemlemişlerdir, diğer bütün değerlendirmeler klinik olarak benzer bulunmuştur.
Vogl, V. ve ark- 2016	RelyX Unicem 2 Scotchbond Universal (3M Deutschland,GmbH, Neuss, Germany) ve RelyX Ultimate (3M Deutschland,GmbH, Neuss, Germany)	18 ay	50 hastaya yapılan 150 restorasyonu 18 aylık süreçte değerlendirilmiştir. 14 restorasyon başarısız olmuştur. Çalışmada başarısız olan restorasyonlardan 11 tanesi self adeziv siman ile yapıştırılmıştır. Selektif mine pürüzlendirmesi yapılarak konvansiyonel siman ile yapıştırılan restorasyonlardaki retansiyon oranı daha yüksek bulunmuştur.
Baader, K. ve ark- 2016	RelyX Unicem (3M ESPE Dental Products, St Paul, MN, USA), RelyX Unicem+ Selektif mine pürüzlendirmesi	6,5 yıl	Minedeki selektif asitleme işleminin self adeziv rezin simanlara hiçbir avantaj sağlamadığı ortaya koyulmuştur. Selektif mine pürüzlendirmesi yapıldığı ve yapılmadığı her iki durumda da marjinal adaptasyonun bozulduğu ve marjinal renk değişikliği ortaya çıktığı ancak bu durumun restorasyonu değiştirmeyi gerektirmediği bildirilmiştir.
Brondani ve ark-2017	Self adeziv rezin siman	6 yıl	Metal seramik kronların uzun ömürlülüğü değerlendirilmiştir. Kronların sağkalım oranlarını %97,7 olduğunu bildirilmiştir.

Çalışmalarda araştırmacılar genel olarak self adeziv rezin simanların klinik kullanımda konvansiyonel rezin simanlardan çok farklı sonuçlarının olmadığını marjinal bütünlüğün daha az olduğunu bildirmişlerdir.

çinko oksit öjenollü geçici siman ve öjenolsüz geçici siman sınırlı antimikrobiyal etki gösterdiğini bildirmişlerdir.

Self Adeziv Rezin Simanlarla İlgili Klinik Çalışmalar

Asit, primer ve yapıştırıcı ajan içeren üç aşamalı sistem hala diş ve restoratif materyallerin marjinal adaptasyonu için altın standarttır. Literatürde birçok çalışma bu sistemin klinik başarısını tanımlamıştır fakat bu sistemin uygulanma prosedürü karmaşık ve teknik olarak hassastır.[54,55] Self adeziv rezin simanlar uygulanması daha az teknik hassasiyet gerektirdiği için, son yıllarda kullanımı klinisyenler tarafından oldukça popüler hale gelmiştir.

Self adeziv rezin simanlarla ilgili klinik çalışmalar Tablo 3'te görülmektedir.

Taschner, M. ve ark[56] self adeziv rezin siman ile yapıştırılan restorasyonlarda postoperatif hassasiyet gözlemlemediklerini ve hastaların hepsinin restorasyonlardan memnun olduğunu bildirmişlerdir. Marcondes, M. ve ark[57] geleneksel siman ve self adeziv rezin siman arasında 1 yıllık takip sonucunda her iki grup için yalnızca renk uyumu açısından bir farklılık gözlemlemişlerdir. Vogl, V. ve ark[58] 48 hastaya yapılan 144 restorasyonu değerlendirmişlerdir ve değerlendirilen kriterlere göre (marjinal uyum ve renklenme, diş sağlamlığı, postoperatif hassasiyet) 14 restorasyon başarısız olmuştur. Çalışmada başarısız olan restorasyonlardan 11 tanesi self adeziv siman ile yapıştırılmıştır. Brondani ve ark[59] 6 yıllık takip sonucunda self adeziv rezin simanla yapıştırılan kronların sağkalım oranlarını %97,7 olduğunu bildirmişlerdir. Baader, K. ve ark[60] minedeki selektif asitleme işleminin self adeziv rezin simanlara hiçbir avantaj sağlamadığı ortaya koymuşlardır.

SONUÇ

Sonuç olarak literatürdeki verilere dayanarak çok aşamalı rezin simanların araştırılan self adeziv simanlardan daha yüksek bağlanma dayanımı olduğu self adeziv simanların dentine bağlanmada daha zayıf oldukları bildirilmiştir. Ancak araştırmacılar postoperatif hassasiyetin geleneksel simanlara göre daha az olduğunu belirtmişlerdir. Araştırmacılar bu simanlardaki sitotoksik etkilerin geleneksel rezin simanlara benzer oldukları konusuna dikkat çekmişlerdir. Bu malzemelerin flor salınımı ve bunun antikaryojenik etkileri kimyasal adezyonları, ağızda kalma başarısı ve çürük durdurucu özellikleri açısından önemli olmakla birlikte klinik anlamlılığı in vivo olarak değerlendirilmesi ve araştırılması gereken bir konu olduğu belirtilmiştir. İndirekt restoratif uygulamalar açısından self adeziv simanlar yeni bir alternatif sunmaktadır. Bu simanların uzun dönem klinik başarıları, bunların kullanımları hakkında daha genel bir yargıya varılmasına sebep olacaktır.

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Magnetic Resonance Imaging and Cone Beam Computed Tomography Evaluated Stafne Bone Cavity: Report of Two Cases

Stafne Kemik Kavitesinin MRG ve KIBT ile Değerlendirilmesi: İki Olgu Sunumu

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ABSTRACT

Stafne bone cavity is a rare, asymptomatic, ovoid, or round-shaped radiolucent mandibular defect detected in the posterior region of the mandible and below the inferior alveolar canal. Although Stafne bone cavity can be seen at any age, it is mostly fifth or sixth decade and more common in men. This report presents two cases of Stafne bone cavity and describes their radiologic characteristics. In both cases, cone beam computed tomography and magnetic resonance imaging were used to evaluate the borders and classification of the lesions. Magnetic resonance imaging revealed that both cases had submandibular gland content. Both patients were informed about the nature of the lesions. Clinical and radiographic follow-up of these lesions without clinical symptoms showed no radiographic changes.

Keywords: Mandible, submandibular gland, magnetic resonance imaging, cone beam computed tomography

ÖZ

Stafne kemik kavitesi, inferior alveolar kanalın altında ve mandibula posterior bölgede nadir olarak görülen, asemptomatik, oval veya yuvarlak şekilli olabilen radyolusent bir mandibula defektidir. Stafne kemik kavitesi her yaşta görülebilmesine rağmen çoğunlukla beşinci veya altıncı dekatta ve erkeklerde daha sık görülür. Bu makalede iki Stafne kemik kavitesi olgusu ve radyolojik özellikleri sunulmuştur. Lezyonların sınırları ve sınıflaması konik ışınlı bilgisayarlı tomografi (KIBT) ve manyetik rezonans görüntüleme (MRG) ile belirlenmiş ve MRG'de her iki vakada da submandibular beze ait yapılar olduğu gösterilmiştir. Hastalar lezyonların özellikleri hakkında bilgilendirilmiş ve klinik semptomları olmayan bu lezyonların klinik ve radyolojik takiplerinde herhangi bir değişiklik gözlenmemiştir.

Anahtar Kelimeler: Mandibula, submandibular bez, manyetik rezonans görüntüleme, konik ışınlı bilgisayarlı tomografi

INTRODUCTION

Stafne bone cavity (SBC) is an asymptomatic mandibular defect and its etiology is still unknown. In 1942, based on the radiographic findings, Stafne described 35 asymptomatic round or oval-shaped radiolucent cases near the angle and the lingual side of the mandible. For the next 5-7 years, he continued the follow-up of 5 cavities and detected no changes both in size or in radiologic characteristics of those defects.[1] Its etiology remained exactly unknown but was described by Stafne as bone depression on the posterior lingual mandible which is inferior to the mandibular canal. Stafne bone cavity's cause was thought to be the ossification failure of Meckel cartilage.[1-3] Later on, it has been recorded that the size of these defects may extend slowly.[2]

Several studies have revealed that Stafne bone cavities are clinically asymptomatic and they are detected as incidental findings during periodic radiographic examinations.[4-7] Previous studies showed that Stafne bone cavity in the posterior mandible was detected in 0.08%-0.48% of panoramic radiographs with a male prediction (60%-90% of the cases) in the fifth and sixth decades.[2]

Stafne bone cavities are commonly described as unilateral, ovoid or round, well-circumscribed radiolucent lesions ranging in diameter from 1 to 3 cm located proximally to the mandibular angle and below the inferior alveolar nerve.[2] Lingual posterior (LP) variations of these defects are most commonly observed in the fossa of the submandibular gland region between the angle of the mandible and the first molar. Rare lingual anterior (LA) defects are associated with lingual salivary glands which are located between incisor and premolar teeth.[3] Several researchers reported that Stafne bone cavities include normal salivary gland tissue and they do not have an epithelial lining. However, many reports showed that they may also contain fat, blood vessels, lymphatic tissue, connective tissue, muscle, nerve bundles, or air.[6,8,9] The location, radiological findings, and the content of the lesions are important for differential diagnosis. Stafne bone cavity-like lesions in the posterior mandibular region above the inferior alveolar nerve are thought to be odontogenic, whereas lesions below the inferior alveolar nerve are non-odontogenic.[2] Although rare, neoplasms may also be developed in that region, particularly in cases with salivary gland contents.[3]

Few studies made an attempt to classify the Stafne lesions. In an earlier computed tomography (CT) report, Ariji *et al* made a detailed classification of 16 SBC cases in terms of their outlines and their associations with the buccal cortical plate. They also made a soft tissue content classification based on the findings of CT or CT-sialography.[9] Several researchers examined the cases using aforementioned classification. In 2016, Chaudhry suggested a modification to the classification of Ariji et al in an editorial note while referring to the report of More et al.[4,10]

This report presents two cases of Stafne bone cavity evaluated by cone beam computed tomography (CBCT) and magnetic resonance imaging (MRI) and describes their radiologic characteristics on the basis of the previous studies.

CASE PRESENTATION

As stated by Ariji et al. and suggested by Chaudry et al., Stafne lesions were assessed as follows: When the lowest part of the cavity concavity did not extend to the buccal cortical plate—*type I*; when the lowest part of the concavity extended to the buccal cortical plate but without showing any distortion or expansion of the plate—*type II*; and when it was characterized by a buccal cortical plate expansion—*type III*.[9] *type IIa*: cavity depth reached the buccal cortical plate and caused its erosion; *type IIb*: it reached the buccal cortical plate and caused its perforation; *type IV*: it reached the buccal cortical plate and caused its expansion and perforation.[10] The following classification was used for the soft tissue contents: *type F*: the concavity was contained just fat density; *type S*: showing the soft tissue structure density indicating any connective tissue, vessel, lymph node, or others; *type G*: submandibular gland was present near to or entrapped in the concavity.[9] Baseline characteristics and classification of the present 2 cases of Stafne bone cavity are summarized in Table 1. Patient consent forms for publication were taken.

Case 1
A 60-year-old male patient was referred to the Faculty of Dentistry for dental and oral examination. The patient's medical history and clinical examination were noncontributory and there was no previous history of trauma to the head and neck region. On viewing the routine panoramic image, a unilocular, ovoid radiolucent lesion was noted in the right posterior mandibula beneath the inferior alveolar canal (Figure 1A).

Subsequently, CBCT imaging revealed a hypodense, non-expansive 1.21 × 0.79 × 0.58 cm sized lesion (Figure 1B-E). It had well-defined cortical borders with an absence of the lingual cortex of the right mandibula (Figure 1B), and the lesion was located beneath the inferior alveolar canal (Figure 1C and D).

Table 1. Baseline Characteristics and Classification of Stafne Bone Cavitiy Cases

	Age	Gender	Side	Location Variant	Lesion Size (cm)	Type of Outline	Content and Type	Treatment
1	60	♂	R	LP	1.21 × 0.79 × 0.58	II	Submand. g., G	Follow-up
2	75	♀	R	LP	2.27 × 1.44 × 0.95	III	Submand. g., G	Follow-up

♂, male; ♀, female; R, right; LP, lingual posterior; Submand. g., submandibular gland.
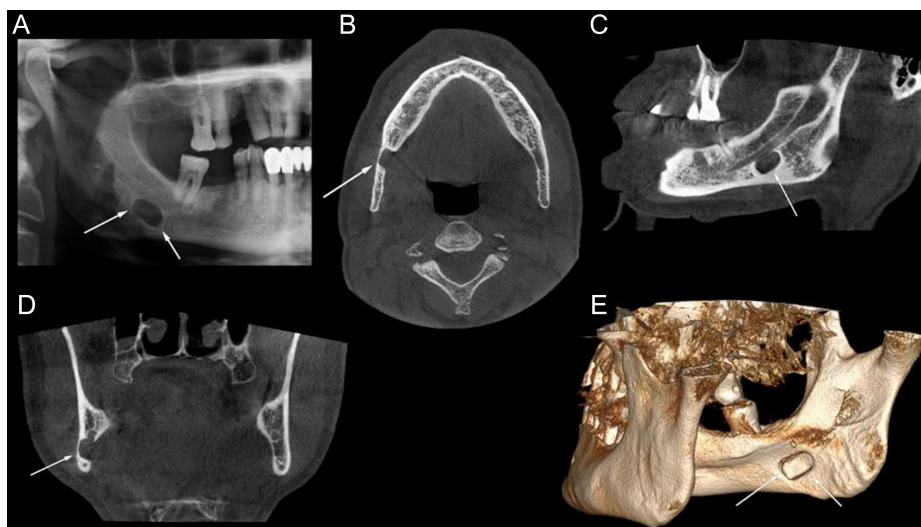

Figure 1. Case 1 is shown with arrows in conventional panoramic and CBCT images: (A) cropped panoramic image, (B) axial section, (C) oblique-sagittal section, (D) coronal section, (E) 3D CBCT reconstruction. CBCT, cone beam computed tomography.
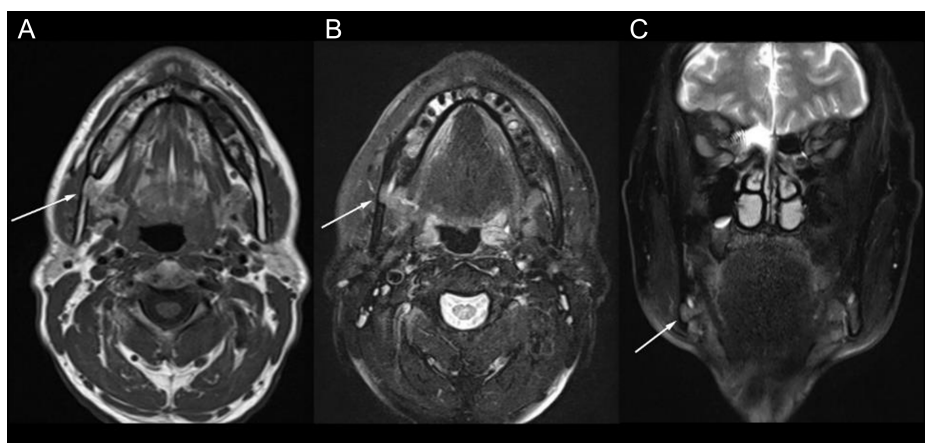
Figure 2. Magnetic resonance images of case 1 shown with arrows: (A) axial T1WI, (B) axial fat-suppression T2WI, (C) coronal fat-suppressed T2WI.

Magnetic resonance imaging was performed with a 1.5-T (Siemens Magnetom Espree, Erlangen, Germany). T1- and T2-weighted images (thickness of the sections: 3.0 mm with a 0.5 mm gap) were evaluated and T1WI showed that the mandibular defect contained isotense soft tissue in continuity with the submandibular salivary gland (Figure 2A). Axial and coronal fat-suppressed T2WI again showed that the bone defect contained the extension of submandibular gland tissue and it was not suppressed (Figure 2B and C).

Based on these findings, MRI verified the diagnosis of Stafne bone cavity. The patient has been on regular follow-up for over 1 year without any change of the lesion.

Case 2
A 75-year-old female patient was referred by her dentist for a further examination regarding the radiolucent cystic lesion detected close to the angle of the mandible. The patient had no complaints referable to the mandible and both her medical and dental history was not contributory. No trauma or any other findings were recorded. The panoramic image showed the ovoid unilocular cavity and CBCT was performed to evaluate the lesion in detail (Figure 3A).

The CBCT showed a hypodense lesion 2.27 × 1.44 × 0.95 cm in diameter (Figure 3B-E). Axial sections showed its well-defined cortical borders, thinned buccal cortex, and also the absence of the lingual cortex (Figure 3B). Oblique sagittal and coronal sections showed the location of the lesion displacing the inferior alveolar nerve to the superior direction (Figure 3C and D).

To evaluate the content of the lesion, a further examination was made by MRI (Siemens Magnetom Espree, Erlangen, Germany) with a 1.5-T. T1- and T2-weighted images (thickness of the sections, 3.0 mm with a 0.5 mm gap) showed that the mandibular defect was continuing with the adjoining submandibular gland having a similar signal intensity to the submandibular gland on both the sequences (Figure 4 A1-2 and B1-2). Axial and coronal post-contrast T1 fat-suppressed sections revealed that the submandibular gland showed diffuse contrast and was not suppressed (Figure 4 C1-2).

Since the defect was again identified as Stafne bone cavity, no further therapy was instituted. Fifteen-month follow-up of the patient showed no radiographic changes.
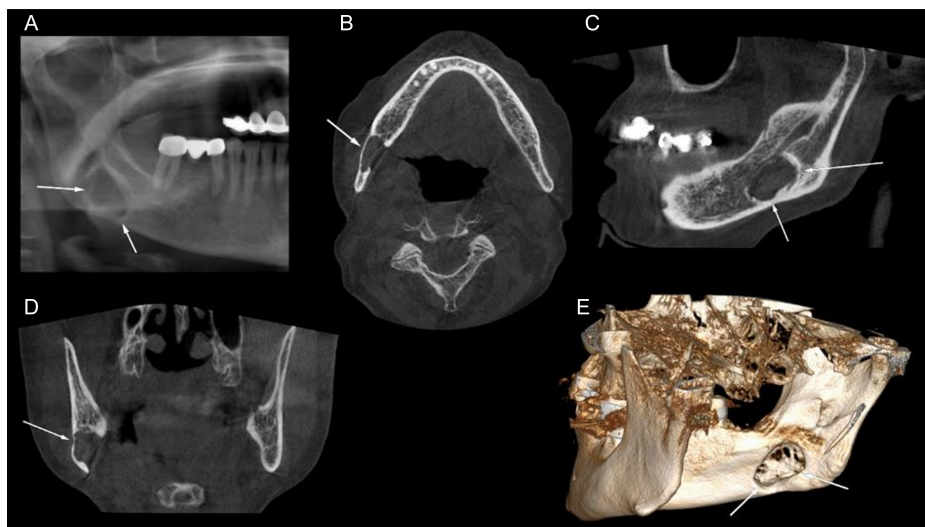

Figure 3. Case 2 is shown with arrows in conventional panoramic and CBCT images: (A) cropped panoramic image, (B) axial section, (C) oblique-sagittal section, (D) coronal section, (E) 3D CBCT reconstruction. CBCT, cone beam computed tomography.
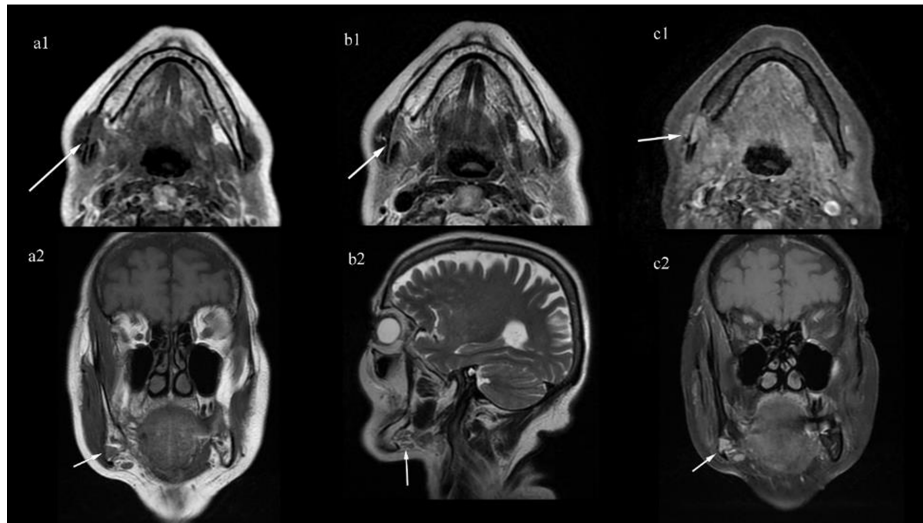
Figure 4. MRI images of case 2, shown with arrows: A (1-axial, 2-coronal) T1WI, B (1-axial, 2-sagittal) T2WI, C (1-axial, 2-coronal) postcontrast T1 fat-suppressed sections.

DISCUSSION

Several terms have been used to identify the specific asymptomatic radiolucencies around the angle of the mandible: Stafne bone cavity, Stafne bone cyst, static bone cyst/cavity, latent bone cyst, developmental bone defect of the mandible, lingual cortical mandibular bone defect, lingual mandibular bone depression, aberrant salivary gland defect, mandibular embryonic defect, etc.[2] Earlier reports of Stafne bone cavities have revealed their findings on conventional intraoral or panoramic radiographs; however, they were not definitive if the lesion was in a nonspecific location and diffuse or lobulated.[1,7,11,12] The differential diagnosis for radiolucencies having proximity to the angle of the mandible includes simple bone cyst, traumatic bone cyst, dentigerous cyst, residual cyst, keratocyst, ameloblastoma, focal osteoporotic bone marrow defect, vascular malformation, the brown tumor of hyperparathyroidism, giant cell tumor, and tumor metastasis. To eliminate the above-mentioned conditions, further investigations with advanced imaging methods are needed to confirm the initial radiological diagnosis. Medical CT and MRI are the most preferred techniques because three different dimensional sections are essential for the extension and size of the lesion and also for its definitive diagnosis.[2,3] When compared to medical CT, CBCT requires a low radiation dose which also provides 3-D data on the shape and size of the lesion. Yet, it is insufficient to give any information about the contents. Previous reports showed that Stafne bone cavity cases may include soft tissues such as lymph nodes, fat, muscle, and blood vessels and some were lacking any content, other than the salivary glands.[7] Therefore, CBCT and MRI examinations were used for the accurate evaluation investigation of the cavities in the present study.

Both cavities were characteristically situated above the angle of the mandible, beneath the inferior alveolar canal without showing any clinical symptoms (i.e., pain, tenderness, or swelling on palpation), and that was in line with previously documented cases.[4-6,13-16]

As in our cases and as stated in the previous reports, the incidence of Stafne bone cavity cases increases with age, particularly in the fifth and sixth decades.[2]

Stafne bone cavities are radiologically observed as oval or round radiolucent cyst-like lesions in the lingual side of the mandibula.[2] *Likewise* present Stafne bone cavity cases had oval well-defined cortical borders, homogeneous radiolucent content, and were located on the right side of the mandibula. The incidence of being in LP and LA locations are reported as 0.10%-0.48% and less than 0.009%, respectively.[2] While the radiological diagnosis of LP cases is simple, it was stated that LA-located cases can easily be confused with odontogenic cysts.[3] In the present report, both cases were LP variants. As stated in the report of Ariji et al.,[9] the most frequent Stafne bone cavity was type II and the majority of the cases contained the submandibular gland. Similarly, our first case was type II and both cases contained the submandibular gland (type G). These findings also match those observed in earlier studies.[5,6]

It is well-known that Stafne bone cavities are asymptomatic and static, hence the surgical treatment of the lesion is usually not indicated. However, it is of great importance to rule out the presence of any neoplastic conditions using various advanced imaging modalities. Prior reports have noted the importance of radiological follow-up to monitor for any changes.[4,8,10,14,16]

Both patients were informed about the nature of the lesions, and since both Stafne bone cavities were quiet and stable, no treatment was required. Radiological continuous monitoring of the cases has been planned to avoid unnecessary surgical interventions that may be associated with complications and other many potential risks.

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