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CONTENTS

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Analysis of Maxillary Sinus Anatomical Variations in Cone Beam Computed Tomography for Dental Implants Treatment Plan

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ABSTRACT

Aim: This study aim was to assess the maxillary sinus anatomical variations and structures using cone beam computed tomography (CBCT), particularly for dental implant treatment planning.
Materials and Methods: In this cross-sectional prevalence study, 200 CBCT images were examined. The assessments were conducted independently by two authors to evaluate the anatomical variations of the maxillary sinus. The anatomical variations assessed in the axial images included alveolar pneumatization, anterior pneumatization, exostosis, and hypoplasia. Additionally, the positioning of sinus septa and the posterior superior alveolar artery (PSAA) was also evaluated.
Results: Among the 400 maxillary sinuses analyzed, alveolar pneumatization was the most commonly detected morphological abnormality. Anterior pneumatization was detected in 84 sinuses (% 21.0). Antral septa were found in 175 sinuses (% 43.7) and were mostly located in the middle region. Among 254 sinuses, the PSAA was most frequently detected intraosseously, accounting for 63.5% of cases.
Conclusion: Maxillary sinus anatomical variations are significant findings in the context of dental implant planning. These variations are frequently observed in CBCT examinations conducted on the maxilla. Understanding the anatomical variations of the maxillary sinus enhances the effectiveness of preoperative dental implant planning and aids in the prevention of potential complications.

Dental İmplant Tedavi Planlaması için Konik Işınlı Bilgisayarlı Tomografide Saptanan Maksiller Sinüsün Anatomik Varyasyonlarının Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

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Anahtar Kelimeler:
Dental implant,
Maksiller sinüs,
Konik ışınlı bilgisayarlı tomografi.

ÖZET

Amaç: Bu çalışmanın amacı dental implant planlaması için gerekli olan konik ışınlı bilgisayarlı tomografilerde (KIBT) maksiller sinüsün anatomik yapılarını ve varyasyonlarını değerlendirmektir.
Gereç ve Yöntemler: Bu kesitsel prevalans çalışmasında, 200 KIBT görüntüsü incelenmiştir. İncelemeler, maksiller sinüsün anatomik varyasyonlarını değerlendirmek amacıyla iki yazar tarafından bağımsız olarak gerçekleştirilmiştir. Aksiyal görüntülerde değerlendirilen anatomik varyasyonlar arasında alveolar pnömatizasyon, anterior pnömatizasyon, ekzostoz ve hipoplazi yer almaktadır. Ayrıca, sinüs septa ile posterior superior alveolar arterin (PSAA) yerleşimi de değerlendirilmiştir.
Bulgular: İncelenen 400 sinüste en sık görülen anatomik varyasyon maksiller sinüs alveoler pnömatizasyonuydu. 84 sinüste (% 21,0) anterior pnömatizasyon saptandı. Antral septa 175 sinüste (% 43,7) bulundu ve en çok orta bölgede yerleşti. PSAA ise 254 sinüste (% 63,5) en çok intraosseöz olarak tespit edildi.
Sonuç: Maksiller sinüsün anatomik varyasyonları, dental implant planlaması açısından önemli bulgular olarak karşımıza çıkmaktadır. Bu varyasyonlar, maksilla üzerinde gerçekleştirilen KIBT incelemelerinde sıkça gözlemlenmektedir. Maksiller sinüs anatomisindeki varyasyonların anlaşılması, dental implant tedavisi öncesi planlama süreçlerinin etkinliğini artırmakta ve potansiyel komplikasyonların önlenmesine yardımcı olmaktadır.

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INTRODUCTION

Dental implant procedures are commonly performed to replace missing teeth for reasons related to appearance, speech, and the mechanics of the mouth. Sufficient bone quantity and quality are crucial for the successful implantation of dental implants and achieving excellent long-term treatment outcomes.[1] The extension of the maxillary sinus and the resorption of the alveolar ridge are the two primary causes of the complexity of posterior maxillary reconstruction. It is essential to understand the anatomical structures in these regions during surgical procedures, such as dental implants, sinus lift surgeries, and bone augmentation.[2] Anatomical variations raise the likelihood of complications, including sinus membrane perforation and bleeding from the posterior superior alveolar artery (PSAA).[1]

Computed tomography (CT) scans provide essential information on anatomical structures, bone dimensions, and jaw topography, which are vital for the planning of dental implants.[3] Cone beam computed tomography (CBCT) is a medical imaging method that creates several projections in a single rotation using a conical or pyramidal beam.[4] While CBCT is sometimes seen as a more economical option to traditional medical CT scans, it is important to note that for maxillofacial imaging, CBCT exposes the patient to higher amounts of radiation compared to classical panoramic radiography.[5] Antral septa, hypoplasia, exostosis, and maxillary sinus pneumatization are examples of structural abnormalities that can occur in the paranasal sinuses.[6,7] The maxillary sinus is highly relevant in cases involving dental implants. Accurate identification of anatomical variations of the maxillary sinus on CBCT is crucial, as CBCT is a vital diagnostic tool in dentistry. We aimed to contribute to the literature by providing more comprehensive information about the prevalence of anatomical variations in the maxillary sinus. Thus, the objective of this study was to evaluate the incidence of alveolar pneumatization, anterior pneumatization, septa, exostosis and hypoplasia of the maxillary sinus using CBCT imaging, a crucial tool for dental implant planning.

MATERIALS AND METHODS

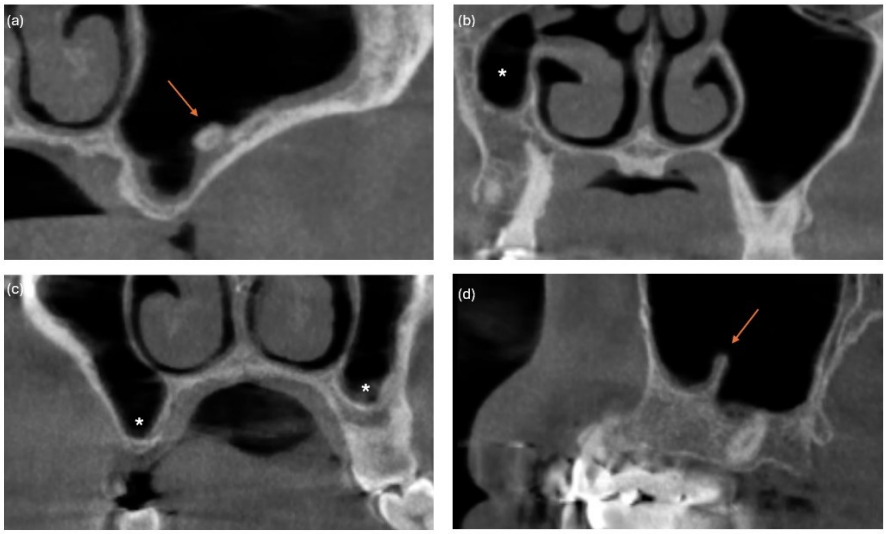
Study design

This cross-sectional prevalence study evaluated 200 CBCT scans collected at Alanya Alaaddin Keykubat University Faculty of Dentistry between 2022-2024. The study received approval from the local ethics committee (6792E-05/06). Inclusion criteria required CBCT images of the maxillary sinus that were clearly visible and utilized for implant planning. Exclusion criteria included CBCT scans where the lower third of the maxillary sinus was not visible, technical artifacts that hindered examination of the maxillary sinus, images indicating pathological changes in the maxillary sinus, or scans showing previous trauma to the maxillary sinus.

Image Acquisition and Analysis

CBCT scans were obtained using Kavo Op 3D Pro device (Biberach, Germany). The images were analyzed with the device's dedicated software, which enabled visualization of axial, coronal, and sagittal planes with 0.2-mm slice thickness. Two independent researchers evaluated the CBCT images, focusing on anatomical variations of the maxillary sinus. All discrepancies among the evaluators were settled by deliberation; if agreement could not be achieved, the patient was omitted from the study. Critical assessments of axial pictures encompassed variables such as alveolar pneumatization, anterior pneumatization, location of the sinus septa, exostosis, hypoplasia, and positioning of the posterior superior alveolar artery (Figure 1).

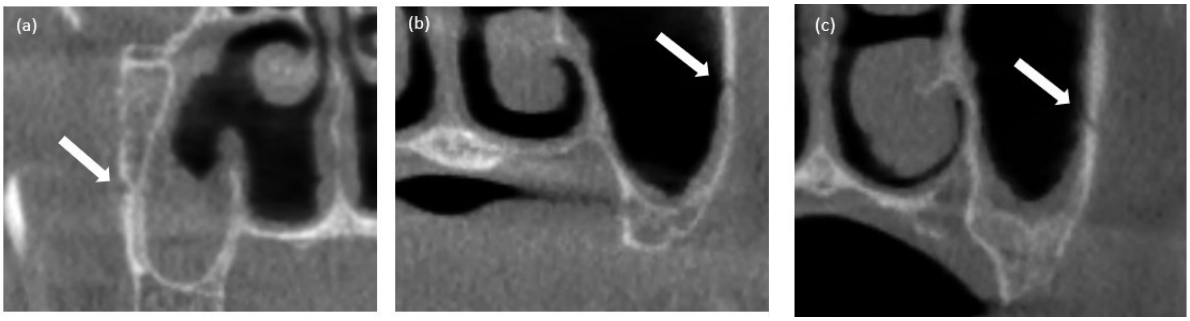
Figure 1: Exostosis (a), maxillary sinus hypoplasia (b), maxillary sinus pneumatization (c), septa (d)



If a patient's septa height was greater than 2 mm, which is a crucial requirement for sinus floor elevation treatments, they were added to the research. Septa were classified as anterior, middle, or posterior depending on where they were located within the sinus. Anterior (from mesial to second premolar), middle (from distal to second premolar to second molar), and posterior (from distal to second molar) were the three regions that comprised the septum location.[8]

Quantifications were conducted from the artery to the medial wall of the sinus, categorizing the arteries into three distinct types: intraosseous**,** submembranes**,** and located inside the outer cortex of the lateral sinus wall (Figure 2). When coronal slices revealed two alveolar antral arteries, the bigger artery was recorded. The existence of septa was also verified on both coronal and sagittal slices.

Figure 2: Coronal view of the maxillary sinus reveals the artery, which is on the outer cortex of the lateral sinus wall (a), below the membrane (b), intraosseous artery (c)



Statistical Analysis

The G*Power program was used to determine the required sample size for the study. The minimum required sample size was calculated as 24, with an expected effect size of 0.70 at a significance level of 0.05. However, in order to ensure demographic diversity and increase actual power, the sample size was determined as 200. Statistical analysis was performed using SPSS software (Version 22.0). Frequencies and percentages related to incidence of each anatomical variations of the patients were given. The actual statistical power of the study was calculated as 0.99 with G*Power.

RESULTS

In total, 400 maxillary sinuses from 200 CBCT scans were analyzed, consisting of 130 female patients (65%) and 70 male patients (35%). The ages of the patients ranged from 16 to 86 years, with an average age of 52 years. Alveolar pneumatization of the maxillary sinus, characterized by the sinus extending into the alveolar process, was the most frequently observed anatomical variation, present in 234 sinuses (58.5%). Within this group, pneumatization occurred in multiple zones in 92 patients (64.7%) and in a single zone in 50 patients (35.3%) (Table 1).

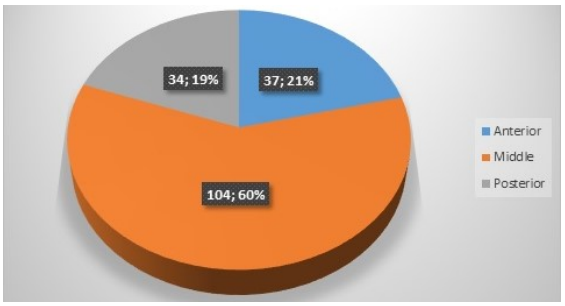
Table 1: Frequency of normal variations

	Hypoplasia	Exostosis	Septa	Alveolar pneumatization	Anterior pneumatization
All sinuses	28 (7.0%)	10 (4.0%)	175 (43.7%)	234 (58.5%)	84 (21.0%)
Unilateral	12 (60%)	2 (33.4%)	65 (54.2%)	50 (35.3%)	40 (64.6%)
Bilateral	8 (40%)	4 (66.6 %)	55 (45.8%)	92 (64.7%)	22 (35.4%)
Total	20 (100%)	6 (100%)	120 (100%)	142 (100%)	62 (100%)

Anterior pneumatization was identified in 84 sinuses (21.0%), appearing as a single zone in 40 cases (64.6%) and as multiple zones in 28 cases (35.4%). Maxillary sinus hypoplasia was found in 28 sinuses (7.0%), with 12 unilateral cases (60%) and 8 bilateral cases (40%) (Table 1).

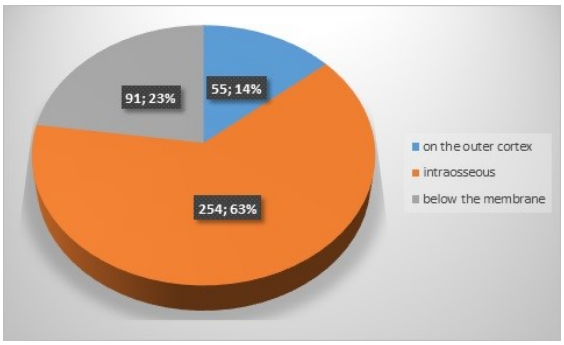
Exostosis was detected in 10 sinuses (4.0%). Antral septa were present in 175 sinuses (43.7%), occurring bilaterally in 55 patients (45.8%) and unilaterally in 65 patients (54.2%) (Table 1). Of the identified sinus septa, 37 (21.1%) were located anteriorly, 104 (59.4%) in the middle region, and 34 (19.5%) in the posterior region (Figure 3). Additionally, septa were observed on coronal images in 54 cases (30.8%) and on sagittal images in 121 cases (69.1%). Among these septa, 96 (54.8%) divided the sinus into two separate cells, and 5 (2.8%) created three separate cells.

Figure 3: Locations of septa



In 26 sinuses (6.5%), PSAA was discovered to be missing. The distribution of artery locations is depicted in Figure 4. Within the outer cortex of the sinus wall, the artery was located in 55 patients (13.7%), intraosseously in 254 sinuses (63.5%), and below the membrane in 91 sinuses (22.8%).

Figure 4: Location of PSAA



DISCUSSION

Maxillary sinus pneumatization, which is characterized as the expansion of the sinus into locations such as the alveolar ridge, anterior region, maxillary tuberosity, palate, zygomatic bone, and orbital area, was the most common morphological variant found in this investigation.[9] Approximately 50% of the population has alveolar pneumatization.[10] Our analysis revealed this variance in 234 sinuses, accounting for 58.5% of the total. Maxillary

atrophy due to tooth loss is marked by both vertical and horizontal bone resorption.[11] Sinus pneumatization, particularly when extending into the alveolar process, can worsen bone loss associated with maxillary atrophy, significantly reducing the bone available for dental implants.[12] As a result, there is not enough space to place dental implants and additional advanced surgical procedures are required. The maxillary sinus floor elevation procedure, which can be executed using either the crestal or lateral fenestration approach, is used to treat this quantitative change of the sinus cavity.[13]

Maxillary sinus hypoplasia (MSH) is defined as the underdevelopment of the maxillary sinus, potentially stemming from factors during embryological development such as trauma, surgical interventions, or structural abnormalities.[14] A constricted infundibulum without a natural ostium can lead to mucosal thickening within the hypoplastic sinus. Sinus floor elevation treatment is contraindicated in cases of ineffective sinus ventilation, blocked sinus pathways, or obstructed sinus drainage.[13,15] In a previous study, although the prevalence of MSH was 4.8 %, it was found to be 7.0 % in our study. This difference may be caused by racial origin.[14] In a recent study by Misăiloaie et al., the incidence of hypoplasia was found to be 6.5%.[16] Their findings are consistent with our study.

Antral septa, also known as maxillary sinus exostoses, are bony projections that can originate from any wall of the sinus.[17] Although found in almost 50% of CBCT scans, these septa can complicate maxillary sinus floor elevation procedures by raising the likelihood of sinus membrane perforation.[18] Complications such as acute or chronic sinusitis and bone graft resorption may arise from membrane perforation during such operation.[19] The presence of septa can also make the surgical removal of the bone plate and membrane more difficult.[1,14]

The present investigation revealed a septa prevalence of 43.7%, beyond the range of 16%–33% documented in prior literatüre.[1,8] This discrepancy may be attributed to differences in imaging techniques, particularly the use of thin-slice CBCT intervals in our study. Although many studies have identified the middle region as the most common location for septa [5,20,21] others have reported higher occurrences in the anterior and posterior regions.[22,23]

An important arterial component found in the maxillary sinus's lateral wall is the alveolar antral artery. It is particularly crucial for surgical techniques like open sinus augmentation and Caldwell-Luc.[24] In addition to increasing the danger of Schneiderian membrane perforation, damage to these veins may cause bleeding, which would obscure the surgical field.[25] 93% of the sinuses in our study had the posterior superior alveolar artery, with the intraosseous region accounting for the majority (63.5%). The high-resolution imaging methods used in this investigation are responsible for the increased artery detection rate as compared to previous research.[1,25-27] Apostolakis and Bissoon, Rathod et al., Tehranchi et al., and Velasco-Torres et al. all reach similar results, so our findings are consistent with theirs.[28-31]

CONCLUSIONS

In conclusion, anatomical variations in the maxillary sinuses are frequently observed in maxillary CBCT scans used for dental implant planning. These variations can influence surgical planning, particularly for more specialized procedures, and should therefore be carefully identified during clinical evaluations. Assessing the location of the posterior superior alveolar artery, maxillary sinus morphology, and normal anatomical variations in preoperative CBCT imaging can aid in planning surgical treatments and contribute to the design of more successful outcomes.

Ethical Approval

The ethical approval for this study was obtained from the Alanya Alaaddin Keykubat University Clinical Research Ethics Committee (6792E-05/06).

Financial Support

The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: BK, KS, Data collection or access: BK, Analysis and comments: BK, KS, Literature search: BK, KS, Writing: BK.

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Effect of Irrigant Activation Techniques on Calcium Silicate Sealer Bond to Dentin

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Root canal obturation.

ABSTRACT

Aim: The aim of this study was to investigate the effect of irrigant activation techniques on the push-out bond strengths of calcium silicate-based sealers.
Material and Methods: 65 single-canal teeth were instrumented with ProTaper rotary instruments. The specimens were randomly divided into two groups according to sealer type. Each group was randomly subgroup into four groups according to the final irrigation activation protocol; Nd:YAG laser, Vibringe, EndoActivator, Conventional Endodontic Needle Irrigation (n=6). The root canals were obturated with single gutta-percha and BioRoot RCS or MTA Fillapex. The teeth were sectioned into 1-mm-thick disc by using Isomet. Push-out force was applied until dislocation of obturating material and the bond strength value obtained was recorded as Newton. Data were analyzed using two-way Anova and Tukey HSD test (P = 0.05).
Results: A significant interaction was found between sealers and irrigation methods ($p < 0.05$), with the highest bond strength in the apical conventionel needle irrigation group and in the coronal Nd:YAG laser and control groups. The BioRoot RCS had higher bond strength values than the MTA Fillapex (p = 0.00). Higher bond strength values were observed from apical to coronally ($p < 0.05$).
Conclusion: Based on the present results, within the limitations of this study, calcium silicate-based sealer (MTA Fillapex and BioRoot RCS) showed better bond strength in the presence of the smear layer.

Farklı ırrigasyon Aktivasyon Tekniklerinin Kalsiyum Silikat Esaslı Patların Dentine Bağlanma Dayanımı Üzerine Etkisi

Makale Bilgisi

Makale Geçmişi

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Kalsiyum silikat,
Kök kanal dolgu materyalleri,
Kök kanal dolumu.

ÖZET

Amaç: Bu çalışmanın amacı, farklı irrigasyon aktivasyon tekniklerinin kalsiyum silikat esaslı kanal dolgu patlarının push-out bağlanma dayanımı üzerindeki etkisini araştırmaktır.
Gereç ve Yöntemler: 65 adet tek kanallı diş ProTaper döner aletlerle şekillendirildi. Örnekler dolgu patlarına göre rastgele iki gruba ayrıldı. Her grup, son irrigasyon aktivasyon protokolüne göre rastgele dört gruba ayrıldı; Nd:YAG lazer, Vibringe, EndoActivator, Konvansiyonel Endodontik İğne İrrigasyonu (n=6). Kök kanalları tek kon gutta-perka ile BioRoot RCS veya MTA Fillapex kullanılarak dolduruldu. Dişler Isomet cihazı kullanılarak 1 mm kalınlığında kesilerek disklere ayrıldı. İtme kuvveti, kanal dolgu materyali yerinden oynayana kadar uygulandı ve elde edilen bağ gücü değeri Newton olarak kaydedildi. Veriler iki yönlü Anova ve Tukey HSD testi kullanılarak analiz edildi (P=0,05).
Bulgular: Sızdırmazlık maddeleri ve irrigasyon yöntemleri arasında önemli bir etkileşim bulundu ($p < 0,05$), en yüksek bağ mukavemeti apikalde konvansiyonel iğne irrigasyon grubunda ve koronalde Nd:YAG lazer ve kontrol gruplarında bulundu. BioRoot RCS, MTA Fillapex'ten daha yüksek bağlanma dayanımı değerlerine sahipti (p = 0,00). Apikalden koronale doğru daha yüksek bağlanma dayanımı değerleri gözlendi ($p < 0,05$).
Sonuç: Mevcut sonuçlara dayanarak, bu çalışmanın sınırlamaları dahilinde, kalsiyum silikat bazlı sızdırmazlık maddesi (MTA Fillapex ve BioRoot RCS) smear tabakasının varlığında daha iyi bağlanma değeri gösterdi.

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INTRODUCTION

Root canal therapy primarily aims to thoroughly cleanse and form the canal system while achieving a three-dimensional seal to isolate it from periapical tissues.[1] In the latest years obturating materials and sealers have been developed on the basis of dentin adhesion technics in an attempt to seal the root canal more effectually.[2]

Mineral trioxide aggregate (MTA)-based root canal sealers have been introduced due to their advantageous biological properties.[3,4] However, without the addition of chemicals that produce adequate flow, MTA's handling properties make it impossible to use as a sealer.[3] To improve cement manipulation, ingredients like gels or water-soluble polymers have been introduced.[5,6] The distinct physical and biological properties of calcium silicate and calcium phosphate-based bioceramic sealers have attracted a lot of attention lately.[7,8] They have a chemical composition with a crystalline structure resembling that of tooth and bone apatite materials, and they incluse calcium phosphate, which increase the setting capabilities.[9]

MTA Fillapex (Angelus, Londrina, Brazil) is a sealer made of salicylate resin that contains silicon dioxide, bismuth oxide, and tricalcium silicate particles.[10] It has low solubility, good sealing, and an appropriate flow [11,12] and recommended for use with both warm and cold root filling methods.[13] Salicylate resin's organic component decreased cell survival rates [14] and increased cytotoxicity.[15]

A calcium silicate-based sealer, BioRoot RCS (Septodont, St. Maur-des-Fossés, France) can be applied using cold lateral condensation or single cone methods. The liquid is an watery solution of calcium chloride and polycarboxylate; the powder is composed of tricalcium silicate, povidone, and zirconium oxide.[16] Upon hydration, calcium hydroxide is released, which reacts with tissue fluid phosphates, resulting in the formation of calcium phosphate or calcium carbonate precipitates on the surface.[17,18] It was reported that BioRoot RCS formed hydroxyapatite following contact with phosphate-buffered saline solution.[17] It has been documented that BioRoot RCS stimulates human periodontal ligament cells to produce angiogenic and osteogenic growth factors;[16] moreover, BioRoot RCS has biocompatibility and antimicrobial activity, may induce hard tissue deposition.[17,19]

Endodontics has continually evolved with efforts to enhance irrigant delivery and agitation methods for more effective root canal irrigation. These techniques contain activation with gutta-percha cones, lasers, brushes, negative pressure irrigation technic, and sonic and ultrasonic machines.[20]

The fundamental method of root canal irrigation is needle irrigation, and the most important aspect influencing solution penetration is the depth at which the needle tip is inserted into the canal.[21]

The EndoActivator System (Dentsply Tulsa Dental Specialties), operates using sonic energy to create dynamic intracanal fluid motion, significantly improving irrigation effectiveness compared to traditional needle techniques. It occurs a portable handpiece and three kind of disposable flexible polymer tips of variant sizes that do not cut root dentin.[22]

One irrigation tool that can be used to sonically activate irrigation solution is the Vibringe system (Vibringe B.V.Corp, Amsterdam, Netherlands).[23] This device uses sonic flow technology in conjunction with acoustic streaming, and it runs at a lower frequency (2-3 kHz) than ultrasonic devices (25-40 kHz).[24,25]

Laser-activated irrigation (LAI) has emerged as a modern technique, utilizing pulsed energy to activate irrigation solutions. In general, the literature demonstrate that mid-infrared erbium lasers have been used for the activation of irrigants [26,27] and there are any written articles regarding Diode [28] and Nd: YAG laser [29] on the LAI.

Following chemomechanical preparation, the root canal walls develop a 1- to 2-mm thick smear layer, which is an amorphous and uneven surface. It is composed of both organic materials that contain pieces of odontoblastic processes, microbes and their byproducts, and necrotic pulp tissues, as well as inorganic dentin debris.[30] The root canal irrigation solutions and medications may not be able to enter the dentinal tubules due to the smear surface.[31] Eliminating the smear layer could strengthen the filling material's attachment to the canal walls.[32] But according to Saleh and Ruyter,[33] a stronger bond was not linked to the endodontic sealers' ability to penetrate the dentinal tubules after the smear layer was removed. To extract the organic and inorganic fragments of the smear surface, a final irrigation procedure utilizing sodium hypochlorite (NaOCl) and chelating chemicals such as EDTA is recommended.[34]

The push-out bond strength test is typically used to assess resistance to endodontic sealers coming loose from the root dentine wall.[35,36] In this mechanical test, a tensile load is applied longitudinally to the root sample's long axis until the sealer and core material are forced out or dislodged. Due to its great reproducibility and the fact that fractures happen parallel to the dentine bonding surface, the push-out bond strength test can be used to evaluate parallel-sided samples even in situations when bond strength is low.[37,38] Additionally, the push-out test has the advantage of being able to test materials inside the root canal without the need for extremely complex equipment, making it more advantageous than other bond strength tests like shear and tensile testing.[39] Using the push-out test, numerous studies have been carried out to ascertain the dislodgement resistance of different endodontic sealers; nevertheless, the reported results differ significantly.[35,36]

Calcium silicate-based sealers' ability to adhere to dentine may be impacted by the physical and chemical changes that irrigation, with or without activation, may bring about on the surface of the dentin. This study researched the effects of various irrigant activation techniques on the calcium silicate-based sealers' push-out bond strength. The null hypothesis was that the binding strength between calcium silicate-based sealers and root dentine treated with various irrigant activation methods would be the same.

MATERIALS AND METHODS

Specimen Preparation

This study was approved by the Selçuk University Faculty of Dentistry Non-Interventional Clinical Research Evaluation Commission with the decision number 05, subject 2013/04, dated 07.05.2013. In this investigation, 65 human teeth that had been removed and had a single canal were used. To get rid of any leftover tissue debris, all teeth were submerged in a 2.5% sodium hypochlorite (NaOCl) solution for 24 hours. They were then kept in distilled water at 4°C until they were needed. Under constant water chilling, specimens were decoronated using a diamond bur (MANI Inc., Tochigi, Japan) to a standard root length of 12±1 mm. A size #15 K-file (Mani Inc., Tochigi, Japan) was used, and the working length was adjusted 1 mm short of the apical foramen. ProTaper (Dentsply, Maillefer, Ballaigues, Switzerland) NiTi rotary files were used to prepare the root canal. From SX to F4,

the ProTaper files were utilized. Between the files, a 30-gauge endodontic irrigation needle (1-side vent) (Transcodent, Sulzer, Germany) was inserted 1 mm short of the working length (WL) to irrigate the canals with 2 mL of 2.5% NaOCl (Caglayan Kimya, Konya, Türkiye).

Specimens (n=30) were randomly divided into two main groups according to the type of root canal sealer used: Group A was filled with BioRoot RCS, and Group B was filled with MTA Fillapex.

Sticky wax (StickyWax KerrLab USA) was used to glue the tooth root ends to the glass petri dishes. Each main group was then further divided into five subgroups (n=6 each) based on the final irrigation protocol used:

Group 1A / 1B: Nd:YAG Laser Activation (n=6); Using a 30-gauge endodontic irrigation needle, the samples were irrigated with 3 ml of 3% NaOCl (Caglayan Kimya, Konya, Türkiye) and 3 ml of 17% EDTA (Merck KGaA, Darmstadt, Germany). After each irrigation solution, 3x10 sec laser application was performed into the root canal. In accordance with Moon, Kim, et al.,[29] a 1064 nm Nd:YAG laser (Fotona, Madrid, Spain) was employed for laser irradiation. In a 200-µm flexible endodontic fiber, the usual settings were 100 mJ/pulse and 15 Hz (average power = 1.5 W). The laser fiber was held 1 mm away from the WL and moved in a circular motion in the apical-coronal direction during irradiation. Three times, the laser fiber was entered and removed for ten seconds each, separated by fifteen seconds.

Group 2A / 2B: Vibringe Activation (n=6); A 30-gauge endodontic needle was utilized with a Vibringe tool. The needle was positioned 2 mm below WL. Using a Vibringe, 3 ml of 3% NaOCl and 3 ml of 17% EDTA solutions were used to irrigate the teeth for 30 seconds.

Group 3A / 3B: EndoActivator (EA) (n=6); EA was administered 2 mm behind the WL to the irrigated samples in group 1 after each irrigation. The EndoActivator System was utilized for 30 seconds at 10.000 cycles, with a 25/02 polymer tip for each solution

Group 4A / 4B: Conventional Needle Irrigation (CNI) (n=6); A syringe was used to apply irrigation solutions, which included a 30-gauge closed-end tip and a needle with side-port aperture. The irrigation needle was put 1 mm short of its WL. All samples were then irrigated with 3 ml of 3% NaOCl and 3 ml of 17% EDTA solutions, each of which was activated using an irrigation needle.

Group 5A / 5B Control group (n=6); Samples in the control group were irrigated with a conventional needle and 6 milliliters of distilled water for 1 minute. Activation was not done.

In addition, one extra sample from each subgroup (not filled) was prepared to evaluate smear layer removal using scanning electron microscopy (SEM). Samples that had been irrigated but not filled were allowed to air dry at room temperature for the whole night before being sputter coated with gold or palladium for three minutes. To evaluate the removal of the smear layer, samples were seen using a scanning electron microscope (SEM) (Leo 440, Electron Microscopy Ltd., Cambridge, UK). SEM was used for the observations, with a magnification of 1.000× and a voltage of 20 kV.

To get rid of any leftovers from the solutions other than the control group, the root canal was irrigated with 3 milliliters of distilled water following the last irrigation treatments. Four Protaper F4 paper cones (Dentsply, Maillefer, Ballaigues, Switzerland) were used to dry the root canals. Following the manufacturer's instructions, a mixture of powder and liquid BioRoot RCS canal sealer was created.

A single gutta-percha cone (ProTaper Universal F4, Dentsply Maillefer) was coated with BioRoot RCS sealer and inserted into the root canal of the WL. Following root filling, the coronal orifice was filled with a temporary filling substance (Cavit, 3M; ESPE, St. Paul, MN), and all specimens were kept in an incubator at 37°C for seven days.

MTA Fillapex Group; The same treatments were followed as in the BioRoot RCS groups, but with MTA Fillapex sealer. MTA Fillapex canal sealer, consisting of two packs, was mixed according to the manufacturer's recommendation.

Push-Out Bond Test

An Isomet saw (Buehler Ltd., Lake Bluff, IL) was used to slice the teeth into a 1-mm-thick disc perpendicular to the long axis while being lubricated with water. A total of 36 specimens were obtained from each group, 18 from the apical and 18 from the coronal.

A digital caliper was used to measure each disk's thickness precisely, to within 0.1 mm. The plungers were attached to a universal testing machine's load cell. In order to closely match the size of the filling material, three plungers of varying sizes were used. On the root canal filling, a vertical load was applied at a rate of 0.5 mm/min in an apical to coronal orientation. Push-out force was applied until dislocation of obturating material and the bond strength value obtained was recorded as Newton (N). Using the formula Area = 2prh, where p = 3.14 and r and h are the measured height and radius of the pushed-out filler material in millimeters, respectively, the area of the bonded interface was computed.

Statistical Analysis

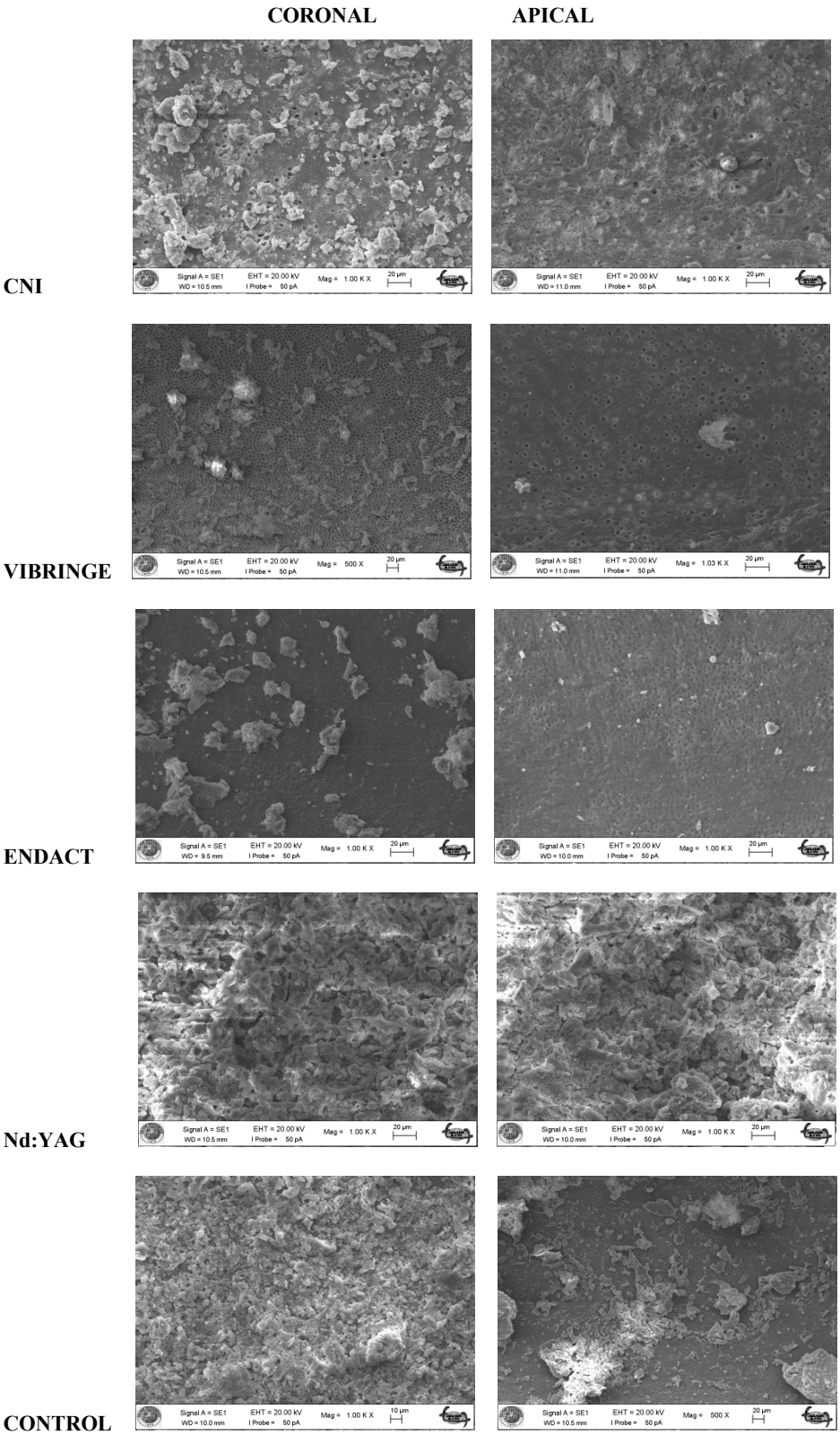
The statistical analysis of the data was carried out using the SPSS (Statistical Package for Social Sciences) 17.0V software. The two-way Anova Test was used to evaluate the results gathered from the bond strength test of root canal filling sealers. The Tukey HSD test was used to statistically evaluate irrigation techniques, sealers, and regional differences. The accepted significance threshold was p=0.05.

RESULT

The removal of the smear layer

Specimens analyzed with a 1000x magnification scanning electron microscope are demonstrated in Figure 1. The apical and coronal areas of the SEM samples from the group that received the Nd:YAG laser treatment displayed recrystallization and the development of smear layers. On the dentin surface, EndoActivator-activated groups exhibit some debris and a smear layer. Neither the control group nor the traditional endodontic irrigation needle were able to eliminate the smear layer on the dentin surface. The vibringe group exhibited open dentinal tubules in the coronal and apical thirds in contrast to the other groups.

Figure 1: Representative scanning electron microscopy pictures for the various irrigant activation techniques (magnification x1000) displaying selected samples from the coronal and apical portions



Push-Out Bond Strength

The BioRoot RCS has considerably higher binding strength values than the MTA Fillapex (p = 0.00).

Bond strength values were higher in the apical region than in the coronal region, according to inter-regional comparisons (p <0.05).

The bond strength values were higher in the apical region (mean=0.79), than the coronal (mean = 0.37) in both sealer groups (p>0.05).

Table 1: Mean and standard deviation values of irrigation activation methods

Techniques	Means
CNI	0.79±1.05[a]
Vibringe	0.47±0.46[b]
Endact	0.42±0.30[b]
Nd:yag	0.64±0.47[ab]
Control	0.57±0.47[ab]

The difference between the means carrying different letters on the same line is significant (p<0.05)

There was statistical interaction between the techniques (p <0.05) (Table 1). Despite the fact that the CNI group (mean = 0.79) demonstrated the strongest binding, there was no discernible difference between the control group, Nd:YAG laser, and CNI group (p>0.05).

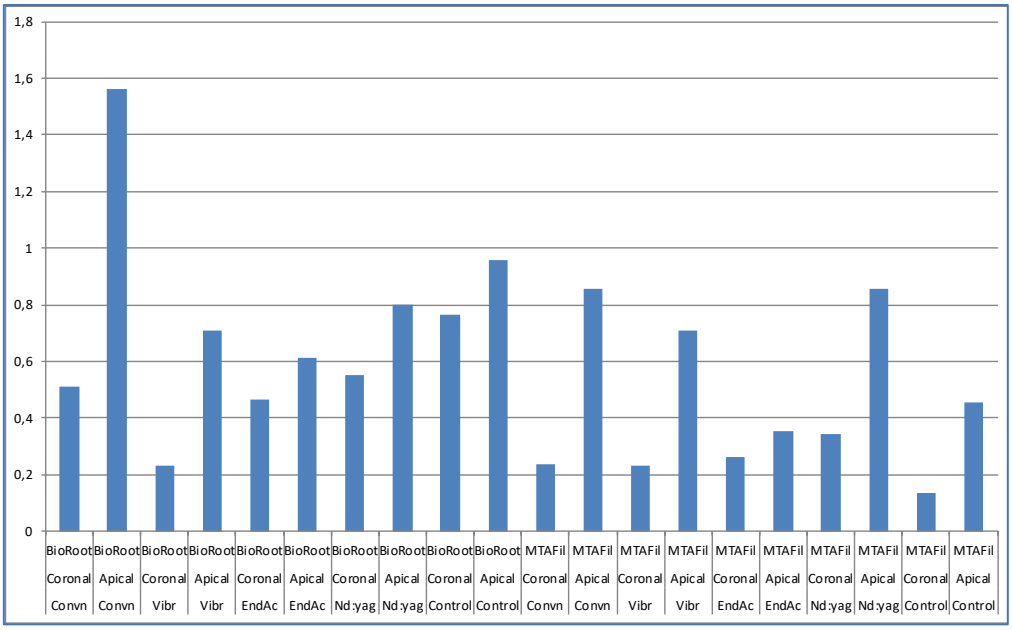
When the regions and techniques were examined, it was seen that the bond strength of the apical region of the teeth was better with manual activation (p<0.05). The bond strength that was the lowest was seen in samples using EA in the apical region and Vibring in the coronal region. The highest bond strength in the coronal region was measured in Nd: Yag laser and control groups.

A significant interaction (p < 0.05) was observed between the sealers and the irrigation methods. The apical CNI approach yielded the highest bond strength values, whereas in the coronal region, the highest values were observed in the Nd:YAG laser and control groups.

When the bonding strength of the sealers was evaluated according to the techniques (p<0.05), the bond strength of BioRoot was higher. Vibringe samples were equally measured in both sealers.

There was no statistical interaction between the sealers, regions and techniques (p>0.05) (Figure 2).

Figure 2: Bond strength findings by sealers, techniques and regions



DISCUSSION

Good filling ability is a desirable feature of a root canal sealer. The purpose of this study was to investigate the effects of sodium hypochlorite and EDTA solutions activated by the EndoActivator, Nd:YAG Laser, Vibringe, and conventional endodontic needle irrigation on the bond strength of bioceramic-based BioRoot RCS and MTA Fillapex sealers to root dentin in removing the smear layer. The null hypothesis proposed that the binding strength between calcium silicate-based sealers and root dentine treated with various irrigant activation methods would be the same. However, based on the results of this study, the null hypothesis was rejected. Significant differences in the push-out bond strength were observed among the different irrigant activation methods. A common method for assessing the root canal filing materials resistance to dislodgement is the push-out test.[40] While dislodging, a selection of two calcium silicate based sealers was investigated in order to get push-out bond strenght and failure mode. To remove the smear, 17% EDTA was applied to the dentine. There are two types of adhesion mechanisms: mechanical and chemical. Smooth surfaces tend to have stronger adhesion when it comes to chemical bonding. Conversely, for micromechanical bonding to occur, the dentin matrix's surface must have non-uniforms that let the material to pass through.[41]

Among canal filling procedures, cold lateral and vertical compaction methods have proven beneficial because they can force the sealer into the uninstrumented sections where bacteria are still present.[42] The application of these techniques is time consuming, it is important for the dentist to be experienced and must be visually supported by radiographs during canal filling. The single cone approach is really employed by the majority of dentists because it is easy and fast to apply. Using nickel-titanium files, it is very advantageous to use gutta-percha cone suitable for the angle and apical diameter of the last applied file. Placing the sealer on the apical portion of the root with a single cone is possible since the gutta-percha cone and the final file used are compatible. The space left from the gutta-percha in the canal is filled with patches and spaces.[43] Therefore, the single cone technique may not be considered reliable. Martins, Leoni [44] stated that the single-cone technique leaves a much larger area for the sealer in the morphologically irregular coronal and middle trinity, and this increases polymerization shrinkage and causes the sealer to separate from the root canal walls. However bioceramic sealers can provide a durable three-dimensional obturation along all root canals. When used with compatible gutta percha, they can spread to areas that instruments cannot reach or any irregular root canal with their perfect wetness and fluidity. In addition, due to their adhesive properties to dentin, they also reduce root fractures that occur over time. BioRoot RCS sealer is one of these new bioceramic materials. BioRoot RCS should be considered not only as a sealer but as a complete root canal filler. BioRoot RCS is clinically very successful, especially as a filler in the single-cone filling technique.[45] Because of these advantages, we chose the single cone technique in our study, where we used bioceramic-based sealers.

BioRoot RCS paste (Avg=0.72) showed higher bond strength than MTA Fillapex paste (Avg=0.44). (p=0.00). MTA Fillapex is known to have weaker bond strength than sealers like AH Plus and iRootSP.[46-50] According to Sagen Ustun,[48] MTA Fillapex's low bond strength is due to the weak adhesion capacity of tag-extension-like structures.

Assmann, Scarparo [47] also reported that the resin in the structure of MTA Fillapex may affect the adhesion of the sealer to the dentin. In this reserach, porosity and cracks in the resin matrix were identified in the samples analyzed under a scanning electron microscope after MTA Fillapex samples were put through a seven-day solubility test in deionized water.[51]

In these studies, as in our study, MTA Fillapex supports low binding values. Camilleri [52] reported that adding calcium chloride to sealers containing MTA improves sealer filling.

Calcium chloride regulates and shortens the setting time, decreases the amount of water required to set the sealer, and increases resistance to hydrostatic pressure.[52,53] One possible explanation for the increased bond strength is that the setting accelerating calcium chloride can alter the characteristics, chemical composition and surface area of the pores of the cements.[54] The calcium chloride concentration of BioRoot RCS accounts for the difference between it and the calcium silicate-based sealer MTA Fillapex employed in this investigation.

Ingle [55] reported that the cause of endodontic treatment failure was inadequate canal filling and endodontic. Depending on the decrease in the diameter and amount of dentinal tubules in the apical region,[56,57] the bond strength decreases.[58] Paque, Luder[59] reported that the difficulty of applying materials to the apical and sclerotic structure of dentin in the apical region makes it difficult to adhere in this region. Considering our study's findings, the reason why the apical bond strength values were better in both sealers may be that the Ni-Ti rotary file used in the preparation was filled using appropriate gutta-percha. When only the regions were compared, the bond strength in the apical region was found to be greater than that in the coronal region. As a result of this finding, the sealers we used in the experiment very advantageous.

EL-Ma'aita, Qualtrough [60] reported that When the smear layer is eliminated, the bond strength of sealers based on calcium silicate decreases. The Vibringe and EndoActivator groups in our study had weaker bonds than the smear layer because they were cleaner, but higher in the control, Nd:YAG laser and manual irrigation groups that had the smear layer. The conventional endodontic needle irrigation, Nd:YAG Laser, and control groups had the highest bond strength for both sealers in our study. Although the application of Nd:YAG laser to the dentin area increases the bonding values, in SEM analysis, it is observed that the smear layer persists and that retention is caused by recrystallized rough regions.[61,62] This micro-thinned surface may also have augmented the bond strength of the Nd:YAG laser groups.

The results of this study may not be fully suitable for estimating a clinical setting. However, this laboratory analysis yields trustworthy and reproducible results that can be utilized to compare novel endodontic sealers and set international standards.

In addition, the bond strength of canal sealer to the root canal is only one of the ideal properties of endodontic paste. As a result, other features of root canal sealers should be researched to provide a more reliable conclusion.

CONCLUSION

According to the results of this study, considering the limitations of the study, MTA Fillapex and BioRoot RCS, which are calcium silicate-based root canal sealers, showed higher bond strength in the presence of the smear layer. The best approach of removing the smear layer is irrigation with Vibringe and EndoActivator. Especially the smear layer remaining after irrigation activation with Nd:YAG laser and endodontic irrigation needle and the recrystallization areas created by the laser increased the bonding of calcium silicate-based sealer. This study presented a feasible and simple approach for assessing the bond strength of a calcium silicate-based sealer to the canal wall.

Ethical Approval

Ethical approval for this study was received by Selçuk University Faculty of Dentistry Non-Interventional Clinical Research Evaluation Commission (2013/04).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: ŞNM, AUE, Data collection or access: ŞNM, Analysis and comments: ŞNM, AUE, Literature search: ŞNM, AUE, Writing: ŞNM.

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Comparison of Color Changes of Vacuum Formed Retainers Made from PET-G Material: An *in-vitro* Study

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ABSTRACT

Aim: Polyethylene terephthalate glycol (PET-G) materials are frequently used in dental practice. Most vacuum formed retainers (VFRs) and trays for bleaching agents are made from PET-G materials. The aim of this in vitro study was to evaluate the color stability of different branded VFRs, made from PET-G material, in various beverages.

Materials and Methods: Two different PET-G materials, Atmos (American Orthodontics, Washington, USA) and Duran (Scheu Dental, Iserlohn, Germany) were tested after thermoforming over a metal casting model of 15 mm diameter and 6 mm height for color stability. Ten samples from each brand were immersed in four different beverages (water, tea, coffee, and coke), and a total of 80 samples were evaluated on the 7th and 14th days using a spectrophotometer. Color changes were evaluated based on the L*,a*,b* color system, according to Commission Internationale de l'Eclairage (CIE). One-way ANOVA was used for ΔE. Student's t-test and Bonferroni tests were applied to compare the variables. The level of statistical significance was set at $P < .05$

Results: There were statistically significant differences between Atmos and Duran. ($P < .001$). Duran showed significant color changes with tea, coffee, and water ($p< 0.05$) while Atmos were more resistant to discoloration.

Conclusion: It was observed that different PET-G materials showed varying performance against discoloration. Duran was more prone to discoloration compared with Atmos. Tea had the greatest discoloration effect on all groups.

Keywords: PET-G, color stability, orthodontic retainers, in vitro

PET-G Malzemesinden Üretilen Vakumla Şekillendirilmiş Tutucuların Renk Değişimlerinin Karşılaştırılması: Bir *in-vitro* Çalışma

Makale Bilgisi

Makale Geçmişi

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In vitro.

ÖZET

Amaç: Polyethylene terephthalate glycol (PET-G) malzemeleri diş hekimliğinde sıklıkla kullanılmaktadır. Vakumla şekillendirilmiş tutucular (VFR) ve beyazlatma maddelerine yönelik plakların çoğu PET-G malzemelerinden yapılır. Bu in-vitro çalışmanın amacı, PET-G materyalinden yapılan farklı markalı VFR'lerin farklı içeceklerdeki renk stabilitesini değerlendirmektir.

Gereç ve Yöntemler: İki farklı PET-G malzemesi Atmos (American Orthodontics, Washington, ABD) ve Duran (Scheu Dental, Iserlohn, Almanya), 15 mm çapında ve 6 mm yüksekliğinde metal döküm modeli üzerinde ısıyla şekillendirme sonrasında renk stabilitesi açısından test edildi. Her markadan 10'ar numune dört farklı içecekte (su, çay, kahve ve kola) bekletilerek 7. ve 14. günlerde toplam 80 numune spektrofotometre kullanılarak değerlendirildi. Renk değişiklikleri, Commission Internationale de l'Eclairage'e (CIE) L*, a*, b* renk sistemine göre değerlendirildi. ΔE için tek yönlü ANOVA kullanıldı. Değişkenleri karşılaştırmak için Student t-testi ve Bonferroni testleri uygulandı. İstatistiksel anlamlılık düzeyi $P < ,05$ olarak belirlendi

Bulgular: Atmos ve Duran arasında istatistiksel olarak anlamlı farklar vardı ($P < ,001$). Duran çay, kahve ve su ile belirgin renk değişiklikleri gösterirken ($P < ,05$), Atmos ise renk solmasına karşı daha dirençliydi.

Sonuç: Farklı PET-G malzemelerinin renk solmasına karşı farklı performans gösterdiği gözlendi. Duran, Atmos' a kıyasla renk bozulmasına daha yatkın olarak bulundu. Çay, her grup için en fazla renk değişikliği etkisine sahipti.

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INTRODUCTION

Vacuum-formed retainers (VFRs) are widely used in orthodontic practice during the retention period after active orthodontic treatment.[1] VFRs also provide tooth movement and serve as carriers for dental bleaching agents.[2] VFRs were first introduced by Ponitz in 1971 [1] and they have gained an increasing popularity over the years.[3]

Orthodontists have shown interest to VFRs for several reasons, including ease of manufacture, lower cost, and improved aesthetics.[4] However, there are also several disadvantages of VFRs, such as subsequent cracking with worsened vertical settling over the long term, insufficient control for arch expansion, [2] and color changes.[1]

It was reported that, patients frequently do not remove their retainers while drinking, leading to color changes as a result of this habit.[5] Since patients choose VFRs for aesthetic considerations, it is essential to enhance the patient motivation to use VFRs to prevent orthodontic relapse.[5]

VFRs are made from thermoplastic transparent materials, and various thermoplastic materials are used for this purpose, including polyethylene terephthalate glycol (PET-G), polypropylene and polyurethane.[6] Most vacuum-formed thermoplastic retainers are made from PET-G.[7] PET-G materials considered more aesthetic due to more translucent structure, although they provide less flexible and less durable products.[8] In previous studies, it was reported that PET-G materials were more resistant to discoloration due to their surface roughness and chemical structure. [1,9] A study was conducted by Aldweesh et al. to investigate the color stability for two different branded PET-G materials and reported insignificant changes between study groups.[1] Similar to this research, the purpose of this in vitro cross-sectional study was to evaluate the color changes of two different branded PET-G materials in contact with various beverages. The null hypothesis was that there woud not be significant differences in color changes between the two materials.

MATERIALS AND METHODS

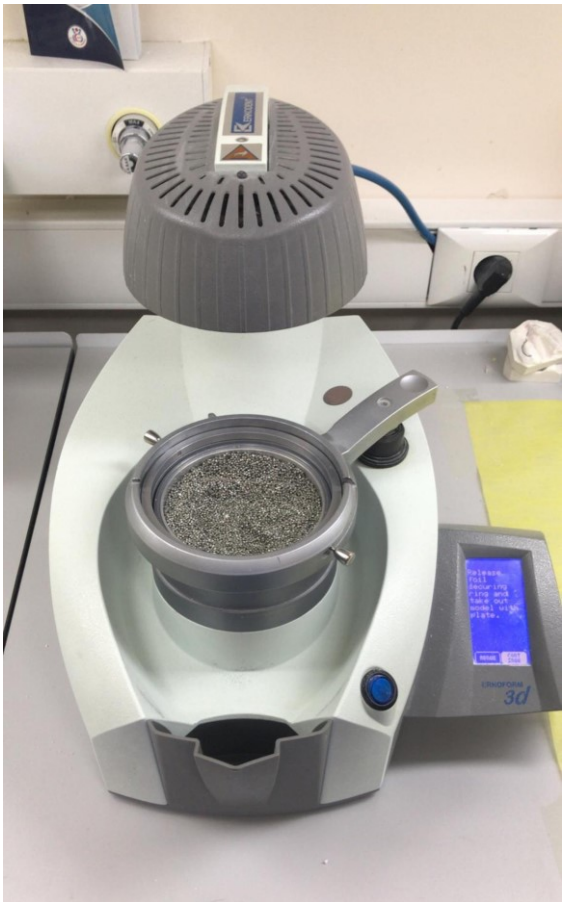
The study was conducted at Akdeniz University, Faculty of Dentistry, Department of Orthodontics, Antalya, Türkiye. Duran brand VFRs (Scheu Dental, Iserlohn, Germany) and Atmos brand VFRs (American Orthodontics, Washington, USA) were chosen as the PET-G materials. The thickness of each sample was 1 mm. The samples were formed under vacuum according to the manufacturer's instructions over a metal casting model of 15 mm diameter and 6 mm height (Figure 1) using an Ercoform vacuum forming machine. (Erkodent Erich Kopp GmbH, Pfalzgrafenweiler, Germany), (Figure 2).

Figure 1: The metal cast model of 15 mm diameter and 6 mm height.

G*Power software (version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used to perform power analysis. The results showed that each group needed a minimum of 10 samples, with a Type I error rate of $\alpha = 0.05$ and a Type II error rate of $\beta = 0.05$ for 95% power at an effect size of $d = 1.2892$. Since, they are frequently consumed daily beverages, coffee (Nescafe Gold, Vevey, Switzerland), black tea (Çaykur, Rize, Türkiye), coke (Coca Cola Company,

Atlanta, USA), and water (Erikli, Bursa, Türkiye) were used in this study. Forty thermoformed samples were obtained from each brand, and the samples were assigned into four groups that consisting of 10 samples each. The samples were immersed in each beverage in a container which was refreshed daily at room temperature (24 C°) for 24h and 14 days.

Figure 2: Ercoform vacuum forming machine. (Erkodent Erich Kopp GmbH, Pfalzgrafenweiler, Germany)



Color changes were evaluated based on the L*,a*,b* color system according to the Commission Internationale de l'Eclairage (CIE). The evaluated color parameters were L, a, and b, respectively. L indicates brightness (+ bright, - dark), a determines the red (+) to green (-) scale, and b determines the yellow (+) to blue (-) scale.[10] All measurements were performed on the flat surface of the samples, on a white background, and under standardized lighting. Initial measurements (T1) were taken after seven days of immersion and after 14 days of staining, second measurements (T2) were performed using a spectrophotometer (SpectroShade Micro, MHT, Italy) to evaluate the color change in the VFRs. The spectrophotometer was calibrated in accordance with the manufacturer's instructions prior to any measurements being taken (Figure 3 and Figure 4). The total color changes were evaluated using the following formula $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.[11]

Figure 3: Image of the Atmos brand sample transferred to the computer after spectrophotometer measurement

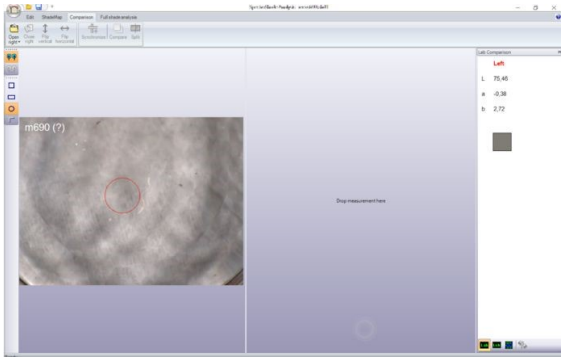
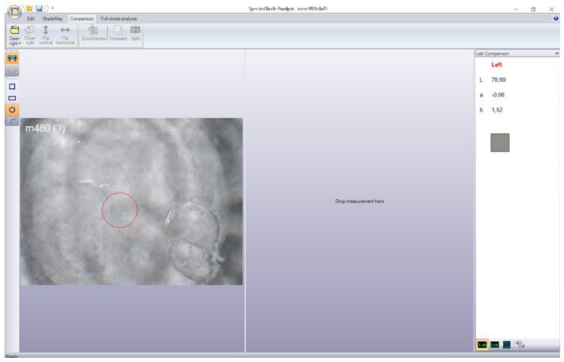


Figure 4: Image of the Duran brand sample transferred to the computer after spectrophotometer measurement



Statistical Analysis

IBM SPSS Statistics version 21.0 (IBM, Armonk, NY) was used to analyze the data. The computation of means and standard deviations (SDs) was a component of descriptive statistics. For ΔE, inferential statistical analysis was conducted using one-way ANOVA. Student's t-test and Bonferroni tests were applied to compare the variables. The level of statistical significance was set at $P < .05$.

RESULTS

This study evaluated color changes of 2 different brands of VFRs immersed in 4 different beverages. Each group consisted of 10 samples, and a total of 80 samples were evaluated. Spectrophotometer measurements were repeated three times, and the means were calculated for each specimen.

The means and standard deviations of the discolorations are presented in Table 1. The results of the study revealed that Atmos brand VFRs showed insignificant discoloration in all beverages ($p > .05$) while Duran brand VFRs showed significant discoloration in coffee, tea, and water ($p < .05$). The coke produced the least color change in two groups among beverages. Thus, it was observed that Atmos brand VFRs with superior features, produced more aesthetic results against color changes compared to Duran brand VFRs.

Table 1. Color changes of the samples according to T_1 and T_2 time periods

Groups	Atmos	P	Duran	P
	mean±sd		mean±sd	
water				
T_1	9.39 ±5.88	.093	5.80±0.29	**.038**
T_2	17.50±11.35		17.22±14.79	
Tea				
T_1	8.28±0.70	.103	7.00±6.08	**.010**
T_2	15.46±12.30		16.34±9.86	
Coffee				
T_1	9.17±6.34	.089	6.50±6.59	**.047**
T_2	16.33±8.39		15.09±8.47	
Coke				
T_1	12.31±8.94	.209	9.27±5.99	.287
T_2	18.98±11.86		12.21±5.30	

T_1: 7th day; T_2: 14th day
$p < .05$

DISCUSSION

PET-G is a non-crystalline or partially cristalline polymer which composed of cyclohexane two methanol, ethylene glycol, and terephthalic acid and it is widely used in orthodontic practice due to its superior aesthetics with transparency and solvent resistance.[12] We evaluated the color changes of two different brands of thermoforming materials produced from PET-G. The results revealed varying levels of color stability across different brands and beverages. Thus the null hypothesis was rejected.

Rye et al. suggested that, the thermoforming procedure significantly alters the physical characteristics of VFRs, such as transparency, water absorption, surface hardness, and solubility.[12] In line with this, we used thermoformed samples from each brand to evaluate color changes in contact with beverages. In a previous study, it was demonstrated that the significant color changes occur after 7 days of immersion.[13] In accordance with this finding, we decided to evaluate the color changes at 7 and 14 days of immersion.

The degree of color stability depends on the characteristics of the VFRs and beverages.[14] It has been reported that the color changes in materials occur due to pigment adsorption or penetration on the material's surface when the VFRs immersed in beverages.[15] In light of this, the use of materials that resistant to discoloration may have importance in clinical practice. Besides this, higher crystallinity and surface roughness have been reported as predisposing factors for color change.[9] In the present study, we found Duran-branded VFRs were more prone to color change, while Atmos-branded VFRs were found to be more resistant to discoloration in all beverages. We attribute this difference the potential effect of more surface roughness of Duran-branded VFRs or the possibility of lower degree of crystallinity in Atmos-branded VFRs.

It was observed that water, tea, and coffee caused more color change, while coke did not have a significant effect. It was reported that, PET-G materials were highly water-

absorbent.[16] It is well known that water absorption may cause hydrolytic degeneration in PET-G materials. Chemical reactions due to hydrolysis can result in structural changes in PET-G materials.[17] Porojan et al. reported that all liquids are potential color-changing agents for PET-G materials, regardless of whether they are colored or not.[18] In light of this, we can explain how water causes color changes in VFRs.

This study has some limitations. Firstly, it is an in-vitro study, and thus does not take into account the intro-oral conditions. Additionally, we only evaluated two brands of PET-G materials with 1 mm thickness. Future studies should be conducted on different brands of PET-G materials with varying thicknesses. Lastly, we only evaluated color changes on flat VFRs surfaces prepared for the metal cylindrical samples; therefore, there may be differences in thermoformed VFRs for dental casts.

CONCLUSİONS

The current study demonstrated statistically significant differences in discoloration between Atmos and Duran-branded VFRs. Duran-branded VFRs showed more color change, while Atmos-branded VFRs were more resistant to discoloration. The coke showed insignificant color changes while tea had the most discoloration effect for each groups. Further research could employ to investigate the potential discoloration effects of different sources (cigarette, gargles etc.) on VFRs.

Ethical Approval

As no human or animal derived data were used in this study, ethical approval was not obtained.

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The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: BCT, GK, GYT, Data collection or access: BCT, GK, GYT, Analysis and comments: BCT, GYT, Literature search: BCT, GK, GYT, Writing: BCT, GYT.

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Assessment of Variables Affecting Caries on the Distal Surface of Second Molars in the Presence of an Impacted Third Molar

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ABSTRACT

Aim: The most impacted teeth in the oral cavity are the third molars. Consequently, their presence within the bone often leads to various pathologies. The most common of these pathologies is distal caries. The aim of this study was to evaluate the relationship between impaction types of maxillary-mandibular third molars and distal caries of second molars using digital panoramic radiography.

Materials and Methods: 750 maxillary and mandibular third molars were examined. Patient age and sex, groups of third molars according to Pell-Gregory and Winter classifications, posterior margin space of second molars, angle between occlusal planes of third and second molars and the distance between cementoenamel junction of third and second molars were recorded.

Results: The prevalence of distal caries in the second molars was 42.0% in the upper jaw versus 47.4% in the lower jaw ($p>0.05$). According to the Pell-Gregory classification, the prevalence of distal caries in the second molar was higher in position A in the maxilla and in position B in the mandible ($p<0.05$). Based on Winter's classification, the prevalence of distal caries in maxillary second molars was higher in vertical position, while in mandibular second molars, it was higher in mesioangular position ($p<0,05$).

Conclusions: The risk of caries in second molars increases if the patient is older, when the vertical impaction level of third molar is A/B and at mesioangular/vertical position and mesial angulation is <40°. Clinicians and surgeons should pay attention to the position of the tooth in decision of early removal of third molars.

Gömülü Üçüncü Azı Dişinin Varlığında İkinci Azı Dişlerinin Distal Yüzeyindeki Çürükleri Etkileyen Değişkenlerin Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 10.07.2024
Kabul Tarihi: 29.01.2025
Yayın Tarihi: 29.08.2025

Anahtar Kelimeler:
İkinci azı dişi,
Üçüncü azı dişi,
Diş çürüğü,
Panoramik radyografi.

ÖZET

Amaç: Ağız boşluğunda en sık gömülü kalan diş üçüncü azı dişleridir. Bundan dolayı kemikte var olurken birçok patolojiye neden olurlar. Bu patolojilerin en yaygın olanı distal çürüktür. Bu çalışmanın amacı, maksiller ve mandibular üçüncü azı dişlerinin gömülülük tipleri ile ikinci azı dişlerinin distal çürüğü arasındaki ilişkiyi dijital panoramik radyografi kullanarak değerlendirmektir.

Gereç ve Yöntemler: 750 maksiller ve mandibular üçüncü azı dişi incelendi. Hasta yaş ve cinsiyeti, üçüncü azı dişlerinin Pell-Gregory ve Winter sınıflamalarına göre grupları, ikinci azı dişlerinin posterior kenar boşluğu, üçüncü ve ikinci azı dişlerinin oklüzal düzlemleri arasındaki açı ve mine-sement birleşim hizasının üçüncü ve ikinci azı dişleri arasındaki mesafesi kaydedildi.

Bulgular: İkinci azı dişlerinde distal çürük prevalansı üst çenede %42, alt çenede ise %47,4 olarak bulundu ($p>0,05$). Pell-Gregory sınıflamasına göre, üst çenede A pozisyonunda, alt çenede ise B pozisyonunda ikinci azı dişinde distal çürük oluşma prevalansı daha yüksekti ($p<0,05$). Winter sınıflamasına göre, üst çene ikinci azı dişlerinde distal çürüklerin prevalansı vertikal pozisyonda, alt çene ikinci azı dişlerinde ise mezioangular pozisyonda daha yüksekti ($p<0,05$).

Sonuç: İkinci azı dişlerindeki çürük riski; hasta yaşının ilerlemiş olması, üçüncü azı dişinin dikey gömülülük seviyesinin A/B olması, mezioangular/dikey pozisyonda olması ve mezial açının <40° olması durumunda artar. Klinik çalışanlar ve cerrahlar, üçüncü azı dişlerinin erken çekimi kararında dişin pozisyonuna dikkat etmelidir.

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INTRODUCTION

Third molars (TM) are the last of the permanent teeth to erupt and develop.[1] They are commonly known as wisdom teeth. Third molars usually appear between the ages of 17 and 21 years.[2] However, during the evolution of humans, the growth of the jaw bones has been impaired due to decreased physiological activity of the maxillary and mandibular bones and substantial changes in dietary habits, resulting in a gradual reduction in their size. This has also affected eruption of the teeth.[2]

Impacted teeth are teeth that do not emerge through the gums within the anticipated timeframe due to a variety of local and systemic factors, remaining lodged within the dental arch.[3] The impaction rate of the TM is higher compared to other teeth, with a prevalence ranging from 16.7% to 68.6%.[4] Additionally, TM constitute 98% of all impacted teeth cases.[5] TM impaction primarily results from delayed maturation and inadequate space. Furthermore, TM may be completely or partially impacted due to factors such as abnormal tooth positioning, limitation in skeletal growth, heightened local bone density, infections, cysts, syndromes, and various systemic diseases.[3,4]

While impacted TM can remain asymptomatic within the bone, they can also contribute to various pathologies. These may encompass bone loss, swelling, pericoronitis, pain, distal caries, root resorption of neighboring teeth, as well as the formation of odontogenic tumors and cysts.[4-7] The most common of these complications is distal caries.[8] Plaque accumulation between second molars (SM) and TM, caused by the abnormal positioning of the TM , can result in caries affecting the SM.[6]

Identifying cavities on the distal surface of a SM, caused by an impacted TM, poses difficulties in clinical diagnosis. Therefore, the radiographs are used for diagnostic purposes.[9-11] Panoramic radiography is the primary diagnostic tool for such scenarios, providing detailed views of the TM and its surrounding anatomy, facilitating detection of related pathologies.[12,13]

Impacted third molars radiologic classification systems are used to assess the position, angulation, and depth of impacted third molars based on radiographic images.[12] The most widely utilized classification systems include Winter's classification which categorizes impaction based on the tooth's angulation, and the Pell and Gregory classification which evaluates the tooth's position relative to the mandibular ramus and second molar.[14] These classifications provide dental practitioners with essential guidance for predicting potential complications and formulating appropriate surgical intervention strategies.

Other diagnostic methods, such as the Shiller and Leanor methods, further contribute to the radiological assessment of impacted teeth. The Shiller method examines the angle between the occlusal planes of the third and second molars, helping evaluate the tooth's relationship with surrounding anatomical structures and estimate potential complication risks.[15] The Leanor method, on the other hand, focuses on the inclination and position of the impacted tooth within the jawbone, aiding in the prediction of possible surgical complications.[16] Both methods assist surgeons in understanding the tooth’s position and its proximity to adjacent structures, supporting more effective surgical planning.

There is much controversy around prophylactic extraction of asymptomatic TM.[17] A crucial consideration is the potential risk associated with retaining TM and their impact on future pathological developments if left untreated. The decision to extract should be made based on weighing the benefits and risks to the patient's health. Potential complications that may arise after surgery should be weighed against the benefits of treatment.[18]

While numerous studies have investigated the development of SM pathologies associated with third molars, differences in ethnicity, culture, economy, and geographic region have produced widely varying results.[9-11] The objective of this study was to assess the correlation between the impaction types of maxillary and mandibular TM and distal caries in SM, using digital panoramic radiography.

MATERIALS AND METHODS

Study Sample

For this study, panoramic radiographs taken between January 2020 and April 2022 for various reasons were retrieved from the archives of the Oral and Dental Health Hospital. These radiographs were obtained using the Castellini X-Radius Trio Plus 2D (Castellini Digital Panoramic System, Bologna, Italy) device by the same dental technician, following the manufacturer's positioning guidelines (76 kVp, 10 mA, 13 sn.). From an initial pool of 1513 panoramic radiographs, 362 met the specified criteria and were selected for the study, resulting in a total of 750 maxillary and mandibular third molars (TM) from 362 patients (188 females and 174 males).

The inclusion criteria for the study were: patients aged 20 to 40 years, the presence of both a TM and an adjacent SM, radiographs of high image quality, and availability of information regarding sex, date of birth, and exposure date. Exclusion criteria included radiographs with artifacts that hinder visualization of the target areas, absence of TM or adjacent SM, presence of cysts, fillings, radiolucent lesions, or root resorption in the SM, and cases where a SM had shifted to fill a space due to a missing tooth in the posterior region.

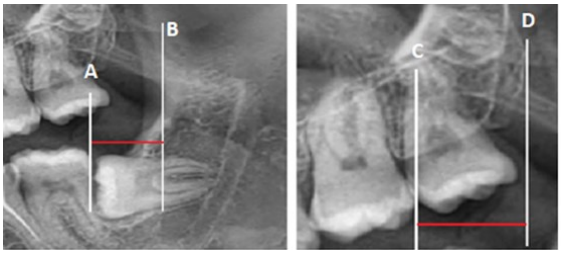
The research protocol was approved by the Ethics Committee for Non-Interventional Clinical Trials at the Balıkesir University Faculty of Medicine (Approval No. 2022/69), and the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Measurements

The study recorded the age and gender of each patient, categorized the TM based on Pell-Gregory and Winter classifications, measured the posterior margin space of SM, analyzed the angle between the occlusal planes of TM and SM, and documented the distance between the cementoenamel junctions (CEJ) of TM and SM. Measurements on the radiographic images were made by a dentomaxillofacial radiologist with 6 years of clinical experience including 3.5 years of experience in radiology using ImageJ (1.50n, National Institutes of Health, Bethesda, MD, USA) image processing program. Panoramic images in JPEG format were evaluated on a 1920x1080 resolution, 15.6 inch LED (Light Emitting Diode) backlit monitor in a semi-dark room.

Measurement of the Posterior Margin Space of Second Molars: For mandibular teeth, the distance from the anterior border of the mandibular ramus to the distal edge of the SM's crown was measured. For maxillary teeth, the measurement was taken from the posterior border of the tuber maxilla to the distal edge of the SM's crown (Figure 1).

Figure 1. Measurement of the posterior margin space (red line) of the lower (left) and upper second molars (right). A-C : distal edge of the crown of the second molar, B: anterior border of the mandibular ramus, D: posterior border of tuber maxilla.



Molars: TM that are impacted are categorized based on the classification systems proposed by Pell–Gregory's [19] and Winter's.[20] The Pell and Gregory classification was

originally designed for lower third molars, but it has also been utilized in studies involving the upper jaw.[4,21-23] Pell and Gregory's classification focuses on the relationship between the occlusal planes of TM and SM. Three positions are identified (Figure 2): Position A, where the occlusal plane of the impacted TM is at or above the occlusal plane of SM; Position B, where the occlusal plane of the impacted TM is below the occlusal plane of the SM but above its CEJ; and Position C, where the occlusal plane of the impacted TM is below the CEJ of the SM. In Winter's classification, the angle of inclination is determined by measuring the angle between the long axis of the TM and that of the SM. Four types of angulation are recognized (Figure 3): vertical angulation (10º to -10º), mesioangulation (11º–79º), distoangulation (−11º to −79º), and horizontal (80º–100º).

Measurement of Angle Between Occlusal Planes: The angle between the occlusal plane of the TM and that of the SM was calculated and categorized into three groups based on Shiller's [24] system as: (1) less than 40º, (2) 40º to 80º, (3) greater than 80º (Figure 4)

Figure 2. Pell and Gregory's classification

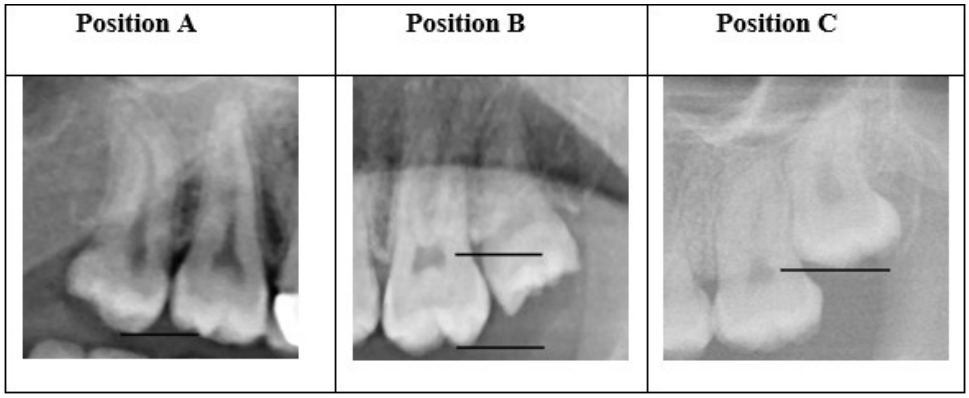
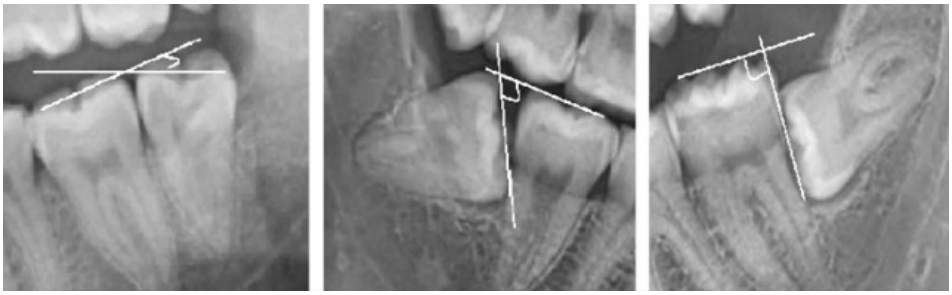


Figure 3. Types of angulation by Winter's classification

Figure 4. Measurement of the angles between the occlusal planes of third and second molars: <40° (left), 40° to 80° (middle) and >80° (right)



Measurement of CEJ Distance Between Second Molar and Third Molar: In the coronal plane, the distance between the CEJ of the mesial surface of the TM and the distal surface of the SM was measured following Leone's method.[25] The CEJ distances were categorized into the following ranges: (1) 1 to 3 millimeters, (2) 4 to 6 millimeters, (3) 7 to 9 millimeters, (4) 10 to 12 millimeters, and (5) greater than 12 millimeters (Figure 5).

Fig. 5 CEJ distance (red line). (A): CEJ of SM distal surface. (B): CEJ of TM mesial surface

Statistical analysis

Statistical analysis was performed using SPSS Statistics version 26.0 (IBM Corp., Armonk, NY). The $\chi 2$ test was used to assess categorical variables. Descriptive data for the posterior margin space of the SM were reported as mean ± standard deviation. To compare two groups, the independent samples t-test was utilized, while one-way analysis of variance (ANOVA) was applied for comparisons among multiple groups. A p-value of less than 0.05 was considered to indicate statistical significance.

RESULTS

In this study, a total of 750 SM and TM pairs from 362 individuals were examined, including 352 molars in the upper jaw and 398 in the lower jaw. The average age of participants was 29.5 years. The incidence of distal caries was found to be 43.3% in individuals aged 20 to 30 years and 56.6% in individuals aged 31 to 40 years. However there was no statistically significant association between age groups and the presence of dental caries ($p>0.05$). Distal caries prevalence in the maxilla was 42.0%, while in the mandible, it was 47.4%, though this difference was also not statistically significant ($p>0.05$).

Tables 1 shows the mean values of posterior margin space distributed by sex, and Pell-Gregory and Winter classifications. The posterior margin space of the SM was lower in females than in males in both jaws (11.4 mm vs 13.8 mm for the upper jaw, 13.0 mm vs 14.4 for the lower jaw, respectively). Statistical analysis of the posterior margin space measurements in both the mandible and maxilla, indicating a statistically significant difference between male and female groups in both jaws ($p<0.05$). In both jaws, it was observed that as the depth of the third molar as assessed by Pell-Gregory's classification increased, the posterior margin space of the SM decreased. When analyzed using Winter's classification, a reduction was observed in the posterior margin space of the SM in both jaws in the following order: vertical, mesioangulation, distoangulation and horizontal. As per both Winter's and Pell-Gregory's classifications, the posterior margin space of the SM was found to be smaller in the mandible compared to the maxilla, with a statistically significant difference observed ($p<0.05$).

There was a trend towards higher distal caries prevalence in maxillary SM among males, and in mandibular SM among females, although these differences did not reach statistical significance. There was a higher prevalence of distal caries in the SM on the right side compared to the left side, although this difference did not reach statistical significance ($p>0.05$) (Tables 2 and 3).

Table 1: Comparison of posterior margin space in the mandible and maxilla between the groups.

Variables	Mandible Posterior Margin Space (mm)	Maxilla Posterior Margin Space (mm)	p value
Sex			
Female	13.0±3.8	11.4±3.9	0,001
Male	14.4±4.1	13.8±4.0	
Pell- Gregory			
Position A	15.4±3.8	13.9±3.9	0,000
Position B	12.7±3.7	11.8±4.0	
Position C	11.3±3.3	9.9±3.2	
Winter			
Vertical	15.3±3.9	14.1±4.3	
Mesioangular	13.3±4.0	11.8±4.3	0,000
Distoangular	12.6±3.3	11.6±3.5	
Horizontal	10.7±3.6	9.8±4.0	

Table 2: The prevalence of caries on the distal surface of the mandibular second molar and the associations among the variables

Variables	CARIES		NO CARIES		TOTAL				
	n	%	n	%	n	%	X^2	Df	p
Sex									
Female	95	44.3	119	55.6	214	53.7	0.005	1	0.942
Male	94	51.0	90	48.9	184	46.2			
Side									
Left	88	45.5	105	54.4	193	48.4	0.894	1	0.344
Right	101	49.2	104	50.7	205	51.5			
Pell-Gregory									
Position A	68	42.7	91	57.2	159	39.9			
Position B	101	51.7	94	48.2	195	48.9	52.667	2	0.000
Position C	20	45.4	24	54.5	44	11.0			
Winter									
Vertical	59	44.3	74	55.6	133	33.4			
Mesioangular	83	56.4	64	43.5	147	36.9	61.561	3	0.000
Distoangular	37	37.7	61	62.2	98	24.6			
Horizontal	10	50	10	50	20	5.0			
Occlusal angle									
<40º	140	43.2	184	56.7	324	81.4			
40-80º	39	70.9	16	29.0	55	13.8	147.841	2	0.000
>80º	10	52.6	9	47.3	19	4.7			
CEJ Distance									
1-3 mm	101	41.0	145	58.9	246	61.8			
4-6 mm	36	66.6	18	33.3	54	13.5			
7-9 mm	36	57.1	27	42.8	63	15.8	152.878	4	0.000
10-12 mm	9	37.5	15	62.5	24	6.0			
> 12 mm	7	63.6	4	36.3	11	2.7			

Table 3: The prevalence of caries on the distal surface of the maxillary second molars and the associations among the variables

Variables	CARIES		NO CARIES		TOTAL				
	n	%	n	%	n	%	X^2	Df	p
Sex									
Female	72	37.1	122	62.8	194	55.1	0.108	1	0.742
Male	76	48.1	82	51.8	158	44.8			
Side									
Left	68	39.5	104	60.4	172	48.8	0.973	1	0.324
Right	80	44.4	100	55.5	180	51.1			
Pell-Gregory									
Position A	72	44.4	90	55.5	162	46.0			
Position B	64	47.4	71	52.5	135	38.3	43.027	2	0.000
Position C	12	21.8	43	78.1	55	15.6			
Winter									
Vertical	65	51.5	61	48.4	126	35.7			
Mesioangular	31	46.2	36	53.7	67	19.0	52.541	3	0.000
Distoangular	47	30.9	105	69.0	152	43.1			
Horizontal	5	71.4	2	28.5	7	1.9			
Occlusal angle									
<40º	135	40.5	198	59.4	333	94.6			
40-80º	8	66.6	4	33.3	12	3.4	223.230	2	0.000
>80º	5	71.4	2	28.5	7	1.9			
CEJ Distance									
1-3 mm	109	44.1	138	55.8	247	70.1			
4-6 mm	20	48.7	21	51.2	41	11.6			
7-9 mm	11	26.1	31	73.8	42	11.9	272.135	4	0.000
10-12 mm	5	41.6	7	58.3	12	3.4			
> 12 mm	3	30.0	7	70.0	10	2.8			

Based on Pell-Gregory classification of the teeth, a significantly higher prevalence of distal caries in the SM was observed in position A in the maxilla and in position B in the mandible than in other positions. Based on Winter's classification, the prevalence of distal caries was higher in the vertical position for the maxillary SM and higher in the mesioangular position for the mandibular SM compared to other positions, and the differences were significant among the positions ($p<0.05$) (Tables 2 and 3).

Upon analysis of the occlusal plane angles, a higher prevalence of caries in both jaws was observed in individuals with angles less than 40º. Significantly higher incidence of distal caries was observed in the first group (1-3 mm) in terms of CEJ distance between SM and TM, compared to other groups ($p<0.05$) (Tables 2 and 3).

DISCUSSION

The presence of TM may cause some symptoms in SM, including distal caries.[8] Therefore, the effect of TM on distal caries has been assessed by many investigators and an answer has been sought to the pivotal question as to whether prophylactic extraction of TM is necessary.

The impaction of TM is influenced by the available space behind the SM. In the current study, posterior margin space of the SM was

found to be significantly associated with sex, and the depth and degree of TM impaction. In both the maxilla and mandible, males exhibited a greater posterior margin space behind their SM (14.4 mm and 13.8 mm, respectively) compared to females (13.0 mm and 11.4 mm, respectively). Yılmaz et al. [4] and Jin et al. [26] have also reported higher posterior margin space values in males, which are in line with our findings. Several factors may contribute to the greater posterior margin space observed in males. Differences in growth and developmental processes influenced by hormonal effects may lead to a generally broader and larger jaw structure in males compared to females. Genetic and evolutionary factors also play a role, creating a predisposition for a wider facial and jaw structure in males, which in turn affects the amount of posterior space available.

When the posterior margin space was compared among the groups as per Pell-Gregory classification, it was greatest at Position A, followed by Positions B and C. This pattern clearly shows that as the posterior margin space decreases, the likelihood of impaction increases, a finding supported by multiple studies.[27-29] Statistical analysis revealed a significant positional difference between the mandible and maxilla ($p<0.05$), suggesting functional adaptations within jaw structures. For instance, the contraction and relaxation of masticatory muscles may influence positional changes, with the relationship between the mandible and temporomandibular joint being a primary factor in these differences.[30] While the maxilla is known for its stability, the adaptability of the mandible to positional shifts highlights the dynamic coordination between facial muscles and joints.[31] With regard to Winter's classification, the posterior margin space decreased when going from vertical to horizontal. Both of these findings are consistent with those reported by Jin et al.[26]

In this study, the prevalence of distal caries in SM attributed to adjacent TM was 42.0% in the maxilla and 47.4% in the mandible. These findings align with a wide range of prevalence rates reported in previous studies, which have shown values between 4% to 49%. For instance, a systematic review and meta-analysis by O'Malley et al. [32] reported a pooled prevalence of 23%, with individual studies varying from 0% to 51%. Similarly, Srivastava et al. [33] observed a 39% prevalence in mandibular SM, while another study reported rates reaching up to 32%.[34] At the extremes, Pepper et al. [35] noted a prevalence as low as 4.2% in a sample of 1.414 SM, whereas Alhobail et al. [36] reported a prevalence of 48.6% in 313 patients, which is close to our findings. This variability in reported prevalence rates (4% to 49%) can be attributed to several factors. Differences in study populations—such as age, socioeconomic background, and regional oral hygiene practices—affect caries risk. The position and impaction level of the TM also significantly influence the likelihood of distal caries in SM. Additionally, variations in diagnostic methods for caries (such as radiographic versus clinical examination) and differences in diagnostic criteria can affect the outcomes of studies. For example, Kang et al. reported that the prevalence of caries on SM caused by an impacted TM was 52% using cone-beam computed tomography (CBCT).[37] In the study conducted by Young et al., [38] which evaluated 100 proximal surfaces, CBCT demonstrated a sensitivity score of 0.61, approximately double that of two-dimensional radiography, which scored 0.33. Similarly, Valizadeh et al. [39] reported that the sensitivity of CBCT was significantly higher than that of two-dimensional radiography. This suggests that CBCT demonstrates superior accuracy and sensitivity for detecting caries on the distal surface of the SM.[40-43]

In the present study, males exhibited a higher prevalence of caries in SM in the

maxilla, while females showed a higher prevalence in the mandible. However, no significant difference was found between the distal caries on the second molar and sex. Falci et al. [13] reported a greater incidence of distal caries in SM among male patients. This finding might be attributed to women generally maintaining better oral hygiene practices and being more attentive to dental care compared to men. Research has shown that gender plays a role in the occurrence of caries, influenced by various sociodemographic (race, culture, ethnicity and education level) and biological factors (saliva, diet, genetic factors and hormonal variations).[44]

As the exposure time of the TM to the oral environment increases, so does the risk of caries developing on the distal surface of the SM.[45] Thus, age may be a factor to be considered when deciding on prophylactic removal of TM. The current study found a higher prevalence of caries (56.6%) on the adjacent distal surface of SM in patients over the age of 30 years, which is in line with some of the previous reports.[10,37,9] However, in our study, there was no statistical significance. Falci et al. [13] found a greater number of caries in persons over the age of 23, whereas Kang et al. [37] detected more caries in patients aged 27 years or older. Therefore, early removal of TM should be considered after the age of 30 years. Prolonged exposure of TM to the oral environment over time can contribute to plaque accumulation and food impaction between the TM and SM, increasing caries risk in older individuals.[37] In a study, McArdle et al. [10] showed that the risk of caries increases with advancing age as opposed to Syed et al.'s [34] study which reported lower risk of caries with increasing age. The higher prevalence of caries observed in individuals under 30 years old may be attributed to several factors. Younger individuals tend to consume more sugary foods and beverages, including processed foods and acidic drinks, which are known contributors to caries.[46] Additionally, oral hygiene practices may not yet be fully established in younger populations, leading to irregular brushing that increase caries risk.[47] Structural and developmental aspects also play a role, as younger individuals may have incomplete tooth and jaw development, with potentially more vulnerable enamel layers.[48] Lastly, awareness of oral health may be lower in this age group, with many young adults delaying dental visits until caries are more advanced.[49] These factors could explain the trend of higher caries prevalence among those under 30.

All three positions as described by Pell and Gregory's classification were found in the present study. However, there were more caries detected at position A in the upper jaw and at position B in the lower jaw compared to other positions ($p<0.05$). In line with our findings, in a study by Marques et al. [5] on mandibular teeth, distal caries of the SM were most common at position B. Arslan et al.'s [50] study also identified a higher incidence of caries in position B in the mandible. Contrary to our findings, they found a greater number of caries at position B in the maxilla and at position A in the mandible in Yıldırım et al.'s study.[21] In the statistical analysis conducted without considering differences between jaws, a significant difference was observed among the positions ($p<0.05$). According to the results, the likelihood of caries formation is highest in position B (50%), followed by position A (43.6%) and position C (32.3%). This suggests that position B is more prone to caries formation compared to the other positions, potentially indicating that position B is a more favorable or higher-risk area for caries development. This may have resulted from the failure to clear the food from the mouth due to interaction of partially erupted impacted TM with the SM. Therefore, preventive measures or oral hygiene practices may need to prioritize position B to reduce the risk of caries.

When the TM were grouped as per Winter's classification, all four positions were observed in the current study. A greater number of caries was detected in the vertical position in the upper jaw and in the mesioangular position in the lower jaw compared to other positions. Consistently, in Yıldırım et al.'s [21] study, caries were more common in the vertical position in the maxilla and in the mesioangular position in the mandible. Several studies concentrating on the mandibular region have indicated that mesioangular impacted TM are linked to a heightened occurrence of caries in SM.[26,34,35] According to Reddy and Prasad [51] vertical positioning was predominantly observed in maxillary TM, whereas mesioangular positioning was more prevalent in mandibular TM. As such, more caries may have been detected in the vertical position in the upper jaw and in the mesioangular position in the lower jaw, since they have a higher background prevalence.

The present study showed that the prevalence of caries was higher in occlusal angulations of less than 40º in both jaws. Contrastingly, McArdle et al.'s [10] and Chang et al.'s [52] studies found that the development of caries in the distal surface of SM is more likely at angulations between 40º and 80º. Also, Kang et al. [37] found a higher rate of caries at angulations between 43º and 73º. The results of aforementioned studies contradict our findings. In our study, as SM and TM contact at a superior point, it is more difficult to clean the triangular area below the contact point, and this may have increased the likelihood of caries formation. This angulation may have created areas that are difficult to access with a toothbrush or dental floss, thereby increasing plaque accumulation. Additionally, it may have influenced the distribution of chewing forces, leading to micro-cracks on the enamel surface and providing a favorable environment for caries development.

The CEJ distance between distal SM and mesial TM was defined by Leone et al. [25] as the distance between two adjacent teeth. In this study, a CEJ distance of 1-3 mm in both jaws was found to increase the risk of distal caries in SM. Increased incidence of caries was reported at a CEJ distance of 4-6 mm by Jin et al., [26] 7-9 mm by Chang et al., [52] 8-15 mm by Kang et al. [37] and 3-10 mm by Falci et al.[13] In cases where the mesial CEJ of TM and distal CEJ of SM overlap on radiographs, the measurement of the CEJ distance between the distal SM and mesial TM becomes challenging. In our study, the adjacent surfaces of the SM and TM were mostly overlapping. Due to the limitations of two-dimensional imaging techniques, the three-dimensional positioning of teeth cannot be fully visualized, leading to an appearance of overlapping teeth that complicates distance assessments.[37]

Historically, panoramic radiographs have frequently been employed in research to evaluate distal caries in SM and ascertain the anatomical orientation of TM.[53] Similarly, panoramic radiographs were employed for caries diagnosis in the current study. Panoramic radiography has a drawback of failure to detect caries at an early stage. In this case, bitewing radiographs should be used.[54] Although bitewing radiographs are the gold standard for the diagnosis of interfacial caries, panoramic radiography stands out as the preferred imaging modality for visualizing impacted teeth in clinical studies.[55,56] Furthermore, panoramic radiography is less costly than CBCT, entails lower radiation exposure, and garners greater patient acceptance.[57]

CONCLUSION

This study underscores the significance of third molar impaction on the development of distal caries in adjacent second molars, indicating that impaction type, angulation, and proximity between teeth are key predictive factors. The increased risk associated with mesioangular and vertical impactions,

particularly at higher impaction levels, highlights the necessity for thorough radiographic assessment and close monitoring of patients with impacted third molars. Additionally, patient age emerged as a contributing factor, with older individuals facing a heightened risk of caries formation. These insights imply that early intervention, including possible prophylactic extraction of third molars in high-risk cases, may help reduce caries development and improve long-term oral health outcomes. Further studies are encouraged to refine these findings and support evidence-based clinical decision-making.

Ethical Approval

The research protocol received approval from the Ethics Committee for Non-Interventional Clinical Trials at the Balıkesir University Faculty of Medicine (Approval No. 2022/69).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: KNÇ, Data collection or access: KNÇ, Analysis and comments: KNÇ, Literature search: KNÇ, Writing: KNÇ.

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The Effect of Different Polishing Techniques on Surface Roughness and Colour Change of Composites

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ABSTRACT

Aim: This study aimed to compare and evaluate the effect of different polishing methods on the surface roughness and colour change of composite resins.

Materials and methods: This study used a total of 100 disc-shaped samples made of microhybrid (M) and nanohybrid (N) composite resins. The experimental groups comprised of 5 groups (n=10) for each composite type. The groups were as follows: control (K), diamond bur+polishing rubber (BP), arkansas bur+polishing rubber (AP), diamond bur+polishing rubber+polishing paste (BPP), and disc+polishing paste (DP). Surface roughness (Ra) and initial colour were measured after the polishing methods were tested on all groups. After 7 days of coffee solution application, the colour changes (ΔE) were measured again and the results were recorded. CIEDE2000 formula was used to calculate the colour change.

Results: Mann-Whitney U test, Kruskal-Wallis test, and one-way analysis of variance were used in statistical analyses where appropriate. The samples to which disc and polishing paste were applied showed statistically significantly brighter surfaces than the other groups ($p<0.05$). The highest colour change was observed in the control group and the groups where arkansas stone was applied ($p<0.05$). Colour change was also higher in the groups with higher surface roughness.

Conclusion: Polishing with polishing paste can give good results in polishing and colour stability of composites.

Farklı Polisaj İşlemlerinin Kompozitlerin Yüzey Pürüzlülüğü ve Renk Değişimine Olan Etkisi

Makale Bilgisi

Makale Geçmişi

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Anahtar Kelimeler:
Kompozit,
Polisaj,
Yüzey pürüzlülüğü,
Renk stabilitesi.

ÖZET

Amaç: Bu çalışmanın amacı farklı polisaj yöntemlerinin kompozit rezinlerin yüzey pürüzlülüğü ve renk değişimine olan etkisininin karşılaştırılması ve değerlendirilmesidir.

Gereç ve yöntem: Çalışmada mikrohibrit (M) ve nanohibrit (N) kompozit rezinlerden oluşan toplam 100 adet disk şeklindeki örnekler kullanılmıştır. Deney grupları her kompozit türü için 5 gruptan (n=10) oluşmaktaydı. Gruplar; kontrol (C), elmas frez+polisaj lastiği (BP), arkansas frez+polisaj lastiği (AP), elmas frez+polisaj lastiği+polisaj patı (BPP) ve disk+polisaj patı (DP) şeklindeydi. Tüm gruplara test edilen polisaj yöntemleri uygulandıktan sonra yüzey pürüzlülüğü (Ra) ve başlangıç renkleri ölçülmüştür. 7 günlük kahve solüsyonu uygulamasından sonra renk değişimleri tekrar ölçülerek elde edilen sonuçlar kaydedilmiştir. Renk değişiminin hesaplanmasında CIEDE2000 formülü kullanılmıştır.

Bulgular: İstatistiksel analizlerde Mann-Whitney U testi, Kruskal Wallis testi ve Tek yönlü varyans analizi kullanılmıştır. Disk ve polisaj pastasının uygulandığı örnekler diğer gruplara göre istatistiksel olarak anlamlı derecede pürüzsüz yüzeyler göstermekteydi ($p<0,05$). En fazla renk değişimi kontrol grubu ve arkansas taşının uygulandığı gruplarda görülmekteydi ($p<0,05$). Yüzey pürüzlülüğünün fazla olduğu gruplarda renk değişimi de fazlaydı.

Sonuç: Polisaj patı ile yapılan polisaj işlemleri kompozitlerin parlatılmasında ve renk stabilitesinde iyi sonuçlar verebilmektedir.

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INTRODUCTION

Composite materials used in restorative treatment have been available in dental clinics for over 50 years.[1] These materials offer key advantages such as their aesthetics, protection of tooth tissue, long service life, and thermal insulation.[2,3] However, they also present certain disadvantages, including susceptibility to discoloration and wear.[4] The successful results of composite resins in long use are closely related to their physical structures. Their microstructures are closely related to their physical properties.[5] The consistency, particle size, particle structure, and distribution of fillers of the composite material used in restorative treatment play an important role in material selection.[6] Reducing the size of filler particles facilitates improved handling characteristics and efficiency.[7] An essential component of composite resins is polishing feature. A smooth surface contributes to better aesthetics and patient comfort. It reduces discolouration that may occur over time, facilitates cleanability and prevents plaque accumulation and thus possible gingivitis and secondary caries.[8,9]

A smooth surface reduces bacterial adhesion to the restoration and to the adjacent tooth surface. The accepted threshold value for bacterial adhesion is 0.2 μm. The tongue can detect a 0.3 μm change in the characteristics of the composite surface with ease.[9] Polishing methods remove particles smaller than 25 μm, whereas finishing procedures remove excess material with particles larger than this size.[10] Recent studies indicate that composites containing nanoparticles can achieve more effective surface polishing. However, in contrast, composites with nanoparticles and those with hybrid particles are said to have similar surface glosses.[11] The classification of composite resins is generally based on criteria such as the size, distribution, and content of filler particles.[12] However, "hybrid" composites containing a combination of nano- and micro-particles instead of only "nano-filler" or "micro-filler" composites are now frequently preferred.[13] Various polishing processes are applied for the best polishing of composite materials whose particles differ in hardness, shape, and size. Today, many different polishing techniques are used in the polishing of composite resins and there is no consensus on which technique polishes better. Some of these techniques are as follows; polishing discs, rubber burs, polishing rubbers, polishing pastes, and abrasive belts. These materials can be applied individually or in stages.[14-16]

The polishing of composite resins aims to achieve optimum aesthetics as well as biological and functional properties in patients. Many in-vitro studies reveal different methods to guide the techniques applied to obtain better polished restorations.[11,17,18] Our study aims to evaluate the effects of various polishing methods on the surface roughness and colour stability of composite resins. The null hypothesis is that the surface roughness and colour stability of composite resins are not affected by different polishing techniques.

MATERIALS AND METHODS

In this in-vitro study, 4 different polishing methods were used on 2 different composite types and included a control group.

Power analysis

The study's minimal sample size of 100 (n=10) was determined when the effect size of 1.32 was anticipated to be obtained when comparing the pre- and post-measurements at a 95% confidence level (α=0.05) and 80% power (β: 0.20).

Preparation of samples and formation of experimental groups

Microhybrid composite (M) (Herculite Classic, Kerr Corp., Orange, CA, USA) and nanohybrid composite (N) (Polofil NHT, Voco, Germany) were used in the study. The contents of the composites used in the study are shown in Table 1. 10 mm wide and 2 mm thick disc-shaped samples were prepared in special Teflon

molds. Excess was removed by pressing the top of the mold with Mylar matrix and polymerisation was carried out for 20 seconds with a second-generation LED light (Woodpecker, Guilin Woodpecker Ltd, Guangxi, China) emitting 1200 mW/cm^2 of light. The samples removed from the Teflon mold were also polymerised on the underside for 20 seconds. A total of 10 experimental groups were formed, 5 experimental groups from each composite (n=10). The control group (C) consists of samples that have been surface treated with a yellow band diamond milling bur. The other groups were treated with 4 different polishing methods: diamond bur+polishing wheel (BP), arkansas stone+polishing wheel (AP), diamond bur+polishing wheel+polishing paste (Kerr SuperPolish, Kerr Corp., Orange, CA, USA) (BPP), and disc+polishing wheel (DP) (OptiDisc, Kerr Corp., Orange, CA, USA). Surface roughness and colour change measurements were made on the top surface of the samples.

Table 1. Contents of the composites used in the study

Composite	Type	Composition	Manufacturer
Polofil NHT	Nanohybrid	Resin: Bis-GMA, UDMA, TEGDMA Particle Size: 0.01-0.1 µm Filler Glass ceramic	Voco, Germany
Herculite Classic	Microhybrid	Resin: Bis-GMA, TEGDMA Particle Size:0.05µm Filler: Colloidal silica, barium-aluminium-silicate glass	Kerr Corp., Orange, CA, USA

Application of different polishing processes

Polishing procedures were performed by a single operator for consistent durations and under water cooling to ensure standardization. A pointed diamond bur with a yellow band was used for finishing. Yellow coloured inverted conical tires were used as polishing wheels. Polishing was carried out with an electric rotary tool at 20.000 rpm for 15 seconds.[19] Before surface roughness and color measurements, all samples were kept in distilled water at 37 degrees Celsius for a duration of 24 hours.

Colouring Procedure

200 millilitres of boiling water were mixed with 3.2 grams of coffee solution (Nescafe Gold, Nestle, Switzerland) to create the coffee solution. A total of 10 coffee solutions were prepared separately for each group. During the storage period (7 days), coffee solutions were changed every 24 hours. This period corresponds to 7 months, assuming a daily coffee consumption of approximately 15 minutes.[20]

Surface roughness measurements

All samples had their surface roughness and color measured by the same person. Surface roughness of each sample was measured using a mechanical profilometer (Mitutoyo SJ-210; Mitutoyo, Kawasaki, Japan). Measurements were taken from 3 different points equal to the center of each sample and the arithmetic mean was taken and recorded. Surface roughness measurements were made at baseline and at after polishing.

Colour measurements

Colour measurements were made using a spectrophotometer (VITA Easyshade V, VITA Zahnfabrik). The color measurement was done on a normal white background with D65 illumination. The obtained color change values were calculated using the CIEDE2000 algorithm.[21]

$$\Delta E_{00} = \left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{k_C S_C}\right) \left(\frac{\Delta H'}{k_H S_H}\right)$$

Table 2. Surface roughness measurements of M and N groups

Variable *	Groups**		*p****
	M	N	
Ra	1.463[a] (0.389-4.222)	1.28[a] (0.545-2.778)	0.994

*: Variables are summarised as 'median (min.-max.)'. **: There is a statistically significant difference in group categories that do not contain the same letter, ***: Mann-Whitney U test

The clinical acceptability criterion $\Delta E \leq 3.3$ units and the detectability threshold $\Delta E > 1$ unit.[22,23] Colour measurements were made at baseline and at 7th month.

Statistical Data Analyses

The Shapiro-Wilk test was used to determine whether the quantitative variables in the study were appropriate for a normal distribution. The median was used to summarize quantitative data that did not follow a normal distribution (minimum-maximum). The mean plus or minus standard deviation was used to summarize quantitative data with a normal distribution. When applicable, one-way analysis of variance, the Mann-Whitney U test, and the Kruskal-Wallis test were employed in statistical studies. Spearman's correlation coefficient was used to ascertain the correlation between the variables. A value of $p<0.05$ was considered statistically significant in the statistical analysis. For reporting statistical differences, the American Psychological Association (APA) 6.0 style was utilized. IBM SPSS Statistics 26.0 for Windows (New York, USA) was used for all analyses.

RESULTS

Surface roughness results

Upon analyzing the surface roughness distributions based on the groups, no statistically significant variation was seen between the initial surface roughness values (p=0.994) (Table 2).

The samples to which disc and polishing paste were applied showed statistically significantly brighter surfaces than the other groups (p<.001). When the median Ra values for group M are ranked from largest to smallest, C (3.147 μm) > BP (2.087 μm) > AP (1.7 μm) > BPP (0.703 μm) > DP (0.499 μm). A statistically significant difference was found between all groups (p<.001) (Table 3).

The samples to which disc and polishing paste were applied showed statistically significantly brighter surfaces than the other groups (p<.001). When the median Ra values for group N are ranked from largest to smallest, C (2.037 μm) > AP (1.721 μm) > BP (1.491 μm) > BPP (1.018 μm) > DP (0.867 μm). There is a statistically significant difference between all groups (p<.001) (Table 3).

Table 3. Surface roughness distributions after polishing processes applied to M and N groups

Variable*	**M Group****					
	C	**BP**	**AP**	**BPP**	**DP**	
Ra	3.147[c] (2.08-4.222)	2.087[a] (1.189-2.425)	1.7[a] (0.853-2.345)	0.703[b] (0.453-0.931)	0.499[d] (0.389-0.663)	**p*** <0.001**
Variable*	**N Grubu****					
Ra	2,037[b] (1.473-2.778)	1.491[a] (0.693-2.359)	1.721[a,b] (0.872-2.263)	1.018[c] (0.733-1.509)	0.867[c] (0.545-1.179)	

*: Variables are summarised as 'median (min.-max.)'. **: There is a statistically significant difference in group categories that do not contain the same letter, ***:Kruskal Wallis test

There was a significant difference in surface roughness between the groups (p<0.001). Specifically, the C group differed significantly from all other groups, while the BP group differed from C, BPP, and DP; the AP group differed from C, BPP, and DP; and the DP group differed from C, BPP, and AP (p<0.001) (Table 4).

Table 4. Pairwise comparison of groups

		Ra	p^*
		Mean±SD	
M and N Groups	C	2.551[c]±0.805	<0.001
	BP	1.708[a]±0.542	
	AP	1.643[a]±0.403	
	BPP	0.899[b]±0.275	
	DP	0.684[b]±0.226	

SD: Standard Deviation, *: One-way analysis of variance, **: There is a statistically significant difference in group categories that do not contain the same letter.

Color change results

There was a discernible statistically significant variation seen between the group M median values for color change (p<.001). ΔE values for the M group at baseline and 7th month showed significant differences (p<0.001). The order of results was C (4.062) > AP (3.623) > BP (2.276) > DP (2.098) > BPP (2.04), with all groups differing significantly (p<0.001) (Table 5).

There was a discernible statistically significant variation seen between the group N median values for color change (p<.001). ΔE values for the N group at baseline and 7th month showed significant differences (p<0.001). The order of results was C (4.3) > AP (3.093) > BP (3.082) > DP (1.944) > BPP (1.47), with all groups differing significantly (p<0.001) (Table 5).

Table 5. Colour changes in the groups after 7 months

Variable*	M Group**					p^{***} <0.001
	C	BP	AP	BPP	DP	
ΔE (Baseline-7 months)	4.062[a] (2.602-8.129)	2.276[b] (1.839-3.258)	3.623[a] (2.732-4.56)	2.04[b] (0.947-3.305)	2.098[b] (1.461-2.485)	
Variable**	**N Group****					
ΔE (Baseline- 7 months)	4.3[c] (2.391-5.63)	3.082[a] (1.553-3.69)	3.093[a] (1.624-3.867)	1.47[b] (1.088-2.088)	1.944[d] (1.613-2.807)	

*: Variables are summarized as 'median (min.-max.)'. **: There is a statistically significant difference in group categories that do not contain the same letter, ***: Kruskal Wallis test

Table 6. Pairwise comparison of groups

		ΔE (Baseline- 7 months)	
		Mean±SD	p^*
M ve N Groups	C	4.441[d]±1.418	<0.001
	BP	2.673[a]±0.675	
	AP	3.267[a]±0.72	
	BPP	1.826[b]±0.679	
	DP	2.054[b]±0.411	

SD: Standart Deviation, *: One-way analysis of variance **: There is a statistically significant difference in group categories that do not contain the same letter.

Table 7. Examination of the relationship between Ra and ΔE variables in M and N groups

			M Group		N Group	
Grup			**Ra**	**ΔE**	**Ra**	**ΔE**
C	**Ra**	**r value***	1.000	-0.588	1.000	0.442
		p value		0.074	-	0.200
	ΔE	**r value***	-0.588	1.000	0.442	1.000
		p value	0.074		0.200	-
BP	**Ra**	**r value***	1.000	-0.321	1.000	0.006
		p value	-	0.365	-	0.987
	ΔE	**r value***	-0.321	1.000	0.006	1.000
		p value	0.365		0.987	-
AP	**Ra**	**r value***	1.000	0.079	1.000	-0.224
		p value	-	0.829	-	0.533
	ΔE	**r value***	0.079	1.000	-0.224	1.000
		p value	0.829	-	0.533	-
BPP	**Ra**	**r value***	1.000	0.818	1.000	-0.564
		p value	-	**0.004**	-	0.090
	ΔE	**r value***	0.818	1.000	-0.564	1.000
		p value	**0.004**	-	0.090	-
DP	**Ra**	**r value***	1.000	0.127	1.000	0.394
		p value	-	0.726	-	0.260
	ΔE	**r value***	0.127	1.000	0.394	1.000
		p value	0.726	-	0.260	-

*: Spearman's rho coefficient

A significant difference in color change was found between the groups ($p<0.001$). Specifically, the C group differed significantly from all other groups, the BP group differed from C, BPP, and DP, the AP group differed from C, BPP, and DP, and the DP group differed from C, BPP, and AP ($p<0.001$).

When surface roughness and color change variables were examined, a significant positive correlation was found after BPP polishing applied to group M ($r=0.818$; $p=0.004$). When the other groups were examined, no statistically significant correlation was found between surface roughness and color change variables ($p>0.05$).

DISCUSSION

This study investigated how different polishing techniques used to nanohybrid and microhybrid composites affected the surface roughness and color changes of composite materials. The study's null hypothesis stated that various polishing methods would not have an impact on the surface roughness and color stability of composite resins. Composite resins are frequently used in clinics during aesthetic restorative procedures. Various polishing methods have been tried to increase the surface gloss. However, there is no known gold standard among these methods.[15] After aesthetic dental treatment, the surface gloss of composites disappears over time and their coloration increases in parallel.[24] In addition to patient-related factors, the structure of the material used, application, and polishing technique have an important place among the reasons for the loss of surface gloss of composites.[25] In this study, surface roughness of composite specimens varied depending on the polishing methods used. Following a 7-day staining period, varying degrees of discoloration were observed. Considering these results, the null hypothesis tested was rejected.

In our study, the control group was formed by applying a yellow banded diamond bur to provide standardised surface roughness. The other groups were compared with different polishing methods and the effectiveness of these methods was evaluated. Similarly, Sahbaz et al. created a standardised initial surface in the control group using a yellow banded diamond bur.[26] In general, this is related to the structure of the composite restorative material. Many similar studies have found similar results to our

study.[27,28] After the polishing methods applied to the M and N groups, the smoothest surface was obtained in the DP group applied to the M group. In this method, polishing discs impregnated with aluminum oxide particles were applied with a polishing paste from thick to thin. In group N, similarly, the most glossy surface was obtained in the group where polishing paste and disk were applied. In similar studies, researchers have obtained the best results in polishing methods with polishing paste and disks.[29,30] Another remarkable part of the data obtained from the results is that the BPP group using polishing paste gives similar results to the DP group. The common feature of these two groups is the use of polishing paste containing aluminum oxide. The effectiveness of polishing methods is closely related to the hardness, size, and arrangement of abrasive particles used during the process.[31] In a study similar to our study, Tepe et al. stated that the polishing systems used in the polishing process are closely related to the abrasive size.[29] After the polishing processes applied in both groups, the surface was the roughest in the BP and AP groups. Similar to our study, Sahbaz et al. also found that polishing with a yellow banded diamond bur polished the surface less than other polishing methods.[26] In another study, white polishing stone is said to polish the surface less than other polishing methods.[32] As a result, the methods using polishing paste polish the surface of the composites better than the methods using polishing rubber without polishing paste.

Groups of composite samples were kept in coffee solutions for 7 days after polishing. The color shifts in the restorative materials were deciphered using the CIE Lab method. The distribution of L*, a*, and b* in perceptual color space is uniform, and this system is extensively employed in dentistry.[33,34] Among the polishing methods applied to the M and N groups, the control and AP groups had the highest discoloration above the clinically acceptable threshold. The least color change was observed in the BPP and DP groups. Studies have shown that the color changes on the surface of composites may increase in proportion to the surface roughness.[18,35] In addition, it has been shown in studies that the degree of coloration of composites may be related to the composite structure.[36] In our study, the color change was also the highest in the groups with the highest surface roughness. Coffee is one of the solutions that cause the most discoloration on composite surfaces.[37] In the study by Soliman et al. it was shown that the colouration increased significantly after the first week of colouring with coffee solution.[38] The duration of the coloring period was approximately 7 months and the use of coffee as a colorant caused discoloration above the clinically acceptable threshold in the control and AP groups ($\Delta E>3.3$).

Composite restorative materials have increased in clinical use in the last 20 years. Increasing aesthetic expectations can be met with composites that are shiny like enamel tissue and do not lose this brightness for a long time.[39] In our study, microhybrid and nanohybrid composites, two composite types frequently used in clinics, were used. The fact that polishing with materials containing aluminum oxide particles gives better results compared to other methods is also supported by the results obtained from similar studies.[31,40] This is closely related to the type and size of abrasive particles used during polishing.

CONCLUSION

In our study, all groups showed color changes that were proportional to surface roughness. Using paste containing aluminum oxide during polishing increases the effectiveness of polishing materials and composites with smoother surfaces are obtained. Using a yellow band diamond bur, polishing tire and polishing paste gives similar results to using a disc and polishing paste. In the control group without polishing, color changes

occur above the clinically acceptable threshold. The smooth surfaces obtained with the applied polishing methods also cause less discoloration.

Ethical Approval

Since this study did not involve any human or animal subjects, ethical committee approval was not required.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: FÖ, BD, Data collection or access: TS, EŞ, BD, Analysis and comments: FÖ, EŞ, Literature search: FÖ, Writing: FÖ.

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Evaluation of Dental Practitioners' Understanding and Approach Towards Oral Mucosal Diseases in Türkiye

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ABSTRACT

Aim: Oral mucosal disease (OMD) includes immune-mediated disorders such as oral lichen planus (OLP), erythema multiforme (EM), pemphigus vulgaris (PV), chronic ulcerative stomatitis (CUS), and others. These conditions often affect the oral mucosa and may even begin with oral involvement. Therefore, oral health professionals must be familiar with these disorders' clinical features and understand their crucial role in management. This study aims to assess dental practitioners' awareness, knowledge, and attitude regarding OMD in Turkey.

Material and Methods: A total of 203 dentists, aged between 23-72, participated in the survey, which utilized a structured questionnaire distributed via Google Forms. Data analysis was performed using PASW Statistics 20, and chi-square tests were used for intergroup comparisons.

Results: The results showed that 30% of participants were periodontists (P), 39% specialized in other dental fields (S), and 31% were general dentists (GD). Periodontists reported the highest frequency of encountering OMD at 93%, followed by GD group at 78% and S group at 68%. OLP was the most common lesion, followed by CUS. The GD group performed significantly worse on the knowledge assessment, particularly in questions related to diagnosis and treatment, including the use of autoantibodies for diagnosis ($p = 0.019$).

Conclusion: The study highlights the importance of clinicians' familiarity with mucocutaneous manifestations of OMD for early diagnosis, optimal management, and improved patient quality of life. Addressing the identified deficiencies in OMD diagnosis among dentists is crucial, as it can enhance patient compliance, expedite diagnoses, and mitigate concerns regarding malignant transformations.

Türkiye'de Diş Hekimlerinin Oral Mukozal Hastalıklar Hakkında Bilgi ve Tutumlarının Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 21.05.2024
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Anahtar Kelimeler:
Oral mukozal hastaliklar,
Liken planus,
Bilgi,
Anket.

ÖZET

Amaç: Oral mukozal hastaliklar (OMH), oral liken planus (OLP), eritema multiforme (EM), pemfigus vulgaris (PV), kronik ülseratif stomatit (KUS) ve diğerleri gibi bir grup immün bozuklukları içerir. Bu durumlar sıklıkla ağız mukozasını etkiler ve hatta ağız tutulumuyla bile başlayabilir. Bu nedenle ağız sağlığı profesyonellerinin bu durumların klinik özelliklerine ve belirtilerine aşina olmaları ve bunların tedavisindeki önemli rollerini anlamaları hastalıkların kontrolü ve tedavisi açısından oldukça önemlidir. Bu çalışmanın amacı Türkiye'deki diş hekimlerinin OMH'a ilişkin farkındalık, bilgi ve tutumlarını değerlendirmektir.

Gereç ve Yöntem: Google Formlar aracılığıyla dağıtılan yapılandırılmış bir anketin kullanıldığı ankete yaşları 23-72 arasında değişen, toplam 203 diş hekimi katıldı. Veri analizi, gruplar arası karşılaştırmalar için ki-kare testi kullanılarak PASW İstatistik 20 yazılımı kullanılarak yapıldı.

Bulgular: Sonuçlar katılımcıların %30'unun periodontist (P), %39'unun diğer diş alanlarında uzman (S) ve %31'inin genel diş hekimi (GD) olduğunu gösterdi. Periodontistler %93 ile OMD ile karşılaşmanın en yüksek sıklığını bildirdi, bunu %78 ile GD grubu ve %68 ile S grubu izledi. OLP, en yaygın lezyon olarak belirlendi, KUS ise ikinci en yaygın lezyon olarak belirlendi. GD grubu, özellikle tanı ve tedavi ile ilgili sorularda, tanı için otoantikor kullanımı dahil olmak üzere bilgi değerlendirmesinde önemli ölçüde daha kötü performans gösterdi ($p=0,019$).

Sonuç: Çalışma; erken tanı, optimal yönetim ve hastanın yaşam kalitesinin iyileştirilmesi için diş hekimlerinin OMH'ların klinik bulgu ve belirtileri konusunda bilgi sahibi olmanın önemini vurgulamaktadır. Diş hekimleri arasında OMH tanısında tespit edilen eksikliklerin ele alınması, hasta uyumunu artırabileceği, teşhisleri hızlandırabileceği ve malign dönüşümlerle ilgili endişeleri azaltabileceğinden oldukça önemlidir.

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INTRODUCTION

Oral mucosal diseases (OMD) can be a consequence of a primary pathology or be secondary to a systemic or autoimmune disease.[1] The oral cavity is frequently implicated in autoimmune diseases. The high prevalence of oral involvement in dermatoses associated with autoimmune diseases is well-documented, and it varies significantly in frequency between different diseases and in the severity of the participation among patients.[2]

Oral lichen planus (OLP), pemphigus vulgaris (PV), erythema multiforme (EM), chronic ulcerative stomatitis (CUS), systemic lupus erythematosus (SLE), mucous membrane pemphigoid (MMP), epidermolysis bullosa (EB) are the most frequently diagnosed conditions in the oral mucosa.[1,3] Despite differing etiologies, systemic conditions, and pathologies, these conditions often present similarly with ulcerations in oral tissues, posing diagnostic challenges.[4] Therefore, an accurate diagnosis often requires an assessment of clinical features complemented by histopathological examination or mucosal biopsy.[5]

Due to their complex nature, autoimmune diseases and their oral manifestations necessitate a multidisciplinary approach to develop appropriate treatment protocols. Early diagnosis of autoimmune skin diseases is paramount, with both general physicians and dental professionals playing pivotal roles in influencing disease progression and outcome. Dentists hold a crucial position in effectively managing these diseases, given their frequent manifestation of initial and sometimes sole symptoms in oral tissues.[2] Thus, it's imperative for dentists to possess adequate knowledge and skills regarding the clinical appearance, differential diagnosis, and treatment of OMD.

While there's a limited number of studies assessing dentists' knowledge and attitudes toward oral lesions in the literature,[6] to our knowledge, no study has explored the relationship between different residencies and dentists' knowledge and attitudes regarding OD alone. We hypothesized that dental practitioners' awareness and knowledge regarding OMD, including their diagnostic and management approaches, varies significantly based on their specialization. A lack of familiarity with immune-mediated oral conditions, particularly among general dentists, may hinder early diagnosis and optimal patient management, potentially affecting patient outcomes and quality of life. This study aims to evaluate the awareness, knowledge, and attitudes of dental practitioners in Turkey towards OMD, such as oral lichen planus (OLP), erythema multiforme (EM), pemphigus vulgaris (PV), and chronic ulcerative stomatitis (CUS). Specifically, it seeks to identify gaps in their understanding of these conditions' clinical presentations, diagnostic tools (e.g., autoantibodies), and management strategies. The ultimate goal is to emphasize the critical role of dental professionals in the early detection and comprehensive care of OMDs, improving patient outcomes and reducing the risk of complications, including malignant transformation.

MATERIAL AND METHODS

Ethical Approval

The study was granted ethical approval by the Human Subject's Ethics Board of Yozgat Bozok University (Approval No: E-65327612-900-98115, dated 23.09.2022) and adhered to the principles outlined in the Helsinki Declaration. The study took place from July 2023 to November 2023. All participants in the study provided online informed consent and were assured of the confidentiality of their information

Study Design

This cross-sectional study included 203 dentists (60 periodontists, 64 general dentists, and 79 specialists from other dental fields) aged

between 23 and 72. It was conducted using an online questionnaire (Supp. Table 1). The survey was created using Google Forms and comprised a structured questionnaire. The survey link was distributed to participants via email.

Table 1. Distribution of demographic data and participants' experience with oral mucosal diseases between the groups

Parameters		GD (n=64)	P (n=60)	S (n=79)	p values
Time as a physician	<5 years	10 (4.9%)	12 (5.9%)	17 (8.4%)	**0.044**
	5-10 years	20 (9.9%)	31 (15.3%)*	36 (17.7%)#	
	>10 years	34 (16.7%)*#	17 (8.4%)	26 (12.8)	
The institution they are working at	State Hospital/ODHC	38 (18.7%)*#	11 (5.4%)	14 (6.9%)	**0.000**
	Private practice	6 (3.0%)	8 (3.9%)	5 (2.5%)	
	Private clinic	20 (9.9%)	12 (5.9%)	12 (5.9%)	
	University	0 (0.0%)	29 (14.3%)*	48 (23.6%)#	
Title	DDS	64 (31.4%)*#	0 (0.0%)	0 (0.0%)	**0.000**
	MSD, DDS	0 (0.0%)	33 (16.2%)*	39 (19.1%)#	
	DDS, Ph.D.	0 (0.0%)	24 (11.8%)*	35 (17.2%)#¥	
	Assoc. Prof.	0 (0.0%)	3 (1.5%)	4 (2.0%)	
	Prof.	0 (0.0%)	0 (0.0%)	1 (0.5%)	
Have you had any experience with oral mucosal diseases before?	Yes	50 (24.6%)	56 (27.6%)	54 (26.6%)	**0.002**
	No	14 (6.9%)	4 (2.0%)*¥	25 (12.3%)	
How often do you encounter symptoms of oral mucosal diseases in patients?	Every day	0 (0.0%)	0 (0.0%)	0 (0.0%)	**0.002**
	Once a week	3 (1.5%)	1 (0.5%)	6 (3.0%)	
	Once in a month	4 (2.0%)*#	12 (5.9%)	12 (5.9%)	
	Once a year	4 (2.0%)	16 (7.9%)	9 (4.4%)	
	Rarely	53 (26.1%)	31 (15.3%)*¥	52 (25.6%)	
Which lesions have you experienced before?	Oral lichen planus	52 (28.0%)	59 (31.7%)	75 (40.3%)	0.012
	Pemphigus vulgaris	11 (22.4%)	18 (36.7%)	20 (40.8%)	
	Mucous membrane pemphigoid	4 (14.8%)	11 (40.7%)	12 (44.4%)	
	Bullous pemphigoid	6 (28.6%)	6 (28.6%)	9 (42.9%)	
	Lupus erythematosus	10 (30.3%)	10 (30.3%)	13 (39.4%)	
	Erythema multiforme	7 (29.2%)	6 (25.0%)	11 (45.8%)	
	Epidermolysis bullosa	2 (16.7%)	3 (25.0%)	7 (58.3%)	
	Linear IgA disease	0 (0.0%)	2 (66.7%)	1 (33.3%)	
	Chronic ulcerative stomatitis	27 (31.0%)	21 (24.1%)	39 (44.8%)	

P: periodontists, S: specialized in other dental fields; GD: general dentists; ODHC: Oral and dental health center; DDS: Doctor of dental surgery; MSD: Master of science in dentistry; Ph.D.: Philosophiae of Doctorate; Assoc. Prof: Associate professor; Prof: Professor
Chi-square test.
Values in bold differ from 0, with a significance level of alpha <0.05.
*Statistically significant difference between GD and P.
Statistically significant difference between GD and S.
¥ Statistically significant difference between P and S.

Upon accessing the link, participants were presented with a brief description of the study, including its objectives and the voluntary, anonymous nature of participation. They were required to acknowledge this information by checking a confirmation box before proceeding to the questionnaire.

The questionnaire, adapted from previous studies [6,7] and refined through expert consultation, gathered demographic information (e.g., gender, age groups, and educational background) and assessed participants' knowledge and attitudes toward OMD.

Validity

The validity of the OMD Awareness Questionnaire was assessed through content and construct validity. Content validity was established by consulting with dental professionals and experts in oral mucosal

diseases to ensure that the items comprehensively addressed the key aspects of OMD knowledge and awareness relevant to dental practice. Construct validity was evaluated by analyzing the correlations between the questionnaire scores and other established measures of dental knowledge. The results confirmed that the questionnaire accurately reflects dental practitioners' awareness and understanding of OMD.

Reliability

The OMD Awareness Questionnaire's test-retest reliability was assessed with five periodontist-oral pathologists. The first questionnaire was filled in at the clinic and then follow-up questionnaires were sent to half of the participants after 3 weeks and to the other half of the participants after 6 weeks. Pearson correlation coefficients demonstrated strong test-retest reliability for all items (data not shown). These findings confirm that the questionnaire is a reliable tool for assessing dentists' awareness of oral mucosal diseases.

Statistical Analysis

Prior to commencing the study, sample size analysis was performed using dedicated software (Sample Size Calculator by Raosoft, Inc.). Based on data from the Faculty of Dentistry, Deans Council Meeting 12 indicated that out of 43378 dentists actively practicing in Turkey, 1278 were periodontists, and 8637 specialized in other departments. Periodontists were considered the primary variable. A margin error of 5% (for CI 95%) was selected, resulting in a determined sample size of 43 for each group.

Data was analyzed using PASW (Predictive Analytics Software) version 20 (SPSS for Windows v.26, IBM SPSS Inc., New York, NY, USA). The chi-square test was employed to compare variables between groups. $p<0.05$ was considered statistically significant.

RESULTS

Study Population

A total of 203 dentists aged between 23 and 72 took part in our study. Among them, 30% were periodontists, 39% specialized in other branches of dentistry, and 31% were general dentists (Figure 1-A, 1-B). There were no significant gender differences between the groups ($p>0.05$) (Figure 1-C), but the mean age of the general dentist (GD) group was notably higher than the other two groups ($p<0.001$) (Figure 1-D).

The GD group predominantly had a duty period exceeding ten years, whereas it ranged between 5 to 10 years for the other two groups ($p=0.044$) (Table 1). State hospitals/oral and dental health centers were the primary workplace for most of the GD group, while the other groups mainly worked in university hospitals ($p=0.000$) (Table 1). All participants in the GD group held the title of Doctor of Dental Surgery (DDS), whereas the other groups often included individuals with titles such as DDS with a Master of Science in Dentistry (MSD) and DDS with a Philosophiae of Doctorate (Ph.D.) ($p=0.000$) (Table 1).

Participants' Experience with OMD

Table 1 presents participants' encounters with OMD. Although the periodontist (P) group encountered OMD most frequently (93%), 78% of the GD group and 68% of specialized in various dental fields (S) had experience with OMD ($p=0.012$). OLP was the most common lesion encountered, followed by CUS ($p=0.012$).

Participants' Knowledge About OMD

The distribution of participants' knowledge levels is displayed in Table 2. The GD group had a statistically significantly lower rate of correct answers than the other groups ($p<0.05$). Additionally, the GD and S groups showed a statistically significantly higher rate of "I don't know" responses compared to the P group ($p<0.05$).

Table 2. Distribution of knowledge level of participants' according to residency

Assessment of knowledge level		GD (n=64)	P n=60)	S (n=79)	p values
Suggestion 1	It's true	47 (23.2%)	58 (28.6%)	60 (29.6%)	**0.005**
	It's false	4 (2.0%)	2 (1.0%)	4 (2.0%)	
	I don't know	13 (6.4%)	0 (0.0%)*¥	15 (7.4%)	
Suggestion 2	It's true	34 (16.7%)	47 (23.2%)	54 (26.6%)	**0.004**
	It's false	14 (6.9%)	12 (5.9%)	14 (6.9%)	
	I don't know	16 (7.9%)	1 (0.5%)*¥	11 (5.4%)	
Suggestion 3	It's true	50 (24.6%)	57 (28.1%)	67 (33.0%)	0.081
	It's false	5 (2.5%)	2 (1.0%)	3 (1.5%)	
	I don't know	9 (4.4%)	1 (0.5%)	9 (4.4%)	
Suggestion 4	It's true	22 (10.8%)	43 (21.2%)	42 (20.7%)	**0.000**
	It's false	11 (5.4%)	9 (4.4.%)	13 (6.4%)	
	I don't know	31 (15.3%)	8 (3.9%)*¥	24 (11.8%)	
Suggestion 5	It's true	32 (15.8%)	55 (27.1%)	57 (28.1%)	**0.000**
	It's false	3 (1.5%)	4 (2.0%)	6 (3.0%)	
	I don't know	29 (14.3%)	1 (0.5%)*¥	16 (7.9%)	
Suggestion 6	It's true	0 (0%)	45 (22.2%)*¥	14 (6.9%)	0.001
	It's false	37 (18.2%)	15 (7.39%)	46 (22.7%)	
	I don't know	27 (13.3%)	0(0%)	19 (9.4%)	
Suggestion 7	It's true	0 (0%)	43 (21.2%)*¥	13 (6.4%)	0.000
	It's false	34 (17.74%)	14 (6.9%)	43 (21.2%)	
	I don't know	32 (15.8%)	3(1.48%)	23 (11.3%)	
Case					
Case 1	OLP	59 (29.1%)	59 (29.1%)	69 (34.0%)	0.321
	PV	2 (1.0%)	1 (0.5%)	3 (1.5%)	
	EM	0 (0.0%)	0 (0.0%)	0 (0.0%)	
	SLE	1 (0.5%)	0 (0.0%)	1 (0.5%)	
	I don't know	2 (1.0%)	0 (0.0%)	6 (3.0%)	
Case 2	OLP	2 (1.0%)	5 (2.5%)	8 (3.9%)	**0.020**
	PV	19 (9.4%)	33 (16.3%)*¥	27 (13.3%)	
	EM	10 (4.9%)	9 (4.4%)	10 (4.9%)	
	SLE	19 (9.4%)	6 (3.0%)	14 (6.9%)	
	I don't know	14 (6.9%)	7 (3.4%)	20 (9.9%)	
Case 3	OLP	0 (0.0%)	0 (0.0%)	1 (0.5%)	0.086
	PV	9 (4.4,%)	4 (2.0%)	6 (3.0%)	
	EM	24 (11.8%)	40 (19.7%)	43 (21.2%)	
	SLE	10 (4.9%)	3 (1.5%)	10 (4.9%)	
	I don't know	21 (10.3%)	13 (6.4%)	19 (9.4%)	
Case 4	OLP	2 (1.0%)	8 (3.9%)	12 (5.9%)	**0.002**
	PV	12 (5.9%)	9 (4.4%)	15 (7.4%)	
	EM	25 (12.3%)	13 (6.4%)	24 (11.8%)	
	SLE	9 (4.4%)	24 (11.8%)*¥	13 (6.4%)	
	I don't know	16 (7.9%)	6 (3.0%)	15 (7.4%)	
Assessment of treatment attitude					
Suggestion 1	I agree	61 (30.0%)	60 (29.6%)	76 (37.4%)	0.353
	I am not sure	2 (1.0%)	0 (0.0%)	3 (1.5%)	
	I don't agree	1 (0.5%)	0 (0.0%)	0 (0.0%)	
Suggestion 2	I agree	62 (30.5%)	57 (28.1%)	78 (38.4%)	0.263
	I am not sure	2 (1.0%)	3 (1.5%)	0 (0.0%)	
	I don't agree	0 (0.0%)	0 (0.0%)	1 (0.5%)	
Suggestion 3	I agree	57 (28.1%)	58 (28.6%)	72 (35.5%)	0.112
	I am not sure	7 (3.4%)	1 (0.5%)	4 (2.0%)	
	I don't agree	0 (0.0%)	1 (0.5%)	3 (1.5%)	
Suggestion 4	I agree	45 (22.2%)	56 (27.6%)*¥	61 (30.0%)	**0.019**
	I am not sure	13 (6.4%)	4 (2.0%)	11 (5.4%)	
	I don't agree	6 (3.0%)	0 (0.0%)	7 (3.4%)	
Suggestion 5	I agree	62 (30.5%)	58 (28.6%)	75 (36.9%)	0.446
	I am not sure	0 (0.0%)	2 (1.0%)	2 (1.0%)	
	I don't agree	2 (1.0%)	0 (0.0%)	2 (1.0%)	
Suggestion 6	I agree	60 (29.6%)	56 (27.6%)	69 (34.0%)	0.608
	I am not sure	2 (1.0%)	3 (1.5%)	6 (3.0%)	
	I don't agree	2 (1.0%)	1 (0.5%)	4 (2.0%)	

P: periodontists; S: specialized in other dental fields; GD: general dentists; OLP: Oral lichen planus; PV: Pemphigus vulgaris; EM: Erythema multiforme; SLE: Systemic lupus erythematosus.
Chi-square test.
Values in bold differ from 0 with a significance level of alpha <0.05.
*Statistically significant difference between GD and P.
[#] Statistically significant difference between GD and S.
[¥] Statistically significant difference between P and S.

Figure 1. Distribution of demographic data between the groups. (1.A. Distribution of participants according to study groups, 1.B. Distribution of participants according to residency, 1.C. Distribution of gender according to residency, 1.D. Distribution of age according to residency)

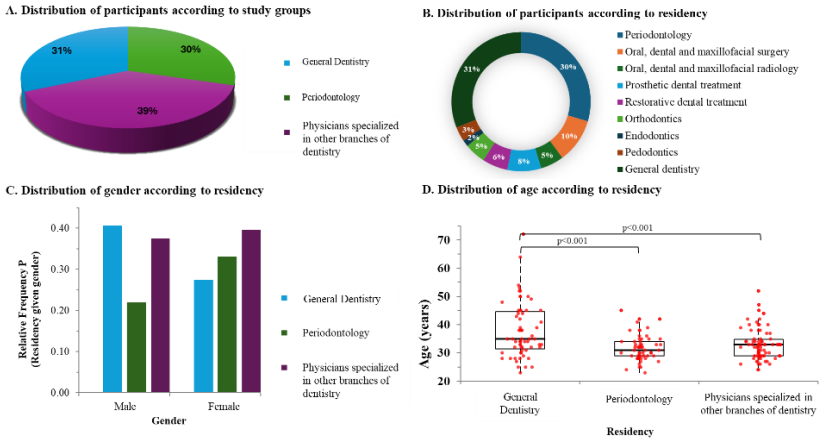

Table 2 also reveals the participants' diagnostic abilities. While almost all participants in each group could diagnose OLP, SLE was the least correctly diagnosed disease (p=0.321, p=0.002, respectively). The GD group had a significantly lower rate of pemphigus vulgaris (PV) diagnosis than the other two groups (p=0.020). The P group exhibited the highest rate of SLE diagnosis (p=0.002).

Table 2 depicts the distribution of participants' diagnoses and treatment approaches according to residency. The GD group demonstrated significantly lower knowledge of using autoantibody tests for diagnosis than the other groups (p=0.019).

Table 3 illustrates participants' knowledge and attitudes regarding risk factors. Almost all participants in each group routinely examined the oral cavity for OMD.

Regarding biopsy application rates (Table 4), it was observed that most dentists in each group did not perform biopsies, with only one person in the GD group conducting biopsies (p=0.000). While incisional biopsy was often preferred by physicians performing biopsies, participants in the P group frequently opted for excisional biopsy. The choice of biopsy area typically depended on inspection, with saline being preferred by other groups and formalin often chosen in the P group as the biopsy medium (Table 5).

Table 3. Distribution of participants' clinical knowledge and attitude according to residency

		GD (n=64)	P (n=60)	S (n=79)	p values
Which area(s) do you consider when evaluating **oral mucosal diseases**?	Buccal/lingual mucosa	7 (26.9%)	3 (11.5%)	16 (61.5%)	0.150
	Tongue	1 (9.1%)	1 (9.1%)	9 (81.8%)	
	Floor of mouth	2 (18.2%)	2 (18.2%)	7 (63.6%)	
	Gum	3 (21.4%)	2 (14.3%)	9 (64.3%)	
	Palatal mucosa	2 (20.0%)	1 (10.0%)	7 (70.0%)	
	Entire oral cavity	56 (32.4%)	56 (32.4%)	61 (35.3%)	
Which one is a risk factor for **oral mucosal diseases**?	Autoimmunity	59 (31.2%)	57 (30.2%)	73 (38.6%)	0.749
	Viral infections	50 (32.5%)	43 (27.9%)	61 (39.6)	
	Smoking	53 (31.0%)	50 (29.2%)	68 (39.8%)	
	Alcohol consumption	48 (31.6%)	44 (28.9%)	60 (39.5%)	
	Stress	55 (32.0%)	50 (29.1%)	67 (39.0%)	
	Other	13 (50.0%)	4 (15.4%)	9 (34.6%)	

P: periodontists; S: specialized in other dental fields; GD: general dentists
Chi-square test.
*Statistically significant difference between GD and P.
Statistically significant difference between GD and S.
¥ Statistically significant difference between P and S.

Table 4. Distribution of performing biopsy according to residency

		GD (n=64)	P (n=60)	S (n=79)	p values
How do you proceed in cases requiring biopsy to diagnose **oral mucosal diseases**?	I perform the biopsy myself	1 (0.5%)	28 (13.8%)*¥	16 (7.9%)	**0.000**
	I refer you to a specialist	41 (20.2%)	15 (7.4%)	48 (23.6%)	
	I refer to the hospital	22 (10.8%)	17 (8.4%)	15 (7.4%)	
Why don't you perform a biopsy?	The patient refuses the procedure	0 (0.0%)	2 (100.0%)	0 (0.0%)	0.180
	Lack of knowledge and skills	45 (43.7%)	13 (12.6%)	45 (43.7%)	
	Lack of equipment required for biopsy	32 (44.4%)	15 (20.8%)	25 (34.7%)	
	Lack of a pathology laboratory nearby	16 (44.4%)	11 (30.6%)	9 (25.0%)	

P: periodontists; S: specialized in other dental fields; GD: general dentists
Chi-square test.
Values in bold differ from 0 with a significance level of alpha <0.05.
*Statistically significant difference between GD and P.
Statistically significant difference between GD and S.
¥ Statistically significant difference between P and S.

Table 5. Comparison of participants' biopsy approach according to residency

		GD (n=64)	P (n=60)	S (n=79)	p values
Which biopsy technique do you prefer?	Incisional biopsy	0 (0.0%)	15 (51.7%)	14 (48.3%)	0.884
	Excisional biopsy	1 (3.4%)	23 (79.3%)	5 (17.2%)	
	Fine needle aspiration biopsy	0 (0.0%)	1 (100%)	0 (0.0%)	
	Brush biopsy	0 (0.0%)	3 (42.9%)	4 (57.1%)	
	Punch biopsy	0 (0.0%)	4 (80.0%)	1(20.0%)	
What technique do you use to determine the appropriate biopsy site?	Visual inspection	1 (2.2%)	27 (58.7%)	11 (23.9%)	0.085
	Staining with toluidine blue	0 (0.0%)	2 (4.3%)	5 (10.9%)	
In what solution do you preserve the biopsy material?	Saline	2 (16.7%)	9 (75.0%)	1 (8.3%)	0.873
	Formaldehyde	0 (0.0%)	20 (55.6%)	16 (44.4%)	
	Alcohol	0 (0.0%)	0 (0.0%)	0 (0.0%)	
	I have no idea	0 (0.0%)	0 (0.0%)	0 (0.0%)	

P: periodontists; S: specialized in other dental fields; GD: general dentists
Chi-square test.
* Statistically significant difference between GD and P.
# Statistically significant difference between GD and S.
¥ Statistically significant difference between P and S.

DISCUSSION

This study aimed to assess dentists' knowledge and attitudes toward oral mucosal diseases (OMD), a group of immune-mediated conditions such as oral lichen planus (OLP), erythema multiforme (EM), pemphigus vulgaris (PV), and chronic ulcerative stomatitis (CUS). Given the frequent oral involvement in these disorders, it is crucial for dental professionals to recognize and manage them effectively.

Our results revealed no significant differences in the number of participants across the groups. However, the general dentists (GD) group had a higher mean age, potentially reflecting recent trends of younger dentists pursuing postgraduate residencies. According to the 2023 Faculty of Dentistry Deans Council Meeting,[8] the number of dental school graduates entering residencies has increased, with residency quotas comprising 25% of

annual dental graduates. While this trend broadens training opportunities, it could reduce the number of GDs providing primary oral healthcare, potentially raising service costs and limiting patient access.

Periodontists reported the highest frequency of encountering OMD in their practice. This is consistent with the routine evaluation of oral mucosal health in periodontology, which focuses on the tissues supporting teeth and implants. Consequently, the periodontist group exhibited superior knowledge and diagnostic accuracy, particularly in identifying conditions like OLP and SLE. This aligns with findings in oral cancer research,[9-13] where oral and maxillofacial surgeons demonstrated greater proficiency in lesion recognition. The preference for specialist referrals noted in our study is similarly reflected in the literature, where many general practitioners rely on specialists to diagnose and manage complex cases.

OLP emerged as the most common and accurately diagnosed condition, while SLE was the most challenging to diagnose. The prevalence of OLP, characterized by reticular white lesions on the buccal mucosa,[14-17] is notably higher than that of SLE, a rare condition.[1] This disparity highlights a natural tendency to recognize more prevalent diseases better, whereas rare conditions pose greater diagnostic challenges. Periodontists' higher diagnostic accuracy for SLE likely stems from their comprehensive training in both hard and soft tissue pathology.

A significant finding was the limited use of autoantibody tests for diagnosis, particularly among GDs. This gap underscores the need for greater access to user-friendly diagnostic tools and laboratory resources, which could enhance diagnostic capabilities and improve patient outcomes. Despite the critical role of biopsies in diagnosing OMD, most practitioners in our study, including many periodontists, did not perform them, citing a lack of knowledge, experience, or equipment. This reflects a broader issue identified in previous studies, where dental practitioners frequently refer patients to specialized centers for biopsy and diagnosis.[18,19]

The reluctance of many practitioners to manage OMD cases directly could be attributed to limited exposure and training. Similar studies in Turkey,[6] Italy,[18] Spain,[20] and France [21] report that while common lesions like traumatic ulcers are more easily recognized, rarer conditions such as pemphigus or systemic disease manifestations are often misdiagnosed or referred to specialists. Delays in diagnosing such conditions can have severe implications, including disease progression.

The findings emphasize the importance of continuous professional development to improve diagnostic and management skills for OMD. Previous research has shown that clinical proficiency improves with experience but can decline without ongoing education.[22] Younger practitioners, particularly those in residency programs, appear more interested in advancing their knowledge of oral mucosal diseases. Encouraging further training in this field is vital for enhancing patient care.

Finally, as highlighted by the Faculty of Dentistry Deans Council,[8] the uneven distribution of educational resources across dental faculties in Turkey underscores the need for improved training opportunities. Establishing collaborative networks between private practices and hospitals could also facilitate better diagnosis and management of oral pathologies, ultimately improving patient outcomes.

Limitations of the study include the reliance on self-reported data, which may be subject to recall bias or misinterpretation. Additionally, the study's cross-sectional design limits the ability to establish causal relationships between variables. The sample

primarily consisted of dentists from Turkey, which may limit the generalizability of findings to other populations with different healthcare systems and educational backgrounds. Furthermore, the study focused on dentists' knowledge and attitudes but did not assess their clinical practices or patient outcomes. Future research could employ longitudinal designs and include diverse populations to address these limitations and provide a more comprehensive understanding of dentists' management of OMD.

CONCLUSION

While most dental practitioners were familiar with OMD, many expressed hesitancy in dealing with them due to insufficient experience and skills. Relevant continuing dental education programs or training focused on handling potentially concerning oral lesions are advisable.

Ethical Approval

The study received ethical approval from the Human Subjects Ethics Board of Yozgat Bozok University (Approval No: E-65327612-900-98115, dated 23.09.2022).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: ZG, MAS, Data collection or access: ZG, FS, Analysis and comments: MAS, Literature search: ZG, FS, Writing: ZG, FS.

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Reconstruction of Defective Alveolar Bone With Non-Resorbable and Titanium Reinforced Membrane Implantation Success

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ABSTRACT

Aim: The aim of this study is to present the clinical success of cases in which implants were placed in defective alveolar bone in a single surgical procedure.
Material and Methods: Thirty-three patients with alveolar bone defects in the maxillary canine and premolar regions were included in the study. Before the procedure, cone-beam computed tomography (CBCT) images were obtained from all patients and the heights of the defective walls were recorded. In the surgical operation, primary stability of the implant was ensured, guided bone regeneration was applied. The prosthetic restoration was completed as cemented or screwed. Six months after this stage, the amount of bone regained was recorded by CBCT imaging. Clinically, peri-implant probing depth and bleeding on probing indexes were examined. The Mann-Whitney U test was applied for comparisons between types of restoration, while bone heights were compared using the Wilcoxon Sign test ($p<0.05$).
Results: The mean total bone height gain was 8.91 ± 1.30 mm. The pocket depth was significantly greater in cemented restorations compared to screwed restorations ($p=0.006$). The mean pink esthetic score score was 12.3 ± 1.8 and the mean white esthetic score score was 8.4 ± 1.5.
Conclusion: In cases where there is a defect of more than half the implant length on one or both sides of the alveolar bone, implants can be placed in a single session with a meticulous surgical approach and appropriate material. The use of screw retainers in prosthetic restorations has been found to be more successful than cemented restorations.

Defektif Alveolar Kemiğin Rezorbe Olmayan ve Titanyumla Güçlendirilmiş Membranla Rekonstrüksiyonu ve İmplantasyon Başarısı

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 18.11.2024
Kabul Tarihi: 09.04.2025
Yayın Tarihi: 29.08.2025

Anahtar Kelimeler:
Immediat implant,
Yönlendirilmiş kemik rejenerasyonu,
Alveolar kemik defekti,
Implant destekli protezler,
Titanyum mesh.

ÖZET

Amaç: Bu çalışmanın amacı, implantların defektif alveoler kemiğe tek bir cerrahi prosedürle yerleştirildiği vakaların klinik başarısını sunmaktır.
Gereç ve Yöntemler: Maksiller kanin ve premolar bölgelerinde alveolar kemik defekti olan 33 hasta çalışmaya dahil edildi. İşlem öncesinde tüm hastalardan konik ışınlı bilgisayarlı tomografi (CBCT) görüntüleri elde edildi ve defektif duvarların yükseklikleri kaydedildi. Cerrahi operasyonda implantın primer stabilitesi sağlandı, yönlendirilmiş kemik rejenerasyonu uygulandı. Protetik restorasyon simante veya vidalı olarak tamamlandı. Bu aşamadan altı ay sonra, kazanılan kemik miktarı CBCT görüntüleme ile kaydedildi. Klinik olarak, peri-implant sondalama derinliği ve sondalamada kanama indeksleri incelendi. Restorasyon tipleri arasındaki karşılaştırmalar için Mann-Whitney U testi uygulanırken, kemik yükseklikleri Wilcoxon İşaret testi kullanılarak karşılaştırıldı ($p<0.05$).
Bulgular: Ortalama toplam kemik yüksekliği kazancı 8.91 ± 1.30 mm idi. Cep derinliği simante restorasyonlarda vidalı restorasyonlara göre anlamlı olarak daha fazlaydı ($p=0.006$). Ortalama pembe estetik skor 12.3 ± 1.8 ve ortalama beyaz estetik skor 8.4 ± 1.5 idi.
Sonuçlar: Alveoler kemiğin bir veya iki tarafında implant uzunluğunun yarısından fazla defekt olduğu durumlarda, titiz bir cerrahi yaklaşım ve uygun materyal ile implantlar tek seansta yerleştirilebilir. Protetik restorasyonlarda vida tutucuların kullanımı simante restorasyonlara göre daha başarılı bulunmuştur.

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INTRODUCTION

Nowadays, dental implant therapy is the first choice of treatment for toothlessness with good functional and esthetical outcomes.[1] However, extensive bone loss can result from a number of procedures such as traumatic tooth extraction, surgical removal of impacted teeth, retrieval of failed implants and cyst enucleation.[2,3] This makes implant placement difficult and prolongs the treatment period. Absence of sufficient alveolar bone may interfere with implant stabilization, osseointegration and long-term prognosis as well as aesthetic considerations.[4]

Classification of alveolar bone defects and determination of appropriate treatment methods are of great importance for clinicians.[5] In a 2022 consensus study, alveolar bone defects were categorized into five types and treatment recommendations were presented for each type. Accordingly, staged treatment is recommended for all defect types except Type I.-0.[6,7] However, this approach prolongs the treatment time and decreases patient comfort.[8] Therefore, faster and more comfortable methods should be investigated.

Guided bone regeneration (GBR) is a widely used technique for the treatment of bone defects.[9,10] The success of GBR depends on the properties of the membrane and graft materials used.[11] In recent years, titanium reinforced PTFE membranes have come to the forefront due to their high stability and biocompatibility.[3,12] However, the efficacy of these materials in different defect types is still not fully investigated.[13]

The primary hypothesis of this study is that the GBR technique using a titanium reinforced polytetrafluoroethylene (PTFE) membrane will be effective in Type I.-I and Type II-0 alveolar bone defects when combined with one-stage implant placement. Supporting hypotheses are that this technique will provide acceptable marginal bone loss and high aesthetic scores, and that screw-retained restorations will offer better peri-implant health than cemented ones.[14]

No research has been done in the literature on implant placement with GBR simultaneously in Type I.-I and Type II-0 alveolar bone defects. This gap is a deterrent to doctors who may want to provide single-stage treatment for these patients.[15] Consequently, this study seeks to generate new information that can be used by doctors for implementing single-stage treatments.

The purpose of this study was to determine the effectiveness of using GBR technique plus titanium reinforced PTFE membrane in treating Type II-0 and Type I.-I alveolar clefts alongside one-stage dental implant placements. Further, the research will seek to investigate how well this method increases bone mass, controls marginal ridge resorption, maintains a stable functional position for implants, and preserves peri-implant tissues including aesthetics. This will not only give more options that promise a shorter therapy period but also enhance patient satisfaction since they are painless alternatives during the healing process as it shortens the therapy phase besides increasing their comfort.

MATERIAL AND METHODS

Ethical Approval

This study has been approved by Nigde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee on 25/01/2024 with protocol number 2024/14. It was carried out in compliance with guidelines stated in the Declaration of Helsinki (1964). All subjects gave informed consent prior to their inclusion in the experiment.

Study Design /Sample

Oral, Maxillofacial and Maxillofacial Surgery Clinic hosted this clinical study

between October 2022 to January 2023. It involved 33 patients (15 males, 18 females) aged between 40.0 ± 14.0 years who had single missing teeth in the maxillary canine or premolar areas together with damaged alveolar bones. The inclusion criteria included (1) being above 18 years old; (2) having only one tooth missing in the upper jaw canines or premolars area; (3) a defect on one side (>5 mm) or two sides (<5 mm) of the alveolar bone for a standard implant size of 10 mm (Type I.-I and Type II-0). Malignancy within the defect region, unoperated cysts or active infections, smoking, and uncontrolled diabetes were among the exclusion criteria used. Impacted tooth extraction, traumatic tooth extraction, and failed implant extraction were identified as causes of defects.

Predictor / exposure / independent variable

The absence of canines or premolars in the maxilla was the independent variable.

Main outcome variable(s)

The main outcome variables were the difference in T0 and T1 bone heights, aesthetic scores, and BOP and PPD indexes related to the type of prosthetic restoration.

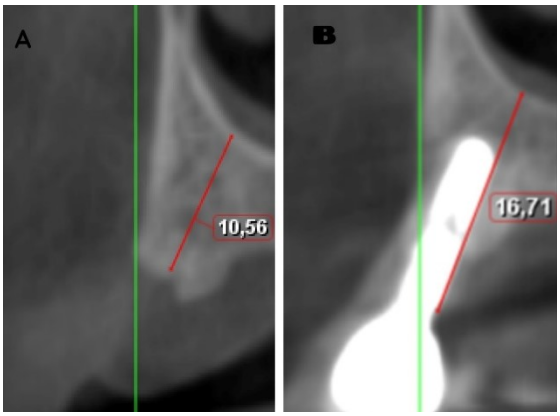
Covariates

The covariates were patient age, gender, and measured bone volumes.

Radiographic Evaluation

Radiographic evaluations were performed before implant placement (T0) and six months after final restoration (T1) using a Planmeca ProMax® 3D Mid CBCT device. Patients were positioned in a sitting position with a grid support. Bone height measurements were taken from the sinus floor in the premolar region and from the base of the nose to the end of the alveolar wall in the canine region. Buccal and palatal defects were analyzed on the sagittal axis, while mesial and distal defects were analyzed on the frontal axis (Figure 1).

Figure 1. a) For tooth 25, the measurement of the defective wall from the sinus floor b) The new bone height 6 months after the prosthetic restoration is shown



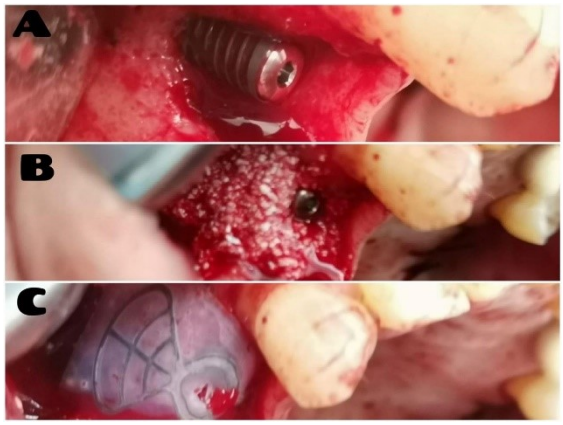
To minimize measurement errors, consistency of measurements by the same researcher was ensured and the calibration of the instrument was checked regularly. Calibration was performed in accordance with the manufacturer's instructions and periodic tests were performed using a standard phantom to improve measurement accuracy. In addition, intra-observer and inter-observer reliability analyses were performed to assess measurement errors and the results were statistically analyzed.

Implant and Graft Materials

For the research, implant materials with a conical shape and hydrophilic surface were used (INNO®, Cowellmedi, Pusan, Korea). The average length of the implants was 10 ± 1.0 mm while the average diameter was 4.0 ± 0.4 mm. All patients undergoing GBR had graft material made of Bio-Oss (Geistlich Pharma AG, Wolhusen, Switzerland) and Wifi-Mesh (COWELL® InnoGenic™, Korea) titanium reinforced PTFE membrane (Figure 2). Their choices were based on clinical success and efficacy as reported in scientific literature. INNO® implants foster osseointegration as well as enhance healing through their hydrophilic nature. Since it is similar to natural bone structure, Bio-Oss has been widely

employed for bone volume reconstruction and aids bone integration through its high biocompatibility. Composed of titanium reinforced PTFE, Wifi-Mesh membranes are stable and can be tolerated by human bodies. These membranes hold grafted bones steady and prevent growth of soft tissues into them considering that titanium reinforced membranes have been established to be effective in bone regeneration.

Figure 2. a) Placing the two walls of the implant in the defective area b) Covering the implant surface with graft material c) Applying titanium supported membrane to protect the surgical field



Surgical Procedure

All surgical procedures were performed by a single oral surgeon with 8 years of experience. Lidocaine 2% (Dentsply Sirona, York, PA) was applied to the mucogingival junction and interdental papilla as a local anesthetic. After anesthesia, alveolar bone incision and vertical incisions were made to the adjacent teeth. The flap was lifted to expose the defective area and all surfaces were curetted. The implant position was planned to be aligned and parallel to the adjacent teeth. A 3 mm length and 3.5 mm diameter drill was made at the apex for apical support. The implant was placed with a torque of 35 N and a cap screw was inserted. The implant periphery was filled with graft material and covered with a barrier membrane. The membrane was fixed with matrix suture and the flap was closed as much as possible with simple suture using Vicryl (Johnson & Johnson, New Brunswick, NJ) after the release incision was made. Four months later, secondary surgery was performed and the membrane skeleton was removed and a healing cap was placed.

A surgeon's experience is vital to the success of a surgical procedure. An eight-year-experienced surgeon in these operations has proven to reduce complications and increase success rates. Success may also be affected by other factors including but not limited to; how well the doctor can use their hands, techniques they employ during an operation, sterilization methods adopted as well as general patient health and oral habits like brushing teeth regularly — among others. Additionally, it is important that surgeons are able to see what they're doing while making incisions or placing implants hence adequate lighting should be provided for them always. In ensuring infection control throughout the process before and after procedures, measures were taken such as closing off areas where surgery was done properly so no germs could enter inside, plus making sure patients follow postoperative instructions carefully. Wound dehiscence and infectious complications were not observed.

Prosthetic Procedure

Since the alveolar bone was defective preoperatively, the restoration was performed after a 4-month healing period. After the second surgery, the impression was taken after waiting for soft tissue healing. A provisional restoration was made, and when no problems were observed, the final restoration was cemented or screwed in place.

Periodontal Evaluation

Peri-implant soft tissue status was assessed by the same clinician using a periodontal probe (15 UNC/CP-11.5B Screening Color-Coded Probe, Hu-Friedy). Peri-implant probing depth (PPD) and bleeding on probing (BOP) were measured at six points around each implant. The mean PPD and percentage of BOP positive sites were calculated (Figure 3).

Figure 3. a) 6 months after the restoration, examination of the restoration perimeter with a periodontal probe starting from the distal papilla b) intraoral view of a sample restoration

Data collection methods

Radiographically, the difference between T1 and T0 bone heights was recorded as bone gain. Clinically, PPD and BOP scores were recorded by periodontal examination, and PES and WES scores were recorded for aesthetic evaluation. STROBE checklist is completed at all stages.

Data Analyses

Continuous variables are mean (standard deviation) and median [minimum-maximum]; categorical variables are expressed as n (%). The Mann-Whitney U test was applied for comparisons between types of restoration, while bone heights were compared before and after the procedure using the Wilcoxon Sign test. The SPSS software (IBM Corp., Released 2017, Version 25.0) was used for statistical analysis; $p < 0.05$ indicated a significant difference. Non-parametric tests like the Mann-Whitney U test and Wilcoxon Sign test are used when the data is not normally distributed or the sample size is small. For comparing the medians of two independent groups, we used the Mann-Whitney U test, and for comparing the medians of two dependent groups, we employed the Wilcoxon Sign test. Since the normal distribution assumption was violated according to Shapiro-Wilk's Test, parametric tests were not considered appropriate for this study.

RESULTS

The study consisted of 33 patients (15 men, 18 women) with a mean age of 40.0 ± 14.0 years. Tooth extraction due to impact was the reason for defective alveolar bone formation in 18 cases; cyst or benign tumor operation in six cases, failed implant extraction in three, and trauma in six. Sixty-three point six percent had two-walled defects while thirty-six point four percent had three-walled defects. In the upper canine region, implants were placed at a rate of 72.7%, and 27.3% in the upper premolar region. Cemented types of restoration accounted for 36.4%, whereas screwed types represented 63.6% (Table 1). Therefore, these demographics indicate that we covered a wide range of defect types and implant locations.

Table 1. Descriptive Statistics

Variables	Statistical Data
D2	21(63.6)
D1	12(36.4)
Maxilla Canine	24(72.7)
Maxilla Premolar	9(27.3)
Cemente	12(36.4)
Screw	21(63.6)
Bleeding on Probing: Yes	3(9.1)
Bleeding on Probing: No	30(90.9)
D1 Gained Bone (mm) (Avg. ± SD)	4.82 ± 1.17
D2 Gained Bone (mm) (Avg. ± SD)	4.09 ± 1.97
Total Gained Bone (mm) (Avg. ± SD)	8.91 ± 1.30
Avg. Probing Depth (mm) (Avg. ± SD)	3.18 ± 0.75

D1: three-walled bone defect D2: double-walled bone defect Avg: average

In D1, defective single wall showed an average bone gain of 4.82 ± 1.17 mm, while the defective second wall (D2) showed an average bone gain of 4.09 ± 1.97 mm. The total bone height increase was on average 8.91 ± 1.30 mm. The mean pocket depth was found to be 3.18 ± 0.75 mm (Table 2). This means that the GBR technique is highly efficient for the regeneration of alveolar bone with defects as shown by these findings.

Table 2. Bone Heights Measured Before and After the Operation

Variables	Average (SD)	Median [Min-Max]	p valuea
D1- T0 (mm)	4.64(1.21)	5[3-6]	0.003*
D1- T1 (mm)	9.45(0.69)	10[8-10]	
D2- T0 (mm)	5.55(2.01)	4[4-9]	0.003*
D2- T1 (mm)	9.64(0.51)	10[9-10]	

*p<0.05 level of significance , a: Wilcoxon Signed Rank test
D1- T0: three-walled bone defect, pre- operation
D1- T1: three-walled bone defect, post- operation
D2- T0: double-walled bone defect, pre- operation
D2- T1: double-walled bone defect, post- operation

There was a significant bone gain in both types of defect (p=0.003). Cemented or screwed restorations did not affect bone gain (p=0.927), whereas pocket depth was significantly higher in cemented restorations (p=0.006) (Table 3). These results may indicate that screw retention will give more benefits in peri-implant health.

Table 3. Comparison of bone gain and mean pocket depth measurements between restoration types

Variables	Cemente (n=12) Median [Min-Max]	Screw (n=21) Median [Min-Max]	*p* value[b]
D1 Gained Bone (mm)	4.50[4-6]	5.00[3-7]	0.788
D2 Gained Bone (mm)	5.00[1-6]	5.00[1-6]	>0.999
Total Gained (mm)	9.50[7-10]	9.00[7-11]	0.927
Average Pocket Depth (mm)	4.00[4-4]	3.00[2-3]	**0.006***

*p<0.05 level of signifiance, b: Mann Whitney U test

In the first 6 months, an average loss of 0.32 ± 0.18 mm was observed during marginal bone loss assessment after implant placement. An additional loss of 0.15 ± 0.09 mm occurred between 6 months and a year later. The overall average marginal bone loss for the one-year period was 0.47 ± 0.22 mm (Table 4). These findings are under acceptable limits for marginal bone loss, suggesting that this technique has potential with respect to long-term implant stability.

Table 4. Marginal Bone Loss

Time Interval	Average Marginal Bone Loss (mm) ± SD	Range (mm)
Baseline - 6 months	0.32 ± 0.18	0.1 - 0.7
6 months - 1 year	0.15 ± 0.09	0.0 - 0.3
Total (1 year)	0.47 ± 0.22	0.2 - 0.9

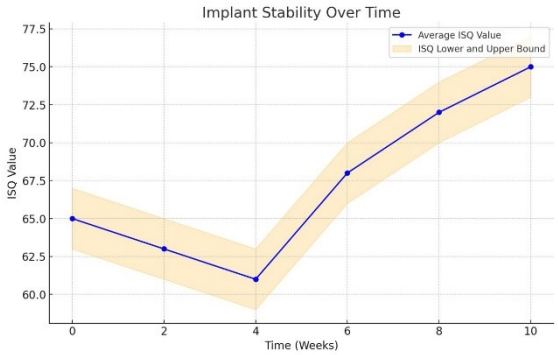
The mean PES total score was measured as 12.3 ± 1.8 and the mean WES total score as 8.4 ± 1.5 using the Pink Esthetic Score (PES) and White Esthetic Score (WES), respectively, to evaluate aesthetic outcomes (Table 5). These scores support the recommended aesthetic success criteria; hence, applying this technique provides good aesthetic outcomes as required by patients' expectations.

Table 5. Pink Esthetic Score (PES) / White Esthetic Score (WES)

Esthetic Parameter	Average Score ± SD	Range
Mesial papilla	1.8 ± 0.4	1 - 2
Distal papilla	1.7 ± 0.5	1 - 2
Soft tissue level	1.9 ± 0.3	1 - 2
Soft tissue contour	1.8 ± 0.4	1 - 2
Alveolar process	1.6 ± 0.5	1 - 2
Soft tissue color	1.7 ± 0.5	1 - 2
Soft tissue texture	1.8 ± 0.4	1 - 2
PES Total	12.3 ± 1.8	9 - 14
Tooth form	1.7 ± 0.5	1 - 2
Tooth volume/outline	1.8 ± 0.4	1 - 2
Color	1.6 ± 0.5	1 - 2
Surface texture	1.7 ± 0.5	1 - 2
Translucency	1.6 ± 0.5	1 - 2
WES Total	8.4 ± 1.5	6 - 10

Mean ISQ of 65 was recorded at the time of insertion during implant stability measurements. There was a slight decrease in the first 4 weeks, and at week 4, the lowest value of 61 ISQ was reached. From week 8, stability started to increase, and osseointegration was completed with an ISQ value of 75 (Figure 4) by week 16. This stability curve is typical for osseointegration and shows that the technique used is associated with successful implant stability.

Figure 4. Implant Stability Graphic



DISCUSSION

In this study, we evaluated whether the GBR technique using a titanium reinforced PTFE membrane combined with single-stage implant placement would be effective in Type I.-I and Type II-0 alveolar bone defects. Our results showed that this method ensures efficient bone regeneration, maintains implant reliability, and affords acceptable marginal bone loss values.

Bone augmentation procedures, especially in the vertical direction, involve a high risk of complications. Distraction osteogenesis and autogenous block graft application are still practiced in vertical bone deficiency. However, among these procedures, the GBR technique has been reported to have the lowest risk of complications.[16] We aimed to contribute to the literature by discussing a new material for material selection used in the GBR technique.

The mean bone gain obtained (8.91 ± 1.30 mm) is an extremely good result when compared to what has been reported in the literature.[16] For instance, Meloni et al.[17] observed a mean vertical bone gain of 3.71 ± 1.24 mm in GBR procedures involving titanium mesh and collagen membrane use. The high level of bone gain noted in our study, on the other hand, promotes the efficiency of the titanium reinforced PTFE membrane employed here as opposed to other studies which used different material types such as collagen membranes.[18]

Marginal bone loss results we obtained (0.47 ± 0.22 mm) were considerably within acceptable limits reported in the literature. Galindo-Moreno et al. [18] reported 0.71 ± 0.76 mm mean marginal bone loss after an implant has been in place for 18 months. In a recent clinical study on the subject, the mean bone loss in the study group with 94% survival was calculated as 0.81 mm. [19] In line with these studies, it can be said that our preferred technique is promising in terms of long-term implant stability because it has less percentage bone loss.

In terms of aesthetic results, we had good Pink Aesthetic Score (PES) and White Aesthetic Score (WES). The reason behind this is that these scores are in agreement with the suggested Belser et al.'s [20] aesthetic success criteria: They have similar PES and WES values to those recorded by Cosyn et al. [21] for early implant placement cases with soft tissue augmentation. In addition, PES and WES serve as tools that can be used in clinical practice to objectively evaluate the outcome of treatment using implants and they indicate that it has a positive effect on patient satisfaction. Moreover, the reliability and reproducibility of the scores in a digital environment have been supported by a recent study.[22] According to this result, the clinical observation-based scoring applied in this study is considered to provide a reliable and objective result.

In our study, screw-retained restorations were observed to be more advantageous in terms of peri-implant health. This finding is consistent with the results of the systematic review by Sailer et al. [23] The authors reported that screw-retained restorations had lower biologic complication rates compared to cemented restorations. Screw-retained restorations are also known to be more advantageous in terms of retrievability, passive placement and ease of repair.[24] Considering the biological usefulness, it is thought that screw-retained restorations should replace cemented restorations.

The titanium reinforced PTFE membrane we used had the advantage of being biocompatible, stable, and easy to shape. These properties are in line with the ideal barrier membrane properties emphasized by Ronda et al.[25] Furthermore, a randomized clinical trial by Cucchi et al. [13] showed that the use of titanium mesh resulted in higher bone gain compared to resorbable membranes. This result can be explained by the longer stability of titanium and its ability to be a durable barrier for bone formation.

It has been reported that the incidence of impacted canines is 2.7% in the population, and 78.4% of cases are unilateral.[26] The success of implant treatment in such cases is of critical importance in terms of esthetic and functional aspects. The results obtained in our study show that successful outcomes can be achieved in these challenging cases.

In addition to the materials used, the surgical technique is also of great importance in the success of the GBR technique. The surgical protocol applied in our study was performed in accordance with the principles recommended by Urban et al.[27] Especially flap design and primary closure were effective in the successful results obtained. In addition to the surgical technique, waiting long enough for bone maturation after surgery and controlling the surgical field during this process significantly affect the success of the procedure.[28] This important point was taken into consideration in patient follow-up.

One of the strengths of our study is that detailed radiographic and clinical evaluations were performed. CBCT images allowed an objective evaluation of bone gain. In addition, standardized aesthetic evaluation criteria such as PES and WES scores were used.[29]

However, our study also has some limitations. The relatively small sample size and short follow-up period limit the generalizability of the results. In future studies, it is important to evaluate the efficacy of this technique with larger patient groups and longer follow-up periods.

Furthermore, comparison of different membrane and graft materials would also be useful.[30,31] In particular, investigating the effectiveness of newly developed bioactive materials in the GBR technique may be an important topic for future studies.[32,33]

CONCLUSIONS

In Type I.-I and Type II-0 alveolar bone defects, single-stage implant placement can be successfully achieved with the GBR technique using a titanium reinforced PTFE membrane. This approach provides effective bone regeneration and acceptable marginal bone loss values. Good postoperative oral care and preservation of the augmented site are critical for long-term success. The use of screw retainers in prosthetic restorations provides better peri-implant health outcomes than cemented restorations. The aesthetic results are also satisfactory. However, these findings need to be confirmed in larger patient groups and with long-term follow-up.

Ethical Approval

This study has been approved by Nigde University Non-Interventional Clinical Research Ethics Committee on 25/01/2024 with protocol number 2024/14.

Financial Support

The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: NG, Data collection or access: NG, Analysis and comments: NG, Literature search: NG, Writing: NG.

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Distribution of Pediatric Oral Pathologies in a Turkish Population Sample

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ABSTRACT

Aim: This study aims to retrospectively evaluate five years of oral biopsy results obtained from pediatric patients aged 0–16 in Konya, and to analyze the distribution of pathological findings by age and gender.
Materials and Methods: In this retrospective study, biopsy samples collected from pediatric patients admitted to the Faculty of Dentistry at Necmettin Erbakan University between 2019 and 2024 were examined. A total of 84 patient records were reviewed. Histopathological diagnoses were obtained from archived pathology reports. Data were statistically analyzed using PSPP v2.0.0 software.
Results: Of the 84 patients, 54.8% (n=46) were male and 45.2% (n=38) were female. The majority of cases occurred in the 13–16 age group (50.0%), while the fewest were in the 6–8 group (14.7%). The most common lesion group was cysts and pseudocysts (53.7%). Dentigerous cysts (28.6%), odontomas (20.2%), and radicular cysts (17.9%) were the most frequent diagnoses. In 8.3% of cases, no definitive pathological diagnosis could be established.
Conclusion: The findings provide updated and region-specific data on the distribution of oral pathologies among the pediatric population in Konya. These results may contribute to improving early diagnosis and developing effective treatment strategies in pediatric dental care.

Türkiye'de Bir Pediatrik Popülasyonda Oral Patolojilerin Dağılımı

Makale Bilgisi

Makale Geçmişi

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Anahtar Kelimeler:
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Biyopsi,
Çocuk hastalar.

ÖZET

Amaç: Bu çalışmanın amacı, Konya ilinde 0–16 yaş aralığındaki çocuk hastalardan alınan beş yıllık ağız içi biyopsi sonuçlarını retrospektif olarak değerlendirerek, elde edilen patolojik bulguların yaş ve cinsiyet dağılımına göre analiz edilmesidir.
Gereç ve Yöntem: Bu retrospektif çalışmada, 2019–2024 yılları arasında Necmettin Erbakan Üniversitesi Diş Hekimliği Fakültesi'ne başvuran çocuk hastalardan alınan biyopsi örnekleri incelenmiştir. Toplam 84 hastanın biyopsi verileri değerlendirilmiş, histopatolojik tanılar arşiv kayıtlarından elde edilmiştir. Veriler PSPP v2.0.0 programı kullanılarak istatistiksel olarak analiz edilmiştir.
Bulgular: Çalışmaya dahil edilen hastaların %54,8'i erkek (n=46), %45,2'si kız (n=38) olup; en fazla vaka 13–16 yaş grubunda (%50,0), en az vaka ise 6–8 yaş grubunda (%14,7) gözlenmiştir. En sık rastlanan lezyon grubu kistler/pseudokistlerdir (%53,7). Dentigeröz kist (%28,6), odontoma (%20,2) ve radiküler kist (%17,9) en yaygın tanılar arasında yer almıştır. Olguların %8,3'ünde ise tanı konulamamıştır.
Sonuç: Elde edilen bulgular, Konya ilindeki pediatrik popülasyonda ağız içi patolojilerin dağılımına dair güncel ve bölgesel veri sunmaktadır. Bu verilerin, erken tanı ve uygun tedavi yaklaşımlarının geliştirilmesine katkı sağlayacağı düşünülmektedir.

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INTRODUCTION

Pathological lesions of the oral cavity exhibit considerable diversity and may arise from cystic, neoplastic, reactive, or systemic disease processes. While many of these lesions are located within the jawbones, they may also appear in soft tissue regions such as the gingiva, tongue, palate, buccal mucosa, and the floor of the mouth.[1,2] Although clinically similar in appearance, oral lesions vary in origin, etiology, and biological behavior, necessitating distinct classification and management approaches.[3]

Some lesions can lead to significant clinical complications such as root resorption, tooth displacement, pain, or paresthesia. Others, including odontogenic keratocysts, are known for their high recurrence rates. Therefore, accurate diagnosis is essential not only for appropriate treatment planning but also for the preservation of systemic and oral health.[4]

In pediatric patients, biopsy serves as a critical diagnostic tool for identifying various oral lesions. The histopathological evaluation of biopsy specimens from children plays a vital role in enhancing early detection strategies and in improving pediatric oral healthcare outcomes.[5,6]

Despite the importance of this topic, comprehensive studies focusing on oral pathological lesions in the pediatric population remain limited in Türkiye. One of the few large-scale studies was conducted by Gültekin et al.,[7] who evaluated 472 oral biopsy specimens obtained from children aged 0 to 15 over an eight-year period. However, considering the two-decade interval since that publication, it is plausible that the distribution patterns of such lesions may have changed, particularly due to environmental, dietary, or socio-economic shifts.

The present study aims to retrospectively evaluate oral biopsy results obtained over a five-year period from pediatric patients aged 0 to 16 in the province of Konya, Türkiye. The hypothesis (H1) of this study is that cystic lesions are the most prevalent type of oral pathology among children aged 0 to 16 years, and that their frequency increases with age. By providing up-to-date, region-specific epidemiological data, this study seeks to contribute to the body of knowledge required for the development of improved diagnostic and treatment strategies in pediatric dentistry.

MATERIAL AND METHODS

This study was conducted as a retrospective, cross-sectional analysis of pediatric oral biopsy records. The patient population consisted of children aged 0 to 16 who underwent oral biopsy procedures at the Department of Pediatric Dentistry, Necmettin Erbakan University Faculty of Dentistry, between January 2019 and April 2024. A total of 84 patients were included based on the availability of complete demographic and histopathological data.

Data were extracted from institutional archives and included patient age, gender, biopsy site, clinical diagnosis, and final histopathological diagnosis. To ensure confidentiality, all personal identifiers were removed, and each patient was assigned a unique code. Ethical approval for the study was obtained from the Necmettin Erbakan University Ethics Committee (Approval No: 2025/617), and all procedures were conducted in accordance with the Declaration of Helsinki.

Oral lesions were identified during routine clinical and radiographic examinations performed by pediatric dentists. Indications for biopsy included persistent swellings, radiolucent or radiopaque lesions

on radiographs, unexplained mucosal abnormalities, or failure of lesions to resolve with conventional treatment. Surgical excision of the lesions was carried out by the Department of Oral and Maxillofacial Surgery under local anesthesia and standard aseptic protocols.

The excised tissue specimens were immediately fixed in 10% neutral-buffered formalin and transported to the Department of Pathology, Necmettin Erbakan University, Faculty of Medicine. Histopathological processing included paraffin embedding, sectioning, and hematoxylin-eosin (H&E) staining. When necessary, additional histochemical or immunohistochemical analyses were conducted using markers such as Calretinin, P63, P40, CD31, CD68, Cytokeratin 19, Pan-cytokeratin, and EVG, to support definitive diagnosis.

All slides were reviewed by board-certified pathologists experienced in oral and maxillofacial pathology. Diagnoses were categorized into lesion groups such as cystic, neoplastic, reactive/inflammatory, and non-diagnostic cases. These data were entered into a structured digital database for further analysis.

Statistical analysis was performed using PSPP version 2.0.0 (Free Software Foundation, Boston, MA, USA). Descriptive statistics-including frequencies, percentages, and mean values-were used to summarize the data. The statistical power of the study was calculated using GPower version 3.1 (Heinrich Heine University, Düsseldorf, Germany). Based on the odontoma prevalence reported by Yasothkumar et al. [13] in a South Indian pediatric population (15.8%), we conducted a goodness-of-fit power analysis using G*Power version 3.1. Assuming a medium effect size (w = 0.3), five lesion categories, and an alpha level of 0.05, the minimum required sample size to achieve 80% statistical power was calculated as 122. Given that the present study included 84 patients, the achieved power was approximately 57.7%. Although this value is below the conventional threshold, the sample size still allows for meaningful exploratory interpretation of regional lesion patterns. Categorical variables, such as lesion type, patient age group (e.g., 6–8, 9–12, and 13–16 years), and gender, were compared using Pearson's chi-square test. For continuous variables, non-parametric tests (e.g., Mann–Whitney U or Kruskal–Wallis tests) were employed where appropriate. Statistical significance was set at a p-value less than 0.05.

RESULTS

A total of 84 pediatric patients aged between 6 and 16 years were included in the present study. The mean age of the cohort was 12.2 years. Among these patients, 46 (54.8%) were male and 38 (45.2%) were female. A detailed overview of the age and gender distribution is presented in Table 1.

Table 1: Patient distribution by age group and gender

Age Group (years)	Male (n)	Female (n)	Total (n)	% of Total	Lesion Count (n)
6–8	7	3	10	14.7%	10
9–12	18	6	24	35.3%	24
13–16	22	12	34	50.0%	34

Pearson's chi-square test ($p > 0.05$).

The highest proportion of cases (n=34, 50.0%) was observed in the 13–16 age group, followed by the 9–12 group (n=24, 35.3%) and the 6–8 group (n=10, 14.7%). As each patient contributed one biopsy specimen, the lesion counts mirrored the demographic distribution.

Histopathological evaluation revealed that the most prevalent lesion category was cysts and pseudocysts, accounting for 53.7% of all cases (Table 2). This group was followed by tumors and tumor-like lesions (26.9%), and inflammatory or reactive lesions (9.0%). Notably, in 8,3% of cases, the biopsy material was either insufficient or lacked diagnostic clarity, resulting in inconclusive histopathological outcomes.

Table 2: Frequency of histopathological diagnoses

Lesion Type	**n**	**%**
Dentigerous cyst	24	28,6%*
Odontoma	17	20.2%
Radicular cyst	15	17.9%
No diagnosis	7	8.3%
Central giant cell granuloma	3	3.6%
Pyogenic granuloma	3	3.6%
Peripheral giant cell granuloma	2	2.4%
Odontogenic keratocyst	2	2.4%
Ossifying fibroma	2	2.4%
Ameloblastic fibroma	2	2.4%
Mucocele	2	2.4%
Granulation tissue	1	1.2%
Fibroma	1	1.2%

Kruskal–Wallis test ($p < 0.05$). * Statistically significant.

Among the specific diagnoses, dentigerous cysts emerged as the most frequently encountered lesion type, constituting 28.6% of the total cases (n=24). Odontomas (n=17, 20.2%) and radicular cysts (n=15, 17.9%) also represented significant proportions of the observed pathology. Less commonly diagnosed entities included pyogenic granulomas, central and peripheral giant cell granulomas, odontogenic keratocysts, ossifying fibromas, and ameloblastic fibromas, each comprising between 1.2% and 3.6% of the total sample.

Importantly, a progressive increase in lesion frequency was noted with advancing age, peaking in the 13-16 year group. This observation may reflect developmental and odontogenic dynamics that contribute to the pathogenesis or detectability of certain lesions, particularly odontogenic cysts and mixed odontogenic tumors such as odontomas.

Considering the predominance of dentigerous cysts and the observed increase in lesion frequency with age, the findings of this study support the proposed hypothesis (H1).

DISCUSSION

The distribution of oral pathological lesions in pediatric populations is a dynamic phenomenon influenced not only by biological factors, but also by environmental, cultural, and regional determinants. In this context, retrospective evaluations provide invaluable insight, particularly in mapping regional disease patterns and supporting clinical decision-making processes. The present study represents the first comprehensive retrospective analysis of oral biopsy specimens in pediatric patients from the city of Konya, Türkiye, spanning a five-year period. The findings contribute substantially to the existing national and international literature by offering updated, region-specific data.

Our results demonstrated that cysts and pseudocysts were the most commonly diagnosed lesion group, accounting for 53.7% of cases. This finding aligns with the results reported by Cavalcante et al. in Brazil[8] and Gültekin et al. in Türkiye,[7] both of which identified cystic lesions as the predominant pathological category among children. Comparable trends have been observed in studies from Taiwan [9] and South Africa,[10] reinforcing the notion that odontogenic cysts constitute a globally prevalent entity in pediatric oral pathology.

The dentigerous cyst emerged as the most frequent individual diagnosis in our study, comprising 28.6% of all cases. This observation is consistent with findings from Chen et al. [11] and more recently Melo et al. [12] who identified dentigerous cysts as the leading intraosseous pathology in children and adolescents. The relatively high frequency of dentigerous cysts in the present study (28.6%) may be attributed to multiple factors, including widespread use of panoramic radiography in routine dental assessments, increased awareness among clinicians regarding impacted teeth, and referral patterns favoring surgical intervention in tertiary care centers. In the Turkish context, comparable prevalence rates have been reported by Gültekin et al. [7] and Işık et al. [15] as well as a more recent study by Eninanç and Mavi,[16] who analyzed 95 cases of dentigerous cysts using CBCT and observed similar demographic and radiological characteristics. This regional alignment suggests that early detection practices, expanded imaging access, and specialist care dominate diagnostic rates of these often asymptomatic lesions. These cysts are typically asymptomatic and discovered incidentally through radiographic imaging; however, in certain cases, they may exert pressure on adjacent structures, leading to clinically significant complications.

Odontomas represented the second most common lesion group in our sample (20.2%). These developmental anomalies, composed of enamel, dentin, and cementum-like tissues, are often detected radiographically due to delayed tooth eruption. The prevalence of odontomas in our study slightly exceeded that reported by Yasothkumar et al. (15.8%) in a South Indian pediatric population, [14] indicating a possible regional variation.

Age-stratified analysis revealed a marked increase in lesion frequency with age, with the 13–16 age group comprising 50.0% of all cases. This trend may reflect heightened odontogenic activity and increased clinical surveillance during adolescence. Our findings

are in agreement with those of Yalçın and Bozan [14] who reported similar age-related patterns in lesion prevalence.

Importantly, 8,3% of the biopsy specimens in our study did not yield a definitive pathological diagnosis. This may be attributed to insufficient tissue samples, suboptimal fixation, or the presence of histologically ambiguous features. A comparable nondiagnostic rate (8.3%) was reported by Melo et al. in their Brazilian cohort.[12]

Collectively, the data from this study provide a timely epidemiological snapshot of oral pathologies in the pediatric population of central Türkiye. The consistency of our findings with prior research from diverse geographic regions [8-15] reinforces the reliability of these patterns and highlights the need for routine histopathological evaluation in the management of oral lesions in children and adolescents. These insights may serve to guide clinicians, inform health policy, and support curriculum development in pediatric dental education.

While this study offers valuable insight into the histopathological profile of pediatric oral lesions in a regional cohort, several limitations must be acknowledged. First, the retrospective design inherently limits the control over data completeness and quality, as it relies solely on existing records. Second, the study was conducted at a single center, which may restrict the generalizability of the findings to broader populations. Third, a non-negligible proportion of cases (8.3%) yielded non-diagnostic results, likely due to inadequate biopsy material or suboptimal processing. Additionally, due to the lack of prior local data, the power analysis was conducted using lesion prevalence rates reported by Bhosale et al. [13] as a model reference. While this approximation supports a preliminary interpretation of statistical adequacy, it does not fully account for regional variability. Therefore, future studies incorporating multi-center, prospective methodologies with standardized biopsy protocols and larger samples are recommended to validate and expand upon these findings.

This retrospective analysis offers region-specific data on pediatric oral pathologies from a central Anatolian population and contributes to the existing national literature. By documenting lesion types and frequencies in a defined cohort, the study may help inform diagnostic approaches and support clinical decision-making, particularly in cases involving asymptomatic or radiographically identified lesions in children.

CONCLUSION

This study presents a comprehensive retrospective analysis of oral biopsy specimens from pediatric patients in the city of Konya, providing valuable insights into the prevalence and distribution of oral pathological lesions in children and adolescents. Cysts and pseudocysts, particularly dentigerous cysts, emerged as the most frequent lesions, followed by odontomas and radicular cysts. The frequency of lesions was found to increase with age, peaking during adolescence.

The results of this study are consistent with national and international findings and underscore the importance of histopathological evaluation in pediatric patients presenting with oral lesions. Early recognition and accurate diagnosis of these pathologies are essential to prevent potential complications and to guide appropriate treatment strategies.

These findings may serve as a regional reference for clinicians and researchers, and highlight the need for broader, multi-center studies to further explore the epidemiology of oral diseases in pediatric populations across different geographic and socioeconomic contexts. In addition to its descriptive findings, this study provides updated data from a central region of Türkiye, which has been relatively underrepresented in the pediatric oral pathology literature. Such data may offer a valuable foundation for future epidemiological comparisons and contribute to improved awareness of regional variations in lesion prevalence and distribution.

Ethical Approval

Ethical approval for the study was obtained from the Necmettin Erbakan University Ethics Committee (Approval No: 2025/617), and all procedures were conducted in accordance with the Declaration of Helsinki.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: ET, HÖÜ, Data collection or access: SF, AE, ET, Analysis and comments: ET, HÖÜ, Literature search: ET, Writing: ET, HÖÜ.

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Assessment of Oral Hygiene Practices of Medical Doctors and Physician Candidates

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ABSTRACT

Aim: Oral diseases are considered a significant public health problem due to their high prevalence. Raising awareness in society about oral hygiene and promoting positive health behaviors are key objectives for oral health educators. This study aims to evaluate the knowledge, attitudes, and practices of healthcare professionals regarding oral health.

Material and Methods: Before the study commenced, informed consent was obtained from all participants. Data were collected using a pre-designed and validated questionnaire consisting of 20 questions. Participants' age, gender, professional title, personal oral hygiene habits, and advice provided to patients regarding oral hygiene were evaluated. Statistical analysis was performed using SPSS 26 (IBM Corp., Armonk, NY, USA). Chi-square and t-tests were applied for statistical comparisons.

Results: A total of 406 healthcare professionals participated in the study. Among them, 54.9% were female and 45.1% were male, with a mean age of 25 years. The proportion of medical doctors who visited the dentist for routine check-ups was 11.6%. A statistically significant relationship ($p<0.05$) was found between the importance of oral hygiene in medical education and the ability to brush correctly, use dental floss properly, and provide guidance to patients seeking oral hygiene advice.

Conclusion: The findings of this study highlight the necessity of incorporating oral and dental health education more extensively in medical school curricula. Enhancing awareness about oral health not only improves personal hygiene practices but also enhances the quality of healthcare services provided to patients.

Tıp Doktorları ve Hekim Adaylarının Ağız Hijyeni Uygulamalarının Değerlendirilmesi

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Koruyucu diş hekimliği,
Ağız ve diş sağlığı,
Halk sağlığı.

ÖZET

Amaç: Ağız hastalıkları, görülme sıklığının yüksek olması nedeniyle bir halk sağlığı sorunu olarak kabul edilmektedir. Toplumun ağız sağlığı hakkında bilinçlendirilmesi ve olumlu hijyen alışkanlıklarının kazandırılması, ağız sağlığı eğitimcilerinin temel hedefidir. Sağlık çalışanlarının ağız sağlığına yönelik bilgi, tutum ve uygulamaları, toplumda ilk sağlık danışmanları olarak önemli bir rol oynar. Bu çalışmanın amacı, sağlık çalışanlarının bilgi, tutum ve uygulamalarını değerlendirmektir.

Gereç ve Yöntem: Bu çalışma, sağlık çalışanlarının ağız sağlığı konusundaki bilgi, tutum ve uygulamalarını değerlendirmek amacıyla tasarlanmış tanımlayıcı kesitsel bir araştırmadır. Çalışmaya başlamadan önce tüm katılımcılardan bilgilendirilmiş onam alındı. Veriler, 20 sorudan oluşan, önceden tasarlanmış ve geçerliliği test edilmiş bir anket aracılığıyla toplandı. Katılımcıların yaş, cinsiyet, mesleki unvan, kişisel ağız hijyeni alışkanlıkları ve hastalarına verdikleri ağız sağlığı tavsiyeleri değerlendirildi. Veri analizi SPSS 26 (IBM Corp., Armonk, NY, ABD) kullanılarak gerçekleştirildi. Ki-kare testi ve t-testi kullanılarak istatistiksel analizler yapıldı.

Bulgular: Çalışmaya toplam 406 sağlık çalışanı katıldı. Katılımcıların %54,9'u kadın, %45,1'i erkekti ve yaş ortalaması 25 olarak hesaplandı. Rutin kontrol için diş hekimine başvuran tıp hekimi oranı %11,6 olarak belirlendi. Tıp eğitiminde oral hijyenin önemi ile doğru fırçalama yapabilme, doğru diş ipi kullanımı ve tıp hekimlerine oral hijyen konusunda danışan hastaya tavsiye verebilme arasında istatistiksel olarak anlamlı bir ilişki bulundu ($p<0,05$).

Sonuç: Çalışmanın bulguları, tıp fakülteleri müfredatında ağız-diş sağlığının daha fazla vurgulanması gerektiğini ortaya koymaktadır. Ağız sağlığına ilişkin farkındalığın arttırılması hem bireysel hijyen alışkanlıklarını iyileştirecek hem de hastalarına sunacakları sağlık hizmetlerini daha bilinçli hale getirecektir.

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INTRODUCTION

Good oral hygiene and a healthy mouth are important not only for aesthetic purposes but also for physiological functions such as chewing, phonation, and digestion. Additionally, it enhances social interaction, self-esteem, and overall well-being.[1] The World Dental Federation (FDI) has defined oral health as a multifaceted concept that includes the ability to smell, touch, taste, chew, swallow, smile, speak, and express emotions.[1,2]

Another significant aspect of oral health is its systemic interaction with other parts of the body. Studies have reported associations between chronic periodontitis and adverse pregnancy outcomes.[3] Other potential connections include cardiovascular diseases, kidney disorders, endometriosis, oral cancer, erectile dysfunction, reduced sperm count, and increased time to conception (TTC).[4] The outdated perception of treating the mouth separately from the body should be abandoned, as oral health issues can significantly impact systemic health, affecting one's ability to eat, speak, and maintain a good quality of life.[5,6]

Despite its critical role in overall health, oral healthcare is often neglected. Awareness and knowledge of oral health remain inadequate among many patients and even healthcare professionals. The World Health Organization (WHO) has emphasized fundamental oral care recommendations, such as brushing at least twice a day, reducing sugar consumption to once a day or less, and the regular use of fluoride toothpaste[7,8,9] (Medical doctors should recognize the importance of oral hygiene, both for their own health and for guiding their patients, particularly those with systemic conditions that may be exacerbated by poor oral health.[5,6]

Raising oral health awareness among physicians is essential, not only for their personal habits but also for their ability to provide preventive healthcare to the community. This study aims to evaluate oral hygiene practices among physicians in a tertiary hospital setting and to examine the importance of including oral hygiene education in medical training. Based on the study findings, appropriate educational programs may be proposed to improve awareness and knowledge among medical professionals.

MATERIAL AND METHODS

Study Design

This study was designed as a cross-sectional observational study using a random sampling method. The research was conducted among 406 physicians and physician candidates working at the Inönü University Medical Faculty Hospital.

Ethical Approval

Approval was received from the non-interventional ethics committee of İnönü University (Decision No: 2021/1923). The study adhered to the principles of the Helsinki Declaration, and informed consent forms were obtained from all participants.

Sample Size Calculation

The minimum sample size was calculated as 320 participants, with a 95% confidence level (1-α), 95% test power (1-β), and an effect size of g=-0.093. A total of 430 surveys were completed, but 24 were excluded from the study due to incomplete responses, leaving 406 valid participants.

Survey and Data Collection

Physicians were interviewed face-to-face by an experienced specialist dentist, who explained the purpose and content of the research. A pre-tested, validated, and structured self-administered questionnaire was used and initially tested on 30 physicians; however, their responses were not included in the final analysis. The questionnaire was developed in Turkish and consisted of 20 questions,

including both open-ended and closed-ended questions. Internal consistency was evaluated using Cronbach's alpha coefficient, which was found to be 0.8.

The questionnaire gathered data on age, gender, professional title, personal oral hygiene practices, education related to oral hygiene, and the advice provided to patients regarding oral hygiene. Participants were then provided with a toothbrush and dental floss and were asked to demonstrate their toothbrushing and flossing techniques using a jaw model. Responses were recorded as correct or incorrect.

Only physicians and intern doctors were included in the study. Physicians who refused to participate were excluded.

Statistical Analysis

The collected data were analyzed using SPSS (Statistical Program in Social Sciences) version 26. A significance level (p) of 0.05 was used for all comparisons. Chi-square analysis was conducted using cross-tabulations for the analysis of categorical data. Descriptive statistics were presented as counts, percentages, means, and standard deviations.

RESULTS

Among the participants, 54.9% were female (n=223) and 45.1% were male (n=183). The mean age was 25 years (SD=3.2). Most of the participants were intern doctors (n=328), while the remaining 78 participants consisted of general practitioners (n=32), residents (n=27), and specialists (n=19).

Among medical doctors, 41.6% (n=169) visited the dentist primarily for treatment, while 30.3% (n=123) sought dental care due to pain. The proportion of medical doctors who visited the dentist for routine check-ups was 11.6% (n=47).

Table 1: Distribution of variables

Varieble	Group	Frequency	Percent
Gender	**Male**	223	54.9
	Female	183	45.1
Status	**Intern**	328	80.8
	Practitioner	32	7.9
	Assistant	27	6.7
	Specialist	19	4.7
Tooth brushing	**Yes**	400	98.5
	No	6	1.5
Brushing frequency	**Twice a day**	289	71.2
	Once a day	98	24.1
	Three times a week or less	19	4.6
Tooth brushing duration	**< 1 min**	14	3.4
	1-2 min	172	42.4
	≥3 min	220	54.2
Fluoride toothpaste usage	**Yes**	343	84.5
	No	63	15.5
Toothpaste amount	**Toothbrush-length amount**	51	12.6
	Pea-sized	355	87.4
Toothpaste amount	**soft**	122	30.0
	medium	247	60.8
	hard	23	5.7
	I don't know	14	3.4
Toothbrush replacement frequency	**Every 3 months**	149	36.7
	Once a year	217	53.4
	Until unusable	29	7.1
	Until unusable	11	2.7

Interdental cleaning	**Yes**	148	36.5
	No	258	63.5
Tongue cleaning	**Yes**	256	63.1
	No	150	36.9
Reason for Dentist Visit	**Consultation**	47	11.6
	Routine check-up	55	13.5
	Due to pain	123	30.3
	For treatment	169	41.6
	Never	12	3.0
Smoking	**Yes**	96	23.6
	No	310	76.4
Oral Hygiene Advice to Patients	**Recommend seeing a dentist**	183	45.1
	I can provide oral hygiene education	161	39.7
	I have never encountered/Irrelevant	62	15.3
Correct brushing	**Yes**	185	45.6
	No	221	54.4
Correct floss usage	**Yes**	73	18.0
	No	333	82.0
Total		**406**	**100.0**
Variable		**Mean ± SD**	**Min - Max**
Age		24.93 ± 4.32	20-44

Table 2: Comparison of oral hygiene habits based on receiving oral hygiene education during medical training

Variable	Group	n / %	Status of receiving oral hygiene training		Total	Test Value	*p* Value
			Yes	No			
Reason for Dentist Visit	**Consultation**	**n**	21	26	47	0.877	0.349
		%	10.3%	12.8%	11.6%		
	Routine check-up	**n**	27	28	55		
		%	13.3%	13.8%	13.5%		
	Due to pain	**n**	59	64	123		
		%	29.1%	31.5%	30.3%		
	For treatment	**n**	91	78	169		
		%	44.8%	38.4%	41.6%		
	Never	**n**	5	7	12		
		%	2.5%	3.4%	3.0%		
Tooth Brushing	**Yes**	**n**	200	200	400	0.000	1.000
		%	98.5%	98.5%	98.5%		
	No	**n**	3	3	6		
		%	1.5%	1.5%	1.5%		
Brushing Frequency	**Twice a day**	**n**	153	136	289	4.510	0.105
		%	75.7%	67.0%	71.4%		
	Once a day	**n**	43	55	98		
		%	21.3%	27.1%	24.2%		
	Three times a week or less	**n**	6	12	18		
		%	3.0%	5.9%	4.4%		
Brushing Duration	**< 1 min**	**n**	7	7	14	*4.438*	*0.035*
		%	3.4%	3.4%	3.4%		
	1 min	**n**	98	74	172		
		%	48.3%	36.5%	42.4%		
	2-3 min	**n**	98	122	220		
		%	48.3%	60.1%	54.2%		
Toothpaste Amount	**Along the toothbrush**	**n**	19	32	51	3.229	0.072
		%	9.4%	15.8%	12.6%		
	Pea-sized	**n**	184	171	355		

		%	90.6%	84.2%	87.4%		
Type of Toothbrush	**Soft**	**n**	66	56	122	0.005	0.942
		%	32.5%	27.6%	30.0%		
	Medium	**n**	117	130	247		
		%	57.6%	64.0%	60.8%		
	Hard	**n**	10	13	23		
		%	4.9%	6.4%	5.7%		
	Idon't know	**n**	10	4	14		
		%	4.9%	2.0%	3.4%		
Correct tooth brushing	**Yes**	**n**	103	82	185	***4.387***	***0.036****
		%	50.7%	40.4%	45.6%		
	No	**n**	100	121	221		
		%	49.3%	59.6%	54.4%		
Correct Floss Usage	**Yes**	**n**	42	31	73	2.027	0.154
		%	20.7%	15.3%	18.0%		
	No	**n**	161	172	333		
		%	79.3%	84.7%	82.0%		
Toothbrush Replacement	**Every 3 months**	**n**	66	83	149	0.986	0.321
		%	32.5%	40.9%	36.7%		
	Every 6 months	**n**	116	101	217		
		%	57.1%	49.8%	53.4%		
	Once a year	**n**	18	11	29		
		%	8.9%	5.4%	7.1%		
	Until unusable	**n**	3	8	11		
		%	1.5%	3.9%	2.7%		
Interdental Cleaning	**Yes**	**n**	88	60	148	***8.374***	***0.004****
		%	43.3%	29.6%	36.5%		
	No	**n**	115	143	258		
		%	56.7%	70.4%	63.5%		
Tongue Cleaning	**Yes**	**n**	129	127	256	0.042	0.837
		%	63.5%	62.6%	63.1%		
	No	**n**	74	76	150		
		%	36.5%	37.4%	36.9%		

n = sample size, % = percentage, Test Value = Chi-square ($\chi 2$), *p* Value = statistical significance, **p*<0.05; statistically significant difference between groups. Different letters in the rows indicate differences between groups, while the same letters indicate no difference

Among those who received oral hygiene training during their medical education, 45.6% (n=185) demonstrated correct toothbrushing techniques (Table 1). However, there was no statistically significant relationship between receiving oral hygiene training and factors such as brushing frequency, duration of brushing, amount of toothpaste used, toothbrush type, toothbrush replacement frequency, interdental cleaning frequency, correct flossing technique, or tongue cleaning habits (p>0.05, Table 2). It was observed that those who received oral hygiene training during medical education had better knowledge of correct toothbrushing compared to those who did not receive training (p=0.036, Table 2).

There was also no statistically significant difference in knowledge of brushing or flossing based on age (p=1, Table 3). Furthermore, professional status did not significantly impact the advice given to patients regarding oral hygiene (p>0.05, Table 3).

Table 3: The relationship between status and providing oral hygiene advice to patients

Variable	Group	n / %	Status				Total	Test value	*p* value
			Intern	General Practitioner	Assistant	Specialist			
Oral Hygiene Consultant Patient Advice	Recommend visiting a dentist	n	150	14	9	10	183	0.085	1
		%	45.7%	43.8%	33.3%	52.6%	45.1%		
	I can provide oral hygiene education, I have sufficient knowledge	n	126	14	12	9	161		
		%	38.4%	43.8%	44.4%	47.4%	39.7%		
	Never encountered / irrelevant to my specialty	n	52	4	6	0	62		
		%	15.9%	12.5%	22.2%	0.0%	15.3%		
Total		**n**	**328**	**32**	**27**	**19**	**406**		
		%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**		

n; sample size, %; percentage, Test Value; Chi-Square Test Value (χ^2), *p* Value; statistical significance, **p*<0.05; there is a statistically significant difference between groups. Different letters in rows indicate differences between groups, while the same letters indicate no difference.

A statistically significant relationship (p<0.05) was found between the importance of oral hygiene in medical education and the ability to brush teeth correctly (p=0.018), use dental floss properly (p=0.001), and provide oral hygiene advice to patients (Table 4).

Table 4: The relationship between the importance of oral hygiene in medical education and providing oral hygiene advice to patients, proper brushing, and proper use of dental floss

Variable	Group	n / %	Status of receiving oral hygiene training		Total	Test value	*p* value
			Yes	No			
Oral hygiene consultant patient advice	Recommend visiting a dentist	n	135	48	183	***22.061***	***0.001****
		%	42.3%	55.2%	45.1%		
	I can provide oral hygiene education, I have sufficient knowledge	n	144	17	161		
		%	45.1%	19.5%	39.7%		
	Never encountered / irrelevant to my specialty	n	40	22	62		
		%	12.5%	25.3%	15.3%		
Correct tooth brushing	Yes	n	155	30	185	***5.577***	***0.018****
		%	48.6%	34.5%	45.6%		
	No	n	164	57	221		
		%	51.4%	65.5%	54.4%		
Correct floss usage	Yes	n	65	8	73	***6.549***	***0.010****
		%	20.4%	9.2%	18.0%		
	No	n	254	79	333		
		%	79.6%	90.8%	82.0%		

Total	**n**	319	87	**406**
	%	100.0%	100.0%	**100.0%**

n; sample size, %; percentage, Test Value; Chi-Square Test Value (χ^2), *p* Value; statistical significance, *$p<0.05$; there is a statistically significant difference between groups. Different letters in rows indicate differences between groups, while the same letters indicate no difference.

DISCUSSION

Oral hygiene is an integral and highly important part of personal hygiene, influencing our overall well-being and self-esteem. This study assessed the oral hygiene behaviors, knowledge, and attitudes toward dental health among intern and medical doctors who had received or had not received oral hygiene education.

The frequency of dental caries is associated with the incidence of cavities. Brushing teeth at least twice a day has been shown to reduce the incidence of caries.[8] In this study, about 95.3% of interns and medical doctors reported brushing their teeth at least once a day, while 36.5% engaged in interdental cleaning. Another study conducted in Turkey found these rates to be 88% and 4%, respectively.[10] These results are consistent with Kamble et al.'s [11] findings, which showed that 79% of medical students brushed their teeth once a day. The proportion of medical doctors brushing their teeth twice a day (71.2%) was higher compared to Ankur's study,[7] where only 25% of medical students did so. This difference may be due to the inclusion of oral and dental health education in the institution where our study was conducted.

The role of fluoride toothpaste in preventing dental caries is well-documented.[12] In Ankur's study,[7] 23.46% of physicians reported using fluoride toothpaste, a lower rate compared to the 95% reported in Folayan et al.'s study.[13] In our study, the rate was 84.5%. This discrepancy may be explained by the inclusion of dental students in Folayan et al.'s study.[13]

Many professional organizations, including the American Dental Association,[14] recommend replacing a toothbrush every 3-4 months or even earlier if the bristles appear worn; however, this practice is often not followed, likely due to a lack of awareness. In our study, 53.4% of participants reported replacing their toothbrush every six months. In Aliyu et al.'s study,[15] 55.6% of participants replaced their toothbrush within 1-3 months.

The use of tobacco, either in smoke or smokeless form, is associated with poor oral health.[16] In Ankur's study[7], all students claimed not to use any form of tobacco. In contrast, 23.6% of physicians in our study reported smoking. A study in India reported this rate as 38.9%.[17] The lower rate in Ankur's study,[7] may be due to the inclusion of younger medical students.

Regular dental visits are a key component of maintaining good oral health. In our study, only 3% of physicians had never visited a dentist in their lifetime. Ankur[7] and Kamble et al.'s [13] studies found that 51% and 45% of medical students, respectively, had never visited a dentist. However, a similar study among medical students in Guddad [18] found that only 18.3% had never visited a dentist. A concerning finding in our study was that only 13.5% of physicians regularly visited the dentist for check-ups. A similar rate was found in Ankur's study [7] (11.7%). The tendency to visit the dentist primarily for treatment (30.3%) or pain (41.6%) highlights a significant lack of awareness among medical doctors regarding dental health.

The unique aspect of our study, compared to other studies in the literature, was that we asked physicians to demonstrate how they brush their teeth and use dental floss on a jaw model during a face-to-face session. While 45.6% of

physicians brushed their teeth correctly, only 18% used dental floss correctly. Physicians who had received oral hygiene education were significantly better at brushing correctly (p=0.018), performing correct interdental cleaning (p=0.01), and providing oral hygiene advice to patients (p=0.001) compared to those who had not received such training. Additionally, physicians who had received oral and dental health education during their medical training were more likely to give oral hygiene advice to patients (p=0.001). As we did not find a similar study in the literature, we could not make a direct comparison. These results highlight the importance of educating medical doctors on oral and dental health.

Recent research has emphasized the importance of integrating oral health education into medical training. A study by Ferullo et al.[19] found that medical students who received oral health education were more confident in performing oral examinations and recognizing oral health issues. Another study highlighted the association between oral health and systemic conditions, such as cardiovascular diseases and diabetes. A study by Tonetti et al.[20] found that individuals with periodontal disease have a significantly increased risk of cardiovascular conditions. Similarly, a review by Sanz et al. [21] emphasized the bidirectional relationship between diabetes and periodontitis, highlighting the importance of oral health in systemic disease management.

This study has several limitations. Firstly, the cross-sectional design limits the ability to establish causality between oral hygiene education and practices. Secondly, the self-reported nature of the data may introduce response biases, such as social desirability bias, where participants might overreport positive behaviors like tooth brushing frequency. Thirdly, the study was conducted in a single institution, which may limit the generalizability of the findings to other settings or populations. Additionally, the study did not account for potential confounding factors such as socioeconomic status, which could influence oral hygiene practices and access to dental care. Future research should consider longitudinal designs, include multiple institutions, and control for potential confounders to provide a more comprehensive understanding of the factors influencing oral hygiene behaviors among medical professionals.

Despite these limitations, the study has notable strengths. It is among the few studies that assess oral hygiene practices specifically among intern and medical doctors, providing valuable insights into this population's behaviors and knowledge. The use of practical demonstrations on a jaw model to assess brushing and flossing techniques adds an objective measure to the self-reported data, enhancing the reliability of the findings. Furthermore, the study highlights the impact of oral hygiene education during medical training, suggesting that such education can improve personal oral hygiene practices and the ability to advise patients on oral health. These findings underscore the importance of integrating oral health education into medical curricula to promote better oral and overall health outcomes.

CONCLUSION

It is clear that the oral health behaviors, beliefs, and attitudes of medical professionals play an important role in the information they convey to their immediate surroundings and the general public. It is necessary to include education on oral and dental health and its importance in the medical school curriculum and to emphasize this topic.

Ethical Approval

Approval was received from the non-interventional ethics committee of İnönü University (Decision No: 2021/1923).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: CY, PD, MBS, Data collection: MBS, HA, BD, Analysis and comments; MBS, HA, BD, Literature search: MBS, HA, BD, Writing: MBS, HA, BD, PD, CY.

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Awareness and Knowledge Level of Oral Cancer Among Patients Visiting The Dentist

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ABSTRACT

Aim: Oral cancers are a significant global health concern. The aim of this study is to investigate the level of awareness and knowledge about oral cancers, their risk factors, and early signs among patients attending dental examinations. This research aims to determine the current level of awareness about oral cancers and to identify gaps in knowledge in this area.

Material and Methods: This cross-sectional survey was conducted among patients aged 18 and above attending the Department of Oral and Maxillofacial Radiology. The survey included a total of 750 participants and covered demographic information, smoking and alcohol habits, awareness of oral cancers, knowledge of early symptoms of oral cancer, and awareness of associated risk factors.

Results: The participants consist of 63.7% females and 36.3% males. The smoking rate is 31.2%, and alcohol consumption is 14.4%. 53.4% of participants lack awareness of oral cancer; among those aware, 21.6% cite media sources and 4.4% cite dentists as their information sources. Despite smoking (70.4%) and alcohol consumption (56.7%) being well-known risk factors, awareness regarding sun exposure (22.7%) and aging (41.2%) is lower. Moreover, knowledge about early symptoms of oral cancer such as non-healing ulcers (40.3%), red sores (31.1%), white plaques (24%), and persistent swellings (31.5%) is also low.

Conclusion: This study shows that awareness about oral cancers is low among patients visiting dentists. Consistent with our findings, media usage in this context can be an effective way to increase awareness, while regular dental check-ups can also play a role in enhancing awareness.

Diş Hekimine Başvuran Hastalarda Ağız Kanserine Yönelik Farkındalık ve Bilgi Düzeyi

Makale Bilgisi

Makale Geçmişi

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Anahtar Kelimeler:
Ağız kanserleri,
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Farkındalık düzeyi,
Risk faktörleri,
Erken belirtiler.

ÖZET

Amaç: Ağız kanserleri önemli bir küresel sağlık sorunudur. Bu çalışmanın amacı, diş muayenesi için başvuran hastaların oral kanserler, risk faktörleri ve erken belirtiler hakkındaki farkındalık ve bilgi düzeylerini araştırmaktır. Bu araştırma, ağız kanserleri konusunda mevcut farkındalık seviyesini belirleyerek bu konudaki bilgi açığını ortaya koymayı hedeflemektedir.

Gereç ve Yöntemler: Bu kesitsel anket, Ağız Diş ve Çene Radyolojisi Anabilim Dalı'na başvuran 18 yaş ve üzeri hastalar arasında uygulanmıştır. Toplamda 750 katılımcının yer aldığı anket; demografik bilgileri, sigara içme ve alkol alışkanlıklarını, ağız kanserlerinin farkındalığını, ağız kanserinin erken belirtileri hakkındaki bilgiyi ve ilişkili risk faktörlerine yönelik farkındalığı kapsamaktadır.

Bulgular: Katılımcıların %63,7'si kadın, %36,3'si erkektir. Sigara kullanım oranı %31,2, alkol kullanımı ise %14,4 olarak tespit edilmiştir. Katılımcıların %53,4'ünde oral kanser farkındalığı bulunmamaktadır; farkındalığı olanların %21,6'sı medya kaynaklarını, %4,4'ü ise diş hekimlerini bilgi kaynağı olarak belirtmiştir. Sigara içme (%70,4) ve alkol tüketimi (%56,7), iyi bilinen risk faktörleri olmasına rağmen, güneş ışığına maruz kalma (%22,7) ve yaşlılık (%41,2) hakkındaki farkındalık daha düşüktür. Ayrıca, ağız kanserinin erken belirtileri olan iyileşmeyen ülserler (%40,3), kırmızı yaralar (%31,1), beyaz plaklar (%24), uzun süre devam eden şişlikler (%31,5) konusunda da bilgi düzeyi düşüktür.

Sonuç: Bu çalışma, diş hekimlerine başvuran hastalarda oral kanserlerle ilgili farkındalığın düşük olduğunu göstermektedir. Bulgularımız doğrultusunda, medya kullanımı farkındalık artırmada etkili bir yöntem olabilir; ayrıca düzenli diş hekimi kontrolleri de bu farkındalığı artırmada önemli bir rol oynayabilir.

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INTRODUCTION

Cancer is a leading global cause of death, significantly affecting life expectancy. In 2019, the World Health Organization (WHO) reported cancer as the primary or secondary cause of death before age 70 in 112 of 183 countries.[1,2] Oral cancers, affecting the mouth's structures, pose a major global health concern.[3] In 2020 alone, approximately 377.713 new cases and 177.757 deaths were recorded worldwide, impacting areas such as the lips, tongue, gums, and palate.[2]

Numerous risk factors for oral cavity cancers have been identified in the literature. Among these, tobacco and alcohol use are considered the most significant risk factors.[4-9] In addition to these, viral infections -especially Human Papilloma Virus (HPV)-, immunosuppression, advanced age, ultraviolet radiation, a family history of cancer, poor oral hygiene, candidiasis, chemical carcinogens, chronic mucosal irritation, and nutritional disorders are among other possible risk factors.[7,10-12]

The clinical appearance of early oral cancer lesions is variable. Lesions that do not heal within two weeks after the causative agent's removal may present as red or white-red ulcerated lesions, spontaneous bleeding, or swelling.[10,13,14] Initially, they may be flat or raised, with symptoms like chewing difficulty, limited tongue movement, pain, or swelling developing over time.[11]

Early diagnosis in oral cancers is crucial for the patient's prognosis, survival time, and quality of life. However, these cancers are often asymptomatic in the early stages, making them difficult to detect. As a result, patients typically seek diagnosis and treatment in advanced stages. Therefore, it is of great importance for both patients and clinicians to be knowledgeable about early symptoms and risk factors.[10,11]

This study aims to investigate the level of awareness and knowledge about oral cancers, their risk factors, and early signs among patients attending dental examinations. By understanding the current level of awareness and knowledge, the goal is to emphasize the importance of educating the public about oral cancer and to develop strategies to increase this awareness. Additionally, this study aims to assess the role of dentists in raising awareness and to enhance the effectiveness of educational and informational efforts in this area.

MATERIAL AND METHODS

This study was submitted to the Bezmialem Vakif University Non-Interventional Clinical Research Ethics Committee. It has been approved ethically with the approval number 2023/263 on 23.08.2023 for the study numbered 16 and dated 23.08.2023 (E-54022451-050.05.04-121165). This study was performed in line with the principles of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

This study is a descriptive cross-sectional research conducted using a questionnaire, involving face-to-face interviews with patients who applied for routine examination to the Department of Oral and Maxillofacial Radiology at Bezmialem Vakif University between August 24, 2023, and November 24, 2023. A total of 750 voluntary patients without mental disabilities, randomly selected and aged 18 and above, were included in the study, with 478 (63.7%) being female and 272 (36.3%) being male. The identity information of the participating patients was kept confidential without being disclosed. No prior information about oral cancers was provided to the participants in the study.

To determine the sample size, a pilot study involving 30 patients was conducted. The required sample size was calculated to be at

least 317 patients, and a total of 750 individuals were included in the study. For determining the internal consistency reliability of the questionnaire, the Kuder Richardson 20 formula (KR-20) was used, and the coefficient was found to be 0.85, indicating high internal reliability (KR-20 > 0.70).

A literature review was conducted, and surveys from previous studies [3,14,15] were evaluated to create the questionnaire. The questionnaire includes 26 questions, addressing participants' demographic information (age, gender, educational status) with 3 questions, lifestyle and habits (smoking, alcohol use, and frequency of smokeless tobacco use) with 6 questions, medical history (the participant and their first-degree relatives) with 2 questions, cancer history (the participant and their relatives (first, second, and third-degree)) with 2 questions, awareness of oral cancer information (knowledge about oral cancer; source of information, if any; preventable or treatable; contagious) with 5 questions, knowledge about risk factors for oral cancers (smoking, alcohol use, sunlight exposure, advanced age) with 4 questions, and knowledge about early signs of oral cancer (non-healing ulcers, red sores, white plaques, persistent swelling) with 4 questions.

Statistical Analyses

All statistical analyses were performed using statistical software (IBM SPSS Statistics, v26.0; IBM Corp, Armonk, NY, USA). Descriptive statistics, including the number and percentage values of the data, were provided. Fisher's exact test was applied to assess the relationship between variables and levels of knowledge and awareness. The significance level was set at 0.05 ($p<0.05$). Based on the results of Fisher's exact test, an adjusted Bonferroni test was applied to determine in which groups the significant differences occurred in the multinomial chi-square tables. In tables examining the relationship between awareness, risk factors, early signs, and age groups, the adjusted p-value was considered to be 0.004. Similarly, in tables investigating the relationship between awareness, risk factors, early signs, and educational status, the adjusted p-value was set at 0.003. All statistical analyses were conducted using IBM SPSS Statistics software (v26.0; IBM Corp, Armonk, NY, USA). Descriptive statistics, including frequencies and percentages, were provided. Fisher's exact test was used to evaluate the relationship between variables and levels of knowledge and awareness. The significance level was set at 0.05 ($p<0.05$). Following the results of Fisher's exact test, an adjusted Bonferroni correction was applied to identify the groups where significant differences occurred in the multinomial chi-square tables. In tables exploring the relationship between awareness, risk factors, early signs, and age groups, the adjusted p-value threshold was set at 0.004. Similarly, in tables investigating the relationship between awareness, risk factors, early signs, and educational status, the adjusted p-value was set at 0.003.

RESULTS

All patients invited to the survey agreed to participate. The participation rate for the survey was 100%. A total of 750 surveys were collected and analyzed over a 3-month period, with participants aged between 18 and over 60 years, and an average age of approximately 36. Of the participants, 63.7% (n=478) were female, and 36.3% (n=272) were male. The demographic data of the participants are summarized in Table 1. Among the participants, 55.9% (n=419) had never smoked, while 12.1% (n=91) of participants reported smoking at least one pack of cigarettes per day. Regarding alcohol consumption habits, 77.2% (n=579) of participants had never consumed alcohol, and among the 14.4% (n=108) who reported alcohol use, 7.6% (n=57) consumed alcohol every day. The data related to the participants' lifestyles and habits, as well as information on cancer history, are summarized in Table 1.

46.5% (n=349) of the participants answered 'yes' to the question 'Have you ever heard of oral cancer?', while 41.7% (n=313) stated that they had not heard of it, and 11.7% (n=88) stated they were unaware of this topic. In response to the question 'From whom/where did you hear about oral cancer?', 21.6% (n=162) of the participants mentioned hearing it from the media, only 4.4% (n=33) from a dentist, and 2.1% (n=16) from a doctor. Regarding the question 'Can oral cancer be prevented?', 46.5% (n=349) of the participants answered 'yes', while 51.1% (n=383) indicated that they did not know. In response to the question 'Can oral cancer be treated?', 53.5% (n=401) of the participants answered 'yes', while 43.7% (n=328) expressed that they did not know. When asked if oral cancer is contagious, 50.8% (n=381) of the participants stated that they did not have information on this, while 36.8% (n=276) answered 'no'. The data related to awareness of oral cancer are provided in Table 1.

70.4% (n=528) of the participants answered 'yes' to the question 'Does smoking increase the likelihood of oral cancer?', while 2.4% stated they were unaware of a link between smoking and oral cancer, and 27.2% (n=204) stated they were unaware of this topic. Regarding the question 'Does alcohol use increase the likelihood of oral cancer?', 56.7% (n=425) of the participants answered 'yes', while 38.5% (n=289) indicated that they lacked knowledge about this. For the question 'Does exposure to sunlight increase the likelihood of oral cancer?', 60.1% (n=451) of the participants stated that they lacked knowledge about this, while 22.7% (n=170) answered 'yes'. For the question 'Does advanced age increase the likelihood of oral cancer?', 50.4% (n=378) of the participants stated that they did not have any information on this, while 41.2% (n=309) answered 'yes'. The data on the knowledge level regarding risk factors for oral cancer are provided in Table 1.

53.6% (n=402) of the participants stated that they did not have any information about whether ‘Are non-healing ulcers a sign of oral cancer?', while 40.3% (n=302) answered 'yes'. For the question 'Are red sores in the mouth a sign of oral cancer?', 62.1% (n=466) of the participants declared that they did not have any information on this, while 31.1% (n=233) answered 'yes'. Regarding the question 'Are white plaques in the mouth a sign of oral cancer?', 63.9% (n=479) of the participants stated that they did not have any information on this, while 24% (n=180) answered 'yes'. For the question 'Are persistent swellings a sign of oral cancer?', 62.5% (n=469) of the participants declared that they did not have any information on this, while 31.5% (n=236) answered 'yes'. The data on the knowledge level regarding the early signs of oral cancer are provided in Table 1.

The level of oral cancer awareness was statistically higher among females compared to males, except for the question 'Can oral cancer be prevented?' (p=0.000; p=0.261; p=0.021; p=0.007) (Table 2). A statistically significant relationship was observed between age groups and their responses to oral cancer awareness questions, except for the question 'Is oral cancer contagious?' (p=0.010; p=0.002; p=0.003; p=0.262). To determine which groups contributed to these differences, a post-hoc test with Bonferroni correction was conducted. The statistical difference arises primarily because the '18-29' age group demonstrated a significantly higher level of awareness about oral cancer across all questions—except ‘Is oral cancer contagious?’—compared to other groups. For the question 'Have you heard of oral cancer?', the '30-44' age group, and for the question 'Can oral cancer be prevented?', the '45-59' age group had a statistically lower level of oral cancer awareness compared to other groups (p<0.004) (Table 2).

Table 1: Demographic information, lifestyle and habits, awareness of oral cancer, risk factors, and early signs information of study participants

			Frequency (n)	Percent (%)
DEMOGRAPHIC VARIABLES	**Gender**	Female	478	63.7
		Male	272	36.3
	Age Group	18-29	319	42.5
		30-44	211	28.2
		45-59	186	24.8
		60-	34	4.5
	Education Level	Primary school	192	25.6
		High school	199	26.5
		University	318	42.4
		Master's degree	32	4.3
		Doctorate	9	1.2
LIFESTYLE AND HABITS	**Smoking Habit - Tobacco Use Habit**	I have never smoked	419	55.9
		I used to smoke	97	12.9
		I currently smoke	234	31.2
	Frequency of Smoking	1-2 per day	35	4.7
		5 per day	35	4.7
		10 per day	67	8.9
		1 pack per day	91	12.1
		2 packs or more	6	0.8
	Alcohol Use Habit	I have never used	579	77.2
		I used to use	63	8.4
		I currently use	108	14.4
	Frequency of Alcohol Use	Rarely	2	0.3
		Once a month	10	1.3
		Once a week	17	2.3
		2-3 times a week	22	2.9
		Every day	57	7.6
	Smokeless Tobacco Use Habit	I have never used	745	99.3
		I used to use	5	0.7
		I currently use	0	0
HISTORY OF CANCER	**Have You Had Cancer?**	Yes	13	1.7
		No	737	98.3
	Does Your Family Have A History Of Cancer?	Yes, I. degree	121	16.1
		Yes, II. degree	108	14.4
		Yes, III. degree	54	7.2
		No	467	62.3
ORAL CANCER AWARENESS INFORMATION	**Have You Ever Heard About Oral Cancer?**	Yes	349	46.5
		No	313	41.7
		Do not know	88	11.7
	Source of Information Regarding Oral Cancer	Dentist	33	4.4
		Doctor	16	2.1
		Media	162	21.6
		Friends-family	83	11.1
		Other	55	7.3
	Can Oral Cancer Be Prevented?	Yes	349	46.5
		No	18	2.4
		Do not know	383	51.1
	Can Oral Cancer Be Treated?	Yes	401	53.5
		No	21	2.8
		Do not know	328	43.7
	Is Oral Cancer Contagious?	Yes	93	12.4
		No	276	36.8
		Do not know	381	50.8

KNOWLEDGE LEVEL ABOUT THE RISK FACTORS OF ORAL CANCER	Do you think smoking is a risk factor for oral cancer?	Yes	528	70.4
		No	18	2.4
		Do not know	204	27.2
	Do you think alcohol is a risk factor for oral cancer?	Yes	425	56.7
		No	36	4.8
		Do not know	289	38.5
	Do you think sunlight exposure is a risk factor for oral cancer?	Yes	170	22.7
		No	129	17.2
		Do not know	451	60.1
	Do you think advanced age is a risk factor for oral cancer?	Yes	309	41.2
		No	63	8.4
		Do not know	378	50.4
KNOWLEDGE LEVEL ABOUT EARLY SIGNS OF ORAL CANCER	Do you think non-healing ulcers are a sign of oral cancer?	Yes	302	40.3
		No	46	6.1
		Do not know	402	53.6
	Do you think red sores are a sign of oral cancer?	Yes	233	31.1
		No	51	6.8
		Do not know	466	62.1
	Do you think white plaques are a sign of oral cancer?	Yes	180	24
		No	91	12.1
		Do not know	479	63.9
	Do you think persistent swellings are a sign of oral cancer?	Yes	236	31.5
		No	45	6
		Do not know	469	62.5

Table 2: Relationship between demographic data and awareness of oral cancer

Oral Cancer Awareness Informations' Questions	Demographic Variables		Oral Cancer Awareness Information Questions' Responses			p-value
			Yes (%)	No (%)	Do not know (%)	
Have you ever heard about oral cancer?	Gender	Female	53.35	37.45	9.20	0.000*
		Male	34.56	49.26	16.18	
	Age Group	18-29	53.29	36.05	10.66	0.010*
		30-44	36.0	51.2	12.8	
		45-59	45.7	41.4	12.9	
		60-	52.94	38.24	8.82	
	Education	Primary school	37.5	50.0	12.5	0.001*
		High school	40.2	45.7	14.1	
		University	55.0	34.6	10.4	
		Master's degree	50.0	46.9	3.1	
		Doctorate	66.7	11.1	22.2	
Can oral cancer be prevented?	Gender	Female	48.74	2.51	48.75	0.261
		Male	42.65	2.20	55.15	
	Age Group	18-29	54.5	1.6	43.9	0.002*
		30-44	45.0	1.9	53.1	
		45-59	35.5	4.3	60.2	
		60-	41.2	2.9	55.9	
	Education	Primary school	30.7	5.2	64.1	0.000*
		High school	45.2	1.5	53.3	
		University	55.3	1.6	43.1	
		Master's degree	56.25	0	43.75	
		Doctorate	66.7	0	33.3	
Can oral cancer be treated?	Gender	Female	56.9	3.1	40.0	0.021*
		Male	47.4	2.2	50.4	
	Age Group	18-29	61.4	1.6	37	0.003*
		30-44	46.92	2.84	50.24	
		45-59	46.8	4.3	48.9	
		60-	55.9	5.9	38.2	
	Education	Primary school	44.8	5.2	50	0.022*
		High school	50.3	1.5	48.2	
		University	60.4	2.5	37.1	
		Master's degree	59.4	0	40.6	
		Doctorate	44.4	0	55.6	

Is oral cancer contagious?	**Gender**	Female	13.6	40	46.4	0.007*
		Male	10.30	31.25	58.45	
	Age Group	18-29	15.05	37.93	47.02	0.262
		30-44	8.5	34.6	56.9	
		45-59	11.8	37.1	51.1	
		60-	14.7	38.2	47.1	
	Education	Primary school	14.1	25	60.9	0.010*
		High school	12.6	37.7	49.7	
		University	11.64	42.14	46.22	
		Master's degree	9.4	40.6	50	
		Doctorate	11.1	66.7	22.2	

Pearson Chi-Square *$p<0.05$

Table 3: Relationship between demographic data and risk factors of oral cancer

Knowledge Level About The Risk Factors Of Oral Cancer's Questions	**Demographic Variables**		**Knowledge Level About The Risk Factors Of Oral Cancer Questions' Responses**			**p-value**
			Yes (%)	**No (%)**	**Do not know (%)**	
Do you think that smoking is a risk factor for oral cancer?	**Gender**	Female	74.1	2.5	23.4	0.009*
		Male	64	2.2	33.8	
	Age Group	18-29	75.2	1.6	23.2	0.002*
		30-44	66.8	0.5	32.7	
		45-59	66.13	4.84	29.03	
		60-	70.6	8.8	20.6	
	Education	Primary school	64.6	3.6	31.8	0.332
		High school	67.3	2.5	30.2	
		University	75.16	1.89	22.95	
		Master's degree	75.0	0	25	
		Doctorate	77.8	0	22.2	
Do you think that alcohol is a risk factor for oral cancer?	**Gender**	Female	60.3	5	34.7	0.017*
		Male	50.4	4.4	45.2	
	Age Group	18-29	59.9	4.7	35.4	0.384
		30-44	55	3.8	41.2	
		45-59	52.15	5.38	42.47	
		60-	61.8	8.8	29.4	
	Education	Primary school	51.6	5.2	43.2	0.409
		High school	53.8	4.5	41.7	
		University	61.3	4.4	34.3	
		Master's degree	59.37	6.25	34.38	
		Doctorate	55.6	11.1	33.3	
Do you think that sunlight exposure is a risk factor for oral cancer?	**Gender**	Female	25.7	18	56.3	0.010*
		Male	17.3	15.8	66.9	
	Age Group	18-29	25.1	18.2	56.7	0.069
		30-44	17.1	17.5	65.4	
		45-59	23.7	13.4	62.9	
		60-	29.4	26.5	44.1	
	Education	Primary school	21.4	16.1	62.5	0.087
		High school	15.6	20.1	64.3	
		University	26.4	17	56.6	
		Master's degree	31.25	9.38	59.37	
		Doctorate	44.45	11.10	44.45	
Do you think that advanced age is a risk factor for oral cancer?	**Gender**	Female	41.8	10.3	47.9	0.026*
		Male	40.1	5.1	54.8	
	Age Group	18-29	45.45	6.27	48.28	0.030*
		30-44	35.5	9	55.5	
		45-59	37.1	11.3	51.6	
		60-	58.8	8.8	32.4	
	Education	Primary school	38.5	11.5	50	0.308
		High school	37.2	7	55.8	
		University	45.6	7.9	46.5	
		Master's degree	37.5	3.1	59.4	
		Doctorate	44.45	11.10	44.45	

Pearson Chi-Square *$p<0.05$

There is a statistically significant relationship between education level and responses to oral cancer awareness questions (p=0.001; p=0.000; p=0.022; p=0.010). A post-hoc test with Bonferroni corrected was performed to identify the groups contributing to this difference. The statistical difference arises because participants in the 'university' education group demonstrated a higher level of oral cancer awareness (p<0.003) (Table 2).

Females' knowledge level about oral cancer risk factors is statistically higher compared to males (p=0.009;p=0.017; p=0.010; p=0.026) (p<0.05) (Table 3). A statistically significant relationship exists between age groups and the response to whether smoking is a risk factor for oral cancer. (p=0.002). A Bonferroni-adjusted post-hoc test was conducted to determine which groups contributed to this difference. The statistical difference is primarily due to the '18-29' age group demonstrating a higher level of knowledge about smoking being a risk factor for oral cancer compared to other groups. (p<0.004) (Table 3).

The knowledge level regarding alcohol consumption as a risk factor for oral cancer is statistically insignificant among age groups (p=0.384; p>0.05) (Table 3). Similarly, knowledge about sun exposure as a risk factor for oral cancer is also statistically insignificant among age groups. (p=0.069; p>0.05) (Table 3).

There is a statistically significant relationship between age groups and the response to whether advanced age is a risk factor for oral cancer (p=0.030). A Bonferroni-corrected post-hoc test was conducted to identify which groups contributed to this difference. The statistical difference is due to the '60-' age group having a higher level of knowledge about advanced age being a risk factor for oral cancer compared to other groups (p<0.004) (Table 3).

The knowledge level about oral cancer risk factors is statistically insignificant across different education level groups (p=0.332; p=0.409; p=0.087; p=0.308) (p>0.05) (Table 3).

Females demonstrate a statistically significant knowledge level about the early symptoms of oral cancer compared to males. (p=0.023; p=0.039; p=0.020; p=0.003) (p<0.05) (Table 4). Additionally, a statistically significant relationship exists between age groups and responses to the question about whether non-healing ulcers are an early symptom of oral cancer. (p<0.001). However, no statistically significant relationship was found between age groups and knowledge of other early symptoms of oral cancer. (p=0.717; p=0.346; p=0.637) (Table 4).

There is also a statistically significant relationship between education levels and responses to questions about non-healing ulcers and red sores being early symptoms of oral cancer (p=0.048; p=0.029) (p<0.05) (Table 4). However, knowledge about white plaques and persistent swellings as early symptoms of oral cancer remains statistically insignificant across education level groups (p=0.351; p=0.721) (p>0.05) (Table 4).

No statistically significant relationship was found between individuals with or without the habit of smoking and their level of oral cancer awareness. Similarly, among individuals with varying smoking frequencies, no statistically significant relationship was observed regarding oral cancer awareness. (p=0.206; p=0.602; p=0.620; p=0.529) (p>0.05) (Table 5). A statistically significant relationship was identified between individuals with and without the habit of alcohol consumption and the awareness question 'Have you heard of oral cancer?' (p=0.001; p<0.05) However, no statistically significant relationship was observed with the awareness question 'Can oral cancer be prevented?' (p=0.809; p>0.05). Among alcohol consumers, no statistically significant relationship was found between

different alcohol consumption frequencies and oral cancer awareness levels. (p=0.372; p=0.558) (p>0.05) (Table 5). Regarding smoking as a risk factor for oral cancer, no statistically significant relationship was found between those with and without the habit of smoking. Similarly, among smokers with different smoking frequencies, no statistically significant relationship was observed regarding smoking as a risk factor. There was no statistically significant relationship between those with and without the habit of alcohol consumption concerning whether alcohol use is a risk factor. Likewise, no statistically significant relationship was observed among alcohol consumers with varying alcohol consumption frequencies concerning alcohol use as a risk factor. (p=0.749; p=0.190; p=0.537; p=0.163) (p>0.05) (Table 5).

Table 4: Relationship between demographic data and early symptoms of oral cancer

Knowledge Level About Early Signs of Oral Cancer's Questions	Demographic Variables		Knowledge Level About Early Signs of Oral Cancer Questions' Responses			p-value
			Yes (%)	No (%)	Do not know (%)	
Do you think that non-healing ulcers are a sign of oral cancer?	Gender	Female	43.9	5.9	50.2	0.023*
		Male	33.8	6.6	59.6	
	Age Group	18-29	43.26	1.88	54.86	0.000*
		30-44	36.97	6.16	56.87	
		45-59	37.1	11.3	51.6	
		60-	50	17.6	32.4	
	Education	Primary school	35.9	12	52.1	0.048*
		High school	39.2	5	55.8	
		University	43.1	4.1	52.8	
		Master's degree	46.9	0	53.1	
		Doctorate	33.3	0	66.7	
Do you think that red sores are a sign of oral cancer?	Gender	Female	34.1	7.1	58.8	0.039*
		Male	25.7	6.3	68	
	Age Group	18-29	32.6	5.6	61.8	0.717
		30-44	28.4	8.1	63.5	
		45-59	31.18	6.45	62.37	
		60-	32.36	11.76	55.88	
	Education	Primary school	30.2	10.9	58.9	0.029*
		High school	32.7	2	65.3	
		University	30.5	8.2	61.3	
		Master's degree	31.25	0	68.75	
		Doctorate	33.3	0	66.7	
Do you think that white plaques are a sign of oral cancer?	Gender	Female	25.9	13.8	60.3	0.020*
		Male	20.6	9.2	70.2	
	Age Group	18-29	25.1	11	63.9	0.346
		30-44	20.85	13.27	65.88	
		45-59	25.3	10.8	64	
		60-	26.5	23.5	50	
	Education	Primary school	24.48	14.06	61.46	0.351
		High school	21.6	14.1	64.3	
		University	24.5	11.3	64.2	
		Master's degree	28.1	0	71.9	
		Doctorate	33.3	0	66.7	
Do you think that persistent swellings are a sign of oral cancer?	Gender	Female	35.56	6.28	58.16	0.003*
		Male	24.3	5.5	70.2	
	Age Group	18-29	31.3	4.4	64.3	0.637
		30-44	31.2	6.2	62.6	
		45-59	31.18	8.07	60.75	
		60-	35.3	8.8	55.9	
	Education	Primary school	31.8	8.3	59.9	0.721
		High school	27.14	6.03	66.83	
		University	33.65	5.03	61.32	
		Master's degree	34.38	3.12	62.50	
		Doctorate	33.3	0	66.7	

Pearson Chi-Square **p<0.05*

Table 5: Relationship between lifestyle and habits with oral cancer awareness and risk factor findings

Oral Cancer Awareness Informations' Questions	Lifestyle and Habits' Questions	Lifestyle and Habits Questions' Responses	Oral Cancer Awareness Information Questions' Responses			p-value
			Yes (%)	No (%)	Do not know (%)	
HAVE YOU EVER HEARD ABOUT ORAL CANCER?	Do you have a smoking habit?	I have never smoked	47.3	43.4	9.3	
		I used to smoke	45.4	41.2	13.4	0.206
		I currently smoke	45.7	38.9	15.4	
	What is the frequency of your smoking?	1-2 per day	52.9	32.4	14.7	
		5 per day	47.1	29.4	23.5	
		10 per day	44.8	41.8	13.4	0.620
		1 pack per day	43.95	42.86	13.19	
		2 packs or more	50	16.7	33.3	
	Do you have a habit of consuming alcohol?	I have never used	47.15	43.35	9.50	
		I used to use	34.9	47.6	17.5	0.001*
		I currently use	50	29.6	20.4	
	What is the frequency of your alcohol consumption?	Rarely	48.3	29.3	22.4	
		Once a month	56.52	39.13	4.35	
		Once a week	41.2	23.5	35.3	0.372
		2-3 times a week	50	20	30	
		Every day	50	50	0	
CAN ORAL CANCER BE PREVENTED?	Do you have a smoking habit?	I have never smoked	47.73	2.63	49.64	
		I used to smoke	39.18	2.06	58.76	0.602
		I currently smoke	47.43	2.14	50.43	
	What is the frequency of your smoking?	1-2 per day	45.95	2.51	51.54	
		5 per day	61.8	0	38.2	
		10 per day	55.9	0	44.1	0.529
		1 pack per day	41.8	4.5	53.7	
		2 packs or more	50	0	50	
	Do you have a habit of consuming alcohol?	I have never used	47	2.6	50.4	
		I used to use	39.7	1.6	58.7	0.809
		I currently use	48.1	1.9	50	
	What is the frequency of your alcohol consumption?	Rarely	48.3	0	51.7	
		Once a month	43.5	4.3	52.2	
		Once a week	47.1	0	52.9	0.558
		2-3 times a week	50	10	40	
		Every day	50	0	50	
DO YOU THINK SMOKING IS A RISK FACTOR FOR ORAL CANCER?	Do you have a smoking habit?	I have never smoked	71.6	2.4	26.0	
		I used to smoke	72.2	1	26.8	0.749
		I currently smoke	67.5	3	29.5	
	What is the frequency of your smoking?	1-2 per day	82.35	5.88	11.77	
		5 per day	61.77	5.88	32.35	
		10 per day	67.2	1.5	31.3	0.190
		1 pack per day	65.9	2.2	31.9	
		2 packs or more	50	0	50	
DO YOU THINK ALCOHOL IS A RISK FACTOR FOR ORAL CANCER?	Do you have a habit of consuming alcohol?	I have never used	58.2	4.5	37.3	
		I used to use	52.38	4.76	42.86	0.537
		I currently use	50.9	65	42.6	
	What is the frequency of your alcohol consumption?	Rarely	60.3	5.2	34.5	
		Once a month	43.5	8.7	47.8	
		Once a week	41.2	0	58.8	0.163
		2-3 times a week	40	10	50	
		Every day	0	50	50	

Pearson Chi-Square **p<0.05*

There was no statistically significant relationship observed between individuals with a history of cancer in their medical history and those without, regarding the level of oral cancer awareness knowledge (p=0.567; p=0.841; p=0.849; p=0.728) (p>0.05) (Table 6).

Similarly, there was no statistically significant relationship observed between individuals with a history of cancer in first, second, and third-degree relatives in their family history and those without, regarding the level of oral cancer awareness knowledge (p=0.117; p=0.397; p=0.574; p=0.493) (p>0.05) (Table 6).

Table 6: Correlation between cancer history and awareness of oral cancer

Cancer History	History Responses	Awareness Question	Awareness Responses			p-value
			Yes (%)	No (%)	Do not know (%)	
HAVE YOU HAD CANCER?	Yes	Have you ever heard about oral cancer?	53.8	46.2	0	0.567
	No		46.4	41.7	11.9	
	Yes	Can oral cancer be prevented?	53.8	0	46.2	0.841
	No		46.4	2.4	51.2	
	Yes	Can oral cancer be treated?	61.5	0	38.5	0.849
	No		53.32	2.85	43.83	
	Yes	Is oral cancer contagious?	7.69	46.16	46.15	0.728
	No		12.5	36.6	50.9	
DOES YOUR FAMILY HAVE A HISTORY OF CANCER?	Yes, I, degree	Have you ever heard about oral cancer?	52.9	41.3	5.8	0.117
	Yes, II, degree		49.08	37.96	12.96	
	Yes, III, degree		53.7	31.5	14.8	
	No		43.5	43.9	12.6	
	Yes, I, degree	Can oral cancer be prevented?	43	0	57	0.397
	Yes, II, degree		47.2	3.7	49.1	
	Yes, III, degree		50	1.9	48.1	
	No		46.9	2.8	50.3	
	Yes, I, degree	Can oral cancer be treated?	50.4	4.1	45.5	0.574
	Yes, II, degree		55.6	4.6	39.8	
	Yes, III, degree		57.4	0	42.6	
	No		53.3	2.4	44.3	
	Yes, I, degree	Is oral cancer contagious?	14.9	33.9	51.2	0.493
	Yes, II, degree		14.8	38	47.2	
	Yes, III, degree		14.82	44.44	40.74	
	No		10.9	36.4	52.7	

Pearson Chi-Square **p<0.05*

DISCUSSION

In cancer, the treatability of lesions through early diagnosis is a crucial factor for survival. In a study conducted by Saadat et al. [16] in the United Kingdom in 2022, an increase in the incidence of oral cancer in the country was attributed to the closure of access to dentists during the Covid-19 pandemic, leading to a negative impact on early diagnosis. In our survey assessing awareness levels of oral cancers, data were obtained from patients visiting our clinic through supervised, face-to-face interviews with physicians. This approach is believed to provide more accurate information compared to surveys conducted through mail, phone calls, and other online methods. Furthermore, with 750 participants included in our survey, exceeding the statistically determined minimum participant count of 317, and a KR-20 value of 0.85, the survey demonstrates high internal consistency reliability. Therefore, it is considered to better reflect the community's views on oral cancer.

In the current study, individuals who claimed to have heard of oral cancer constituted 46.5% of the participants. A literature review revealed varying percentages in studies conducted worldwide, including 73.8% in Australia,[17] 58.2% in Nepal,[18] 30.7% in Iran,[19] 72% in Spain,[20] 52.9% in China,[15] 81.3% in Brazil,[21] 53.2% in Indonesia,[22] 65.4% in a joint study in Poland and Germany,[23] 68.4% in Italy,[24] 70% in Jordan,[25] and 66% in Singapore.[16] Although the participants in the mentioned studies reported awareness of oral cancer in the specified percentages, it does not necessarily indicate their knowledge of the symptoms, etiologies, and preventive measures for oral cancers. It is a fact in our study that the awareness rate is quite low, and this is believed to be influenced by the low sociocultural and socioeconomic levels in the vicinity of the hospital where our study was conducted.

In our study, when participants were asked about the source from which they heard about oral cancer, the responses revealed that the highest percentage obtained information

from the media (21.6%), while the lowest percentages were reported for doctors (2.1%) and dentists (4.4%). Evaluating this question as an indicator of awareness sources among participants, it is notable that doctors and dentists have a significantly weak impact on patient education, a trend observed in previous studies on the subject. A literature review on the topic was conducted, and in the study by Zachar et al.,[17] the reported sources were TV/Radio (33.1%), cigarette packages (35.7%), newspapers/magazines (15.2%), friends/ acquaintances (21.2%), dentist (20.7%), doctor (7.2%), and internet (14%). In the study by Wimardhani et al.,[22] the percentages were health warnings (43.3%), print media (6.2%), TV/radio (17.8%), internet (9.5%), dentist (18.9%), doctor (8.1%). Gerber et al.'s study [23] reported percentages as TV/radio/newspaper (34.8%), internet (33.7%), doctor (23.7%), friends/acquaintances (19.6%). Rupel et al.'s study [24] indicated percentages as media (44.3%), school (21%), family/friends (34.5%), dentist (13.7%), other (11.8%). Finally, in the study by Jarab et al.,[25] the reported percentages were friends (5.03%), doctor (16.8%), TV (3.6%), newspaper (0.11%), radio (0.22%), health pamphlets (5.79%), internet (29.29%), educational campaigns (5.79%), and social media (20.87%). Although the parameters of these studies do not directly align, it suggests a weak communication between patients and healthcare professionals, emphasizing the need for training for healthcare personnel at all levels to increase awareness about oral cancer in the community.

In our study, when oral cancer awareness, risk factors, and early signs were compared with demographic information, it was observed that, within the gender group, women, within the age groups, participants aged 18-29, and within the education groups, participants with advanced education levels such as university, master's, and doctorate, although not always statistically significantly different, had a better level of knowledge about oral cancers. Similar results were obtained in studies conducted in Australia,[17] Italy,[24] Jordan,[25] and Iran [26] on this subject. The better knowledge level observed in the age group of 18-29 is thought to be due to their more effective use of technology, making access to information easier. Additionally, the fact that oral cancer is more prevalent in men and at an older age [5] contributes to this worrisome indication for gender and age. In general, this low level of awareness is considered to expose older men to a higher risk of delayed diagnosis, leading to increased morbidity and higher mortality rates.

In terms of awareness of risk factors for oral cancers, 70.4% of participants identified smoking, 56.7% identified alcohol consumption, 22.7% identified exposure to sunlight, and 41.2% considered advanced age as a risk factor for oral cancers. In comparison, Zachar et al.'s study [17] reported rates of 96.4% for smoking, 57.1% for alcohol, and 35.8% for advanced age; Rupel et al.'s study [24] reported rates of 94.1% for smoking, 51.4% for alcohol, and 15.4% for exposure to sunlight; Jarab et al.'s study [25] found rates of 92.79% for smoking, 83.28% for alcohol, 20.66% for exposure to sunlight, and 47.98% for advanced age as risk factors. While our study had a higher rate of smoking, the awareness rate of smoking as a risk factor was lower compared to the aforementioned studies. Additionally, no significant difference in awareness of smoking as a risk factor was observed between smokers and non-smokers among our study participants. All these findings suggest a generally low level of awareness in the community regarding the association of smoking with oral cancer, despite the higher prevalence of smoking in our study.

The awareness rates of our participants regarding early signs of oral cancers were as follows: long-lasting non-healing ulcers 40.3%, red sores 31.1%, white plaques 24%, and persistent swellings 31.5%. In comparison, awareness rates in Zachar et al.'s study[17] for the same topic were 90.3% for non-healing ulcers, 44.6% for red sores, and 44.1% for white

plaques. Wimardhani et al.'s study [22] reported awareness rates of 36.3% for non-healing ulcers, 8.7% for red sores, and 6.1% for white plaques. As observed, our study's awareness rates on non-healing ulcers are notably lower than those reported by Zachar et al.,[17] particularly, and higher than those from Wimardhani et al.'s study,[22] especially for red sores and white plaques. This difference is thought to be primarily related to the level of development of the countries. Furthermore, the awareness rate of early signs of oral cancers, as in similar studies, was found to be higher in women, individuals with a university degree, and those aged between 18-29 and above 60. The higher awareness among individuals aged 60 and above is considered to be due to the increased likelihood of oral cancer with age and the higher occurrence of oral cancer in their age group, even if the individual themselves does not have oral cancer.

Despite the large sample size, the limitation of this study lies in its data being restricted to a single university clinic. Future multicenter research across Istanbul and Turkey is recommended to assess oral cancer awareness comprehensively. A broader sample would better highlight regional and urban-rural differences, facilitating the development of targeted campaigns and educational programs to improve public health policies.

CONCLUSION

This study investigates the awareness and knowledge of oral cancers, their risk factors, and early signs among patients in hospital dental clinics. Findings reveal a generally low level of awareness within the community, underscoring the need for public education on oral cancer. While media is effective for information dissemination, regular dental check-ups also play a role in increasing awareness. These findings can guide efforts to enhance oral cancer awareness in the community.

Ethical Approval

The study was approved by the Non-Interventional Research Ethics Committee of Bezmialem Vakif University under approval number 2023/263, with reference code E-54022451-050.05.04-121165.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: EA, Data collection or access: EA, NK, İS, Analysis and comments: EA, İS, Literature search: EA, NK, İS, Writing: EA, İS.

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Patients' Chief Complaints Across Different Periodontal Diseases: A Cross-Sectional Study

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ABSTRACT

Aim: This study assesses the relationship between periodontal chief complaints and different periodontal diseases, including variations across periodontitis stages and grades.

Methods: A total of 309 patients were enrolled. Demographic data, smoking status, brushing frequency, diabetes, periodontal complaints, and clinical parameters were recorded. Periodontal diseases were categorized as Gingivitis, Gingival Inflammation on a Reduced Periodontium, and Periodontitis. Periodontitis was further classified based on its stages and grades according to clinical and radiographic findings. Associations between periodontal disease groups, periodontitis stages/grades, and chief complaints were analyzed.

Results: Significant differences in age, plaque index, probing depth, bleeding on probing, and gingival index were observed among the periodontal disease groups. Halitosis was most the common complaint in the Gingival Inflammation on a Reduced Periodontium (12.8%) and Gingivitis (9.6%) groups, while it was significantly less frequent in the Periodontitis group (3.4%, $p<0.001$). Gingival recession was significantly more reported in the Gingival Inflammation on a Reduced Periodontium (23.4%) and Periodontitis (15.1%) groups. A significant proportion of patients in Stage I, II, and III primarily reported dental calculus removal as their chief complaint, whereas gingival bleeding and mobility were significantly more common among Stage IV patients. No significant differences were found between periodontal chief complaints and the grades of periodontitis.

Conclusion: Patients' periodontal complaints varied across disease types and periodontitis stages but not grades. Understanding these complaints can improve patient cooperation and treatment adherence, ultimately enhancing outcomes.

Farklı Periodontal Hastalıklar Karşısında Hastaların Başlıca Şikayetleri: Kesitsel Bir Çalışma

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 05.02.2025
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Anahtar Kelimeler:
Gingivitis,
Periodontal başlıca şikayetler,
Periodontitis,
Azalmış periodonsiyum.

ÖZET

Amaç: Bu çalışma, periodontitis evreleri ve dereceleri arasındaki farklılıklar da dahil olmak üzere, periodontal başlıca şikayetler ile farklı periodontal hastalıklar arasındaki ilişkiyi değerlendirmektedir.

Yöntem: Toplam 309 hasta çalışmaya dahil edildi. Demografik veriler, sigara içme durumu, diş fırçalama sıklığı, diyabet, periodontal şikayetler ve klinik parametreler kaydedildi. Periodontal hastalıklar Gingivitis, Azalmış Periodonsiyumda Gingival İnflamasyon ve Periodontitis olarak kategorize edildi. Periodontitis ayrıca klinik ve radyografik bulgulara göre evrelerine ve derecelerine göre sınıflandırılmıştır. Periodontal hastalık grupları, periodontitis evreleri/dereceleri ve başlıca şikayetler arasındaki ilişkiler analiz edilmiştir.

Bulgular: Periodontal hastalık grupları arasında yaş, plak indeksi, sondalama derinliği, sondalamada kanama ve gingival indeks açısından anlamlı farklılıklar gözlendi. Ağız kokusu en sık Azalmış Periodonsiyumda Gingival Enflamasyon (%12,8) ve Gingivitis (%9,6) gruplarında görülürken, Periodontitis grubunda anlamlı olarak daha az görülmüştür (%3,4, $p<0,001$). Dişeti çekilmesi Azalmış Periodonsiyumda Gingival Enflamasyon (%23,4) ve Periodontitis (%15,1) gruplarında anlamlı olarak daha fazla bildirilmiştir. Evre I, II ve III' teki hastaların önemli bir kısmı diş taşı temizliğini başlıca şikayetleri olarak bildirirken, diş eti kanaması ve mobilite şikayetleri Evre IV hastaları arasında önemli ölçüde daha yaygındı. Periodontal başlıca şikayetler ile periodontitis dereceleri arasında anlamlı bir fark bulunmamıştır.

Sonuçlar: Hastaların periodontal şikayetleri hastalık tipleri ve periodontitis evreleri arasında farklılık göstermiş ancak dereceler arasında farklılık göstermemiştir. Bu şikayetlerin anlaşılması, hasta işbirliğini ve tedaviye uyumu artırabilir ve nihayetinde tedavi sonuçlarını iyileştirebilir.

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INTRODUCTION

Periodontal diseases are multifactorial, multi-microbial conditions that progressively damage the supporting structures of the teeth, including the cementum, gingiva, alveolar bone, and periodontal ligament.[1] Gingivitis is the mildest form of periodontal disease and it is characterized by gingival inflammation without the loss of periodontal attachment. While gingivitis is reversible with proper oral hygiene, its progression can lead to periodontitis.[2] In addition to its local effects, periodontitis is also known to be associated with various systemic conditions, including cardiovascular diseases, diabetes, respiratory diseases, and pregnancy complications. This association is thought to be mediated through several physiological pathways, particularly the systemic dissemination of proinflammatory cytokines such as IL-1β, TNF-α, and IL-6, which can contribute to systemic inflammation and disease progression.

Gingival inflammation on a reduced periodontium can be challenging due to structural and functional vulnerabilities from periodontal attachment loss. As first defined in the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, this condition often arises from a history of periodontal disease, restorative treatments such as crown lengthening, or gingival recessions that compromise the periodontium.[3] Unless specific preventive strategies—such as proper oral hygiene, a balanced diet, regular dental check-ups, and control of risk factors like smoking and systemic conditions—are implemented, patients remain at risk of further periodontal destruction.

Periodontitis represents a more advanced phase of periodontal disease, characterized by an inflammatory process that extends deeper into the periodontal tissues, resulting in irreversible destruction of periodontal attachment and alveolar bone. To enhance the understanding and clinical management of periodontitis, the 2018 classification system introduced a revised framework, integrating staging and grading criteria.[4] The staging system stratifies the disease based on its severity, extent, and complexity of management, derived from clinical, radiographic, and historical findings. In parallel, the grading system allows for the assessment of the disease's progression rate and its association with factors such as daily amount of smoking and HbA1c levels related to diabetes mellitus.[5] This comprehensive approach aims to individualize treatment planning and improve prognostic evaluations.

Both gingivitis and periodontitis are prevalent in communities and are considered to be preventable and treatable diseases. According to estimates, 46% of people over 30 are affected by periodontal diseases in the United States.[6] It is estimated that 10% of people worldwide suffer from severe periodontitis, and the prevalence rises with age. [7] Severe periodontal disease was ranked as the eleventh most common disease worldwide by the Global Burden of Disease Study (2016).[8]

Patients' chief complaints, or the primary reasons they seek dental care, play a critical role in clinical diagnosis and treatment planning.[9] These complaints often reflect the most noticeable or distressing symptoms experienced by the patient, such as bleeding gums, sensitivities, tooth mobility, bad breath, aesthetic concerns, or the discomfort caused by the presence of dental calculus.[10] Understanding these chief complaints within the context of different periodontal diseases offers valuable insights into patients' priorities and perceptions of oral health.[11] Specifically, examining the relationships between gingivitis, reduced periodontium with gingival inflammation, different stages and grades of periodontitis, and the chief complaints can aid clinicians in personalizing interventions and improving

patient communication, ultimately enhancing treatment outcomes.

Therefore, this cross-sectional study aims to examine the chief complaints of patients with periodontal diseases and explore how these diseases influence patient experiences and awareness, providing guidance for clinicians to address their concerns effectively.

MATERIALS AND METHODS

Study design and participants

The data for this study included 309 individuals who visited the Periodontology clinics for various treatment purposes. Participants were included in the study after reviewing and signing the written informed consent following the ethical principles of the Declaration of Helsinki. The research protocol was approved by the Ethics Committee of Necmettin Erbakan University Faculty of Dentistry Non-Drug and Non-Medical Device Research Ethics Committee (Protocol No: 2024/498).

The inclusion criteria for the study were as follows: being over 18 years of age, not being pregnant, having a diagnosis of gingivitis, gingivitis in reduced periodontium, or periodontitis, and not having any mental or physical illness that could prevent them from expressing their chief complaint. The exclusion criteria included having undergone dental scaling within the past six months and having a diagnosis of gingival health or gingival health on reduced periodontium. This criterion was applied to avoid potential bias due to ongoing healing or alveolar remodeling following recent treatment, which could affect both clinical parameters and patient-reported outcomes.

Demographic data, including periodontal chief complaints (pCC), sex, age, diabetes mellitus status, smoking, and daily brushing frequency, were collected and recorded for the patients included in the study. Age groups were classified as under 30 years, 30 to 45 years, and over 45 years. Smoking behaviours were classified as smokers and non-smokers. Brushing frequency was assessed as follows: 1) no brushing, 2) once a day, 3) twice a day, and 4) several times a week. Gingival bleeding, tooth mobility, gingival recession, halitosis, gingival pain, gingival enlargement, sensitivity, dental calculus cleaning, and dental staining were classified as pCC.

Clinical measurements

Clinical periodontal parameters have been measured by the same clinician (M.D.). To assess the reliability of the clinician's measurements, a cohort of ten volunteers, who were not involved in the study, received periodontal assessments. The examinations were subsequently repeated two days later. The clinician exhibited a measurement consistency surpassing 90% between the two assessments. Bleeding on probing (BOP), gingival index (GI), plaque index (PI), and probing depth (PD) were documented for each patient utilizing a Williams periodontal probe (Hu-Friedy, Chicago, IL).[12,13] Clinical periodontal parameters were assessed for the full mouth at six areas per tooth: mesio-lingual, mid-lingual, disto-lingual, disto-facial, mid-facial, and mesio-facial surfaces.

Classification of Periodontal Diseases

The calibrated expert clinician determined periodontal disease according to the most recent and widely accepted 2017 classification of periodontal diseases criteria based on radiographic and clinical examination.[3] Patients exhibiting no radiographic bone loss (RBL), no clinical attachment loss (CAL), PD less than 3 mm, and bleeding on probing at 10% or greater were diagnosed with gingivitis.

According to the 2017 Classification of Periodontal and Peri-Implant Diseases and Conditions, gingival inflammation on a reduced periodontium refers to the presence of bleeding on probing (BOP) in sites with shallow probing depths (≤3 mm), in patients with a history of

periodontitis but without signs of active disease progression. These individuals have previously experienced clinical attachment loss (CAL) and/or radiographic bone loss (RBL) as a result of periodontitis, yet currently present with a stable periodontal condition—characterized by probing pocket depths of ≤4 mm, minimal or no BOP, and no further attachment loss. When gingival inflammation is observed in these patients without concurrent deep pockets or ongoing destruction, the diagnosis is defined as "gingival inflammation in a reduced but stable periodontium.

Periodontitis diagnosis was established based on interdental CAL affecting at least two non-adjacent teeth or the presence of buccal CAL ≥ 3 mm with PD ≥ 4 mm at two or more teeth. The severity of periodontitis was categorized into stages and grades. Stage I included cases with a maximum interproximal CAL of 1–2 mm. Stage II was defined by an interproximal CAL of 3–4 mm, PD up to 5 mm, RBL confined to the coronal third (15–33%), and no history of tooth loss due to periodontal disease. Stage III involved an interdental CAL of ≥ 5 mm, RBL reaching to the middle third of the root, and tooth loss attributed to periodontitis. Stage IV was characterized by interdental CAL ≥ 5 mm, deep periodontal lesions, and RBL reaching the apical of the root.

The grade was evaluated based on indirect indicators of progression through RBL relative to age, as no direct evidence of progression was available at the 5-year follow-up. RBL was determined as the percentage of root length lost in the worst-affected tooth in the dentition. Patients were assigned Grade A if the bone loss percentage divided by age was below 0.25; Grade B if it ranged from 0.25 to 1.0; and Grade C if it exceeded 1.0. Subsequently, grade modifications were made based on HbA1c levels for individuals with diabetes and the daily smoking quantity for smokers.

Statistical Analysis

The sample size for this research was determined based on the primary outcome of differences between the groups (gingivitis, gingivitis on reduced periodontium, and periodontitis, subdivided into 3 and 4 subgroups) in terms of the patients' chief complaints. Using an effect size of d = 0.50 (medium effect), $\alpha = 0.05$, and a power of 80% (1 - β), the minimum sample size required for each group was determined to be 34, resulting in a total of 309 participants across all groups. The study data were analyzed using IBM SPSS v23. The associations between categorical variables were examined using the Pearson chi-square test and the Monte Carlo-corrected Fisher's Exact test. Multiple comparisons were assessed using the Bonferroni-corrected z test. Descriptive statistics for continuous variables were reported as mean ± standard deviation and median (range), while categorical variables were summarized using frequency (n) and percentage (%). A p-value below 0.05 was deemed statistically significant.

RESULTS

This study evaluated the clinical and demographic characteristics of 309 patients. The mean age of the participants was 42.41 ± 15.4 years, and 176 of the individuals (57%) were female. Three periodontal disease groups were evaluated in the study: Gingival Inflammation on a Reduced Periodontium, Gingivitis, and Periodontitis. Significant differences were identified among these groups in terms of age, mean PD, GI, PI, and the mean percentage of BOP. In the Gingival Inflammation on a Reduced Periodontium group, the mean age was 51.94 ± 11.43 years, PD was 2.39 mm, GI was 1.39, PI was 1.53, and BOP was 46.57%. For the Gingivitis group, these values were 25.82 ± 8.54 years, 2.11 mm, 1.21, 1.42, and 38.85%, respectively. In the Periodontitis group, the mean age was 47.6 ± 12.79 years, PD was 3.41 mm, GI was 1.8, PI was 2.18, and BOP was 65.52%.

When the stages of periodontitis were analyzed, the mean PD increased progressively from Stage I to Stage IV, measured as 2.82 ±

0.34 mm, 3.19 ± 0.37 mm, 3.55 ± 0.74 mm, and 4.11 ± 0.94 mm, respectively. For Stage I, the PI, GI, and BOP values were 2.12 ± 0.41, 1.7 ± 0.44, and 55.65 ± 27.16, respectively, with a statistically significant increase observed across the stages ($p < 0.05$). Similarly, when the grades of periodontitis were analyzed, the mean PD increased from Grade A to Grade C, with values of 3.07 ± 0.41 mm, 3.43 ± 0.67 mm, and 3.57 ± 0.96 mm, respectively. In addition, there was no differences were observed between grades for PI, GI, or BOP values ($p > 0.05$).

Table 1. Relationship Between Periodontal Disease Groups and Chief Complaints/Demographics

	Gingival Inflammation on a Reduced Periodontium (n=47)	Gingivitis (n=83)	Periodontitis (n=179)	Total (N=309)	Test Statistics	p
Age Groups. *n* (%)						
<30 years	0 (0)[a]	65 (78.3)[b]	16 (8.9)[a]	81 (26.2)	164.364	**< 0.001**[x]
30-45 years	16 (34)[a]	13 (15.7)[b]	59 (33)[a]	88 (28.5)		
>45 years	31 (66)[a]	5 (6)[b]	104 (58.1)[a]	140 (45.3)		
Gender. *n* (%)						
Female	23 (48.9)[a]	63 (75.9)[b]	90 (50.3)[a]	176 (57)	16.642	**< 0.001**[x]
Male	24 (51.1)[a]	20 (24.1)[b]	89 (49.7)[a]	133 (43)		
Brushing Frequency						
No brushing	0 (0)[ab]	0 (0)[b]	17 (9.5)[a]	17 (5.5)	78.275	**< 0.001**[y]
Once a day	25 (53.2)[a]	24 (28.9)[b]	72 (40.2)[ab]	121 (39.2)		
Twice a day	17 (36.2)[a]	56 (67.5)[b]	35 (19.6)[c]	108 (34.9)		
Several times a week	5 (10.6)[a]	3 (3.6)[a]	55 (30.7)[b]	63 (20.4)		
Diabetes Mellitus						
Yes	9 (19.2)[a]	2 (2.4)[b]	20 (11.2)[ab]	31 (10)	10.630	**0.004**[y]
No	38 (80.9)[a]	81 (97.6)[b]	159 (88.8)[ab]	278 (90)		
Smoking						
Yes	12 (25.5)[ab]	12 (14.5)[b]	55 (30.7)[a]	79 (25.6)	7.887	**0.019**[x]
No	35 (74.5)[ab]	71 (85.5)[b]	124 (69.3)[a]	230 (74.4)		
Chief Complaints						
Halitosis	6 (12.8)[a]	8 (9.6)[ab]	6 (3.4)[b]	20 (6.5)	61.216	**< 0.001**[y]
Gingival Pain	3 (6.4)	6 (7.2)	9 (5)	18 (5.8)		
Gingival Enlargement	1 (2.1)	4 (4.8)	5 (2.8)	10 (3.2)		
Gingival Recession	11 (23.4)[a]	0 (0)[b]	27 (15.1)[a]	38 (12.3)		
Gingival Bleeding	4 (8.5)	10 (12)	30 (16.8)	44 (14.2)		
Dental Scaling	20 (42.6)	40 (48.2)	66 (36.9)	126 (40.8)		
Sensitivity	1 (2.1)	5 (6)	15 (8.4)	21 (6.8)		
Mobility	1 (2.1)[ab]	0 (0)[b]	18 (10.1)[a]	19 (6.2)		
Dental Staining	0 (0)[a]	10 (12)[b]	3 (1.7)[a]	13 (4.2)		
Number of Teeth						
≤20 teeth	9 (19.2)[a]	2 (2.4)[b]	33 (18.4)[a]	44 (14.2)	13.020	**0.002**[x]
≥21 teeth	38 (80.9)[a]	81 (97.6)[b]	146 (81.6)[a]	265 (85.8)		

x Pearson chi-square, y Monte Carlo corrected Fisher Exact Test, n (%); a-c: There is no difference between groups with the same letter.

Table 1 presents the relationship between periodontal disease groups and demographic data, along with periodontal chief complaints. A significant association was detected between age groups, gender, brushing frequency, and disease groups ($p < 0.001$). The Gingivitis group consisted predominantly of younger patients and had a higher proportion of females. Daily brushing frequency was statistically higher in the Gingivitis and Gingival Inflammation on a Reduced Periodontium group, whereas the Periodontitis group had a greater proportion of patients who brushed infrequently or not at all. The prevalence of diabetes differed significantly across the disease groups ($p = 0.004$). Diabetes was most prevalent in the Gingival Inflammation on a Reduced Periodontium group, followed by the Periodontitis group, and was least common in the Gingivitis group. Smoking prevalence also varied significantly ($p = 0.019$), with a notably higher rate observed in the Periodontitis group compared to the Gingivitis group.

Table 2. Relationship Between Periodontal Chief Complaints and Demographics

	Halitosis (n=20)	Gingival Pain (n=18)	Gingival Enlargement (n=10)	Gingival Recession (n=38)	Gingival Bleeding (n=44)	Dental Scaling (n=126)	Sensitivity (n=21)	Mobility (n=19)	Dental Staining (n=13)	Total (N=309)	Test Statistics	p
Age Groups												
<30 years	4 (20)^{abcdefg}	5 (27.8)^{cfg}	6 (60)^{dg}	0 (0)^{c}	13 (29.5)^{abdefg}	36 (28.6)^{abdefg}	8 (38.1)^{abdefg}	0 (0)^{bcf}	9 (69.2)^{adeg}	81 (26.2)	60.809	**<0.001**^{x}
30-45 years	8 (40)	5 (27.8)	0 (0)	16 (42.1)	12 (27.3)	33 (26.2)	1 (4.8)	9 (47.4)	4 (30.8)	88 (28.5)		
>45 years	8 (40)^{ab}	8 (44.4)^{ab}	4 (40)^{ab}	22 (57.9)^{b}	19 (43.2)^{ab}	57 (45.2)^{ab}	12 (57.1)^{b}	10 (52.6)^{ab}	0 (0)^{a}	140 (45.3)		
Gender												
Female	9 (45)	13 (72.2)	6 (60)	23 (60.5)	24 (54.6)	68 (54)	13 (61.9)	10 (52.6)	10 (76.9)	176 (57)	6.065	0.652^{x}
Male	11 (55)	5 (27.8)	4 (40)	15 (39.5)	20 (45.5)	58 (46)	8 (38.1)	9 (47.4)	3 (23.1)	133 (43)		
Brushing Frequency												
No brushing	1 (5)	0 (0)	0 (0)	4 (10.5)	3 (6.8)	7 (5.6)	0 (0)	2 (10.5)	0 (0)	17 (5.5)	24.779	0.319^{x}
Once a day	10 (50)	4 (22.2)	2 (20)	15 (39.5)	20 (45.5)	46 (36.5)	13 (61.9)	6 (31.6)	5 (38.5)	121 (39.2)		
Twice a day	6 (30)	10 (55.6)	4 (40)	13 (34.2)	10 (22.7)	48 (38.1)	6 (28.6)	4 (21.1)	7 (53.8)	108 (34.9)		
Several times a week	3 (15)	4 (22.2)	4 (40)	6 (15.8)	11 (25)	25 (19.8)	2 (9.5)	7 (36.8)	1 (7.7)	63 (20.4)		
Diabetes Mellitus												
Yes	2 (10)	2 (11.1)	1 (10)	8 (21.1)	4 (9.1)	9 (7.1)	2 (9.5)	3 (15.8)	0 (0)	31 (10)	7.920	0.372^{x}
No	18 (90)	16 (88.9)	9 (90)	30 (79)	40 (90.9)	117 (92.9)	19 (90.5)	16 (84.2)	13 (100)	278 (90)		
Smoking												
Yes	7 (35)	2 (11.1)	4 (40)	7 (18.4)	10 (22.7)	28 (22.2)	11 (52.4)	5 (26.3)	5 (38.5)	79 (25.6)	14.317	0.062^{x}
No	13 (65)	16 (88.9)	6 (60)	31 (81.6)	34 (77.3)	98 (77.8)	10 (47.6)	14 (73.7)	8 (61.5)	230 (74.4)		

x Monte Carlo corrected Fisher Exact Test; n (%); a-g: There is no difference between groups with the same letter.

Table 3. Relationship Between Periodontitis Stages and Chief Complaints/Demographics

	Stage I (n=31)	Stage II (n=54)	Stage III (n=64)	Stage IV (n=30)	Total (N=179)	Test Statistics	p
Age Groups						14.133	**0.023**^{x}
<30 Age	5 (16.1)	3 (5.6)	8 (12.5)	0 (0)	16 (8.9)		
30-45 Age	11 (35.5)	18 (33.3)	25 (39.1)	5 (16.7)	59 (33)		
>45 Age	15 (48.4)^{a}	33 (61.1)^{ab}	31 (48.4)^{a}	25 (83.3)^{b}	104 (58.1)		
Gender						3.970	0.265^{y}
Female	11 (35.5)	30 (55.6)	35 (54.7)	14 (46.7)	90 (50.3)		
Male	20 (64.5)	24 (44.4)	29 (45.3)	16 (53.3)	89 (49.7)		
Brushing Frequency						16.758	**0.047**^{x}
No brushing	1 (3.2)	3 (5.6)	10 (15.6)	3 (10)	17 (9.5)		
Once a day	13 (41.9)	21 (38.9)	26 (40.6)	12 (40)	72 (40.2)		
Twice a day	9 (29)^{a}	10 (18.5)^{ab}	15 (23.4)^{ab}	1 (3.3)^{b}	35 (19.6)		
Several times a week	8 (25.8)	20 (37)	13 (20.3)	14 (46.7)	55 (30.7)		
Diabetes Mellitus						0.246	1.000^{x}
Yes	3 (9.7)	6 (11.1)	8 (12.5)	3 (10)	20 (11.2)		
No	28 (90.3)	48 (88.9)	56 (87.5)	27 (90)	159 (88.8)		
Smoking						4.869	0.182^{y}
Yes	12 (38.7)	11 (20.4)	20 (31.3)	12 (40)	55 (30.7)		
No	19 (61.3)	43 (79.6)	44 (68.8)	18 (60)	124 (69.3)		
Chief Complaints						38.998	**0.007**^{x}
Halitosis	1 (3.2)	2 (3.7)	0 (0)	3 (10)	6 (3.4)		
Gingival Pain	2 (6.5)	3 (5.6)	2 (3.1)	2 (6.7)	9 (5)		
Gingival Enlargement	1 (3.2)	0 (0)	2 (3.1)	2 (6.7)	5 (2.8)		
Gingival Recession	4 (12.9)	10 (18.5)	9 (14.1)	4 (13.3)	27 (15.1)		
Gingival Bleeding	5 (16.1)	6 (11.1)	13 (20.3)	6 (20)	30 (16.8)		
Dental Scaling	14 (45.2)^{a}	26 (48.1)^{a}	23 (35.9)^{ab}	3 (10)^{b}	66 (36.9)		
Sensitivity	1 (3.2)	6 (11.1)	4 (6.3)	4 (13.3)	15 (8.4)		
Mobility	1 (3.2)	1 (1.9)	10 (15.6)	6 (20)	18 (10.1)		
Dental Staining	2 (6.5)	0 (0)	1 (1.6)	0 (0)	3 (1.7)		
Grade						15.365	**0.018**^{y}
Grade A	9 (29)	10 (18.5)	8 (12.5)	3 (10)	30 (16.8)		
Grade B	12 (38.7)	36 (66.7)	34 (53.1)	13 (43.3)	95 (53.1)		
Grade C	10 (32.3)^{ab}	8 (14.8)^{b}	22 (34.4)^{ab}	14 (46.7)^{a}	54 (30.2)		
Number of Teeth						49.968	**<0.001**^{y}
≤20 teeth	4 (12.9)^{a}	7 (13)^{a}	3 (4.7)^{a}	19 (63.3)^{b}	33 (18.4)		
≥21 teeth	27 (87.1)^{a}	47 (87)^{a}	61 (95.3)^{a}	11 (36.7)^{b}	146 (81.6)		

x Monte Carlo corrected Fisher Exact Test, y Pearson chi-square, n (%), a-b: There is no difference between groups with the same letter.

Several periodontal chief complaints demonstrated significant variations among the periodontal disease groups. Halitosis was most common in the Gingival Inflammation on a Reduced Periodontium (12.8%) and Gingivitis (9.6%) groups, while it was significantly less

frequent in the Periodontitis group (3.4%, $p < 0.001$). Gingival recession was predominantly observed in the Gingival Inflammation on a Reduced Periodontium (23.4%) and Periodontitis (15.1%) groups, with no cases reported in the Gingivitis group. Similarly, mobility was most frequently observed in the Periodontitis group (10.1%) but was absent in the Gingivitis group. Dental staining was significantly more common in the Gingivitis group (12%) compared to other groups. Other complaints, including gingival pain, gingival enlargement, gingival bleeding, scaling needs, and sensitivity, showed no statistically significant differences between the periodontal disease groups. The relationship between periodontal chief complaints and demographic data is presented in Table 2, where significant differences were observed only for age groups ($p < 0.001$).

The associations between the stages (Table 3) and grades (Table 4) of periodontitis and both periodontal chief complaints and demographic variables were also analyzed. Among the periodontitis stages, only the need for dental scaling showed statistically significant differences ($p = 0.007$). Regarding periodontitis grades, significant differences were observed only for age groups, gender, and smoking habits ($p < 0.05$).

Table 4. Relationship Between Periodontitis Grades and Chief Complaints/Demographics

	Grade A (n=30)	Grade B (n=95)	Grade C (n=54)	Total (N=179)	Test Statistics	p
Age Groups (years)					18.660	**0.001**[x]
<30 Age	4 (13.3)	4 (4.2)	8 (14.8)	16 (8.9)		
30-45 Age	16 (53.3)[a]	23 (24.2)[b]	20 (37)[ab]	59 (33)		
>45 Age	10 (33.3)	68 (71.6)	26 (48.1)	104 (58.1)		
Gender					6.800	**0.033**[y]
Female	14 (46.7)[ab]	56 (58.9)[b]	20 (37)[a]	90 (50.3)		
Male	16 (53.3)[ab]	39 (41.1)[b]	34 (63)[a]	89 (49.7)		
Brushing Frequency					5.524	0.484[x]
No brushing	1 (3.3)	9 (9.5)	7 (13)	17 (9.5)		
Once a day	15 (50)	37 (38.9)	20 (37)	72 (40.2)		
Twice a day	8 (26.7)	19 (20)	8 (14.8)	35 (19.6)		
Several times a week	6 (20)	30 (31.6)	19 (35.2)	55 (30.7)		
Diabetes Mellitus					2.959	0.231[x]
Yes	1 (3.3)	14 (14.7)	5 (9.3)	20 (11.2)		
No	29 (96.7)	81 (85.3)	49 (90.7)	159 (88.8)		
Smoking					47.429	**<0.001**[x]
Yes	0 (0)[a]	18 (18.9)[a]	37 (68.5)[b]	55 (30.7)		
No	30 (100)[a]	77 (81.1)[a]	17 (31.5)[b]	124 (69.3)		
Chief Complaints					22.824	0.070[x]
Halitosis	2 (6.7)	1 (1.1)	3 (5.6)	6 (3.4)		
Gingival Pain	3 (10)	5 (5.3)	1 (1.9)	9 (5)		
Gingival Enlargement	1 (3.3)	1 (1.1)	3 (5.6)	5 (2.8)		
Gingival Recession	4 (13.3)	17 (17.9)	6 (11.1)	27 (15.1)		
Gingival Bleeding	7 (23.3)	12 (12.6)	11 (20.4)	30 (16.8)		
Dental Scaling	9 (30)	42 (44.2)	15 (27.8)	66 (36.9)		
Sensitivity	2 (6.7)	9 (9.5)	4 (7.4)	15 (8.4)		
Mobility	1 (3.3)	8 (8.4)	9 (16.7)	18 (10.1)		
Dental Staining	1 (3.3)	0 (0)	2 (3.7)	3 (1.7)		
Stages					15.365	0.018[y]
Stage I	9 (30)	12 (12.6)	10 (18.5)	31 (17.3)		
Stage II	10 (33.3)	36 (37.9)	8 (14.8)	54 (30.2)		
Stage III	8 (26.7)	34 (35.8)	22 (40.7)	64 (35.8)		
Stage IV	3 (10)	13 (13.7)	14 (25.9)	30 (16.8)		
Number of Teeth					0.215	0.898[y]
≤20 teeth	5 (16.7)	17 (17.9)	11 (20.4)	33 (18.4)		
≥21 teeth	25 (83.3)	78 (82.1)	43 (79.6)	146 (81.6)		

x Monte Carlo corrected Fisher Exact Test; y Pearson Chi-square; n (%); a-b: There is no difference between groups with the same letter.

DISCUSSION

Identifying the relationship between periodontal chief complaints and periodontal diseases can aid early diagnosis and improve both clinician and patient decision-making. Periodontitis often lacks noticeable symptoms like pain, leading to delayed recognition and complaints.[14] Understanding how specific complaints correspond to distinct periodontal disease stages or grades may enhance awareness and provide insights into the natural progression of these conditions. This study investigates the relationship between various periodontal diseases, including different stages and grades of periodontitis, and patients' chief complaints. Additionally, this research is the first in the literature to examine the association between chief complaints and both gingival inflammation on reduced periodontium and periodontitis grades according to the 2017 periodontal disease classification.

The number of studies examining periodontal chief complaints in the literature is relatively limited.[10] In a 2020 study by Abdulkareem et al., chief complaints were categorized into "true" and "others".[15] They reported that the proportion of periodontitis patients with true periodontal chief complaints was less than 25%. In a study conducted by Elhassan et al., the chief complaints of 121 patients with periodontal disease were recorded.[16] It was noted that 32% of the patients did not have a true chief complaint but were informed by another clinician that they had gingival disease. Additionally, 31% of the patients reported gingival bleeding as their chief complaint, while the third most common complaint was a request for dental calculus cleaning, reported by 9% of the patients. Although the findings of our study differ from these previous studies, they are consistent with the studies by Grover et al. [17] and Gürbüz et al.[11] Both studies identified the need for dental calculus cleaning as the most common periodontal chief complaint among periodontitis patients. Similarly, in our study, the need for dental calculus cleaning emerged as the most frequently reported chief complaint among all periodontal disease groups (40.8%). This finding may be associated with the low level of periodontal disease awareness among individuals in the Turkish population. Problems such as gingival bleeding might not be perceived as complaints by some patients and could instead be regarded as a physiological condition. Furthermore, the discomfort caused by dental calculus in the oral cavity and its unaesthetic appearance could also contribute to the prominence of this complaint.

In the study by Yeh et al., a relationship was found between patients' chief complaints at their first periodontal visit and their adherence to basic periodontal treatment.[9] The results indicated that patients with acute symptomatic or asymptomatic complaints were more motivated to start periodontal treatment compared to those with chronic symptomatic complaints. In the study conducted by Brunsvold et al. in 1999 on patients with periodontitis, it was reported that over 50% of patients were unaware they had periodontal disease, yet their chief complaints were referrals and preserving their teeth.[10] The same study identified gingival bleeding, a true symptom of periodontitis, as the third most common chief complaint, reported by 20.4% of periodontitis patients. Similarly, the prevalence of halitosis as a chief complaint was reported as 6.8%, which is highly comparable to the rate observed in our study (6.5%). In the present study, 16.8% of periodontitis patients reported gingival bleeding, 10.1% reported mobility, 5% reported gingival pain, and 15.1% reported gingival recession as their chief complaints. The infrequent reporting of pain in complaints may be attributed to the chronic nature and slow progress of most periodontal diseases.

The chief complaint of halitosis was statistically significantly more prevalent in the gingival inflammation on reduced periodontium group in our study. This could be attributed to the history of previous periodontitis, the higher prevalence of papillary loss, and the subsequent difficulty in maintaining optimal interdental oral hygiene.[18-20] Additionally, the fact that 66% of patients in this group were over 45 years old, along with an increase in prosthetic treatments such as crown lengthening, may explain the higher frequency of halitosis as a chief complaint compared to the other groups.

In the study conducted by Soundarajan et al., gingival bleeding was reported as the most frequently reported chief complaint (22.95%), which differs from other studies.[21] After classifying periodontitis into severe, moderate, and mild stages, they found a link between the severity of periodontitis and chief complaints. In patients with chronic symptomatic complaints, the rate of severe periodontitis was higher (44.67%), while in patients with acute symptomatic and asymptomatic complaints, this rate was lower. Furthermore, the types of complaints varied according to the severity of periodontitis; for instance, in patients with severe periodontitis, the most prevalant complaint was bleeding gingivas (24.68%).

Smoking was most prevalent in the periodontitis group (30.7%) compared to other periodontal disease groups. This finding highlights the potential impact of smoking on periodontal health, as it is known to exacerbate inflammation, promote tissue destruction, weaken immune responses, and reduce gingival blood flow—factors that collectively contribute to the progression of periodontal disease.[22] These observations underscore the importance of smoking cessation in the management and prevention of periodontal conditions. As periodontitis progresses from stage I to stage IV, clinical periodontal parameters worsen and patients' chief complaints change accordingly. Gürbüz et al. conducted a regression model revealing that complaints of mobility and gingival bleeding were approximately threefold more prevalent in Stage III periodontitis patients compared to those in Stage I/II, while mobility complaints in Stage IV patients increased up to thirteenfold compared to Stage I/II.[11] Our study revealed a comparable trend, with mobility complaints increasing at the same with the progression of disease stages. Mobility complaints were more common in Stage III (15.6%) and Stage IV (20%) patients than in Stage I (3.2%) and Stage II (1.9%) patients. Gingival bleeding was more often in Stage III (20.3%) and Stage IV (20%) than in Stage I (16.1%) and Stage II (11.1%) patients. This observation suggests that as periodontitis progresses to higher stages, gingival bleeding becomes more frequent, which may reflect an increase in the severity of periodontal inflammation and the extent of tissue damage.

The distribution of patints' chief complaints among different age groups reveals significant patterns in the motivations for seeking periodontal care ($p<0.001$). Consistent with the findings of Gürbüz et al.,[11] patients under 30 years old predominantly reported halitosis (20%) and dental staining (69.2%), indicating concerns tied to aesthetics and social interactions. Conversely, patients over 45 years old exhibited higher rates of gingival recession (57.9%), mobility (52.6%), and sensitivity (57.1%), reflecting age-related periodontal deterioration. In the present study, patients with stage I or II periodontitis were more likely to brush their teeth once or twice daily, suggesting better oral hygiene habits. In contrast, those with Stage III or IV periodontitis exhibited higher rates of inadequate brushing, including "no brushing" (25.6%) or brushing "several times a week" (67%). These findings align with the established understanding that insufficient oral hygiene is a critical factor influencing the developing stages of periodontal disease.[23]

The absence of a statistically significant associations between periodontitis grades and chief complaints in our study, suggests that patients' reported complaints may not directly correlate with the progression rate of the periodontitis.[24] These findings highlight the importance of examining the periodontal clinical parameters to accurately assess disease progression, rather than relying on patient-reported complaints.[22]

There are certain limitations to our study. The study's cross-sectional design, the absence of assessment regarding the history of periodontitis in the reduced periodontium group, the single-center nature of the research, and the nonhomogeneous distribution of patients across the stages and grades of periodontitis are notable limitations. The grading of periodontitis patients was calculated using indirect evidence rather than 5-year follow-up data, which constitutes a methodological limitation. Furthermore, another limitations of this study is that smoking status was categorized only as smoker or non-smoker in the statistical analysis. Although the number of cigarettes smoked per day was considered during the clinical grading of periodontitis, a more detailed stratification among smokers (e.g., light, moderate, heavy smokers) was not performed. This may have limited our ability to assess the dose-dependent effect of smoking on periodontal parameters. Moreover, the subjective nature of chief complaints and the lack of a standardized questionnaire to assess them may have introduced variability in patient-reported data. Future studies could benefit from employing validated patient-reported outcome measures to better assess the relationship between subjective symptoms and clinical periodontal parameters.

CONCLUSION

Knowing patients' chief complaints can help clinicians personalize interventions and improve patient communication. Implementing periodontal therapies aimed at addressing these complaints can strengthen cooperation with the patient by encouraging more regular attendance at check-ups, ultimately leading to improved treatment outcomes. A better understanding of the relationship between chief complaints and periodontal disease stages can guide clinicians in tailoring their approach to enhance patient satisfaction and treatment success. Future multicenter studies with larger, diverse populations and longitudinal designs are needed to better understand the effect of chief complaints on periodontal treatment adherence and outcomes.

Ethical Approval

Ethical approval was obtained from the Necmettin Erbakan University Faculty of Dentistry Non-Drug and Non-Medical Device Research Ethics Committee (Protocol No: 2024/498).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: OB, MD Data collection or access: OB,MD Analysis and comments: OB, FUY, ZTE Literature search: OB, ZTE, FUY, MD Writing: OB.

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Implant Scan Bodies in Digital Dentistry

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ABSTRACT

The traditional impression-taking technique in dentistry has begun to be replaced by digital impression systems with the development of technology. Digital impression technique has many advantages such as ease of standardization, the possibility of creating a virtual patient, easier to store data, accelerating the production process and ensuring more efficient use of time, and increasing patient comfort in patients with taste, smell sensitivity and gag reflex. With this developing impression technique, the impression of the relevant region is transferred indirectly to the digital environment with scanners. Accuracy of impression-making has importance in the successful production of implant-supported prothesis with a digital workflow. In the digital workflow, transfer of implant positions to the virtual environment is provided by implant scan bodies. It is critical to accurately match the image of the implant scan bodies stored in the virtual library of the computer-aided design software with the scan body in digital impression. This process is necessary to virtually determine the position of the implant within the design software. The material and the geometry of the implant scan bodies are some of the parameters that can affect scanning accuracy. In addition, factors such as the tightening torque applied to the scan bodies, the sterilization process, and the number of uses can also affect the sensitivity of the scan. The aim of this article is to present information about implant scan bodies used in digital impression and to examine the effect of the features of implant scan bodies on scanning accuracy.

Dijital Diş Hekimliğinde Kullanılan İmplant Tarama Gövdeleri

Makale Bilgisi

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Anahtar Kelimeler:
Bilgisayar destekli tasarım,
Dental implantlar,
Dental ölçü tekniği.

ÖZET

Diş hekimliğinde geleneksel ölçü alma tekniği, teknolojinin gelişmesiyle beraber yerini dijital ölçü sistemlerine bırakmaya başlamıştır. Dijital ölçü tekniğinin standardizasyon kolaylığı, sanal hasta oluşturabilme imkanı, alınan ölçünün fiziki yer kaplamayıp veri saklamayı kolay hale getirmesi, üretim sürecini hızlandırarak zamanın daha verimli kullanılmasını sağlaması, özellikle tat, koku hassasiyeti ve bulantı refleksi olan hastalarda hasta konforunu arttırma gibi birçok avantajı mevcuttur. Gelişmekte olan bu ölçü alma tekniği sayesinde ilgili bölgeye ait ölçü, tarayıcılar ile direkt ya da indirekt olarak dijital ortama aktarılmaktadır. İmplant destekli protezlerin, dijital iş akışı ile başarılı bir şekilde üretilmesinde doğru ölçü alımı büyük öneme sahiptir. Dijital iş akışında, implant konumlarının sanal ortama aktarılması implant tarama gövdesi adı verilen ara parçalar ile sağlanmaktadır. Bilgisayar destekli tasarım yazılımının sanal kütüphanesindeki implant tarama gövdesinin üç boyutlu görüntüsü, dijital ölçüdeki implant tarama gövdesiyle doğru bir şekilde eşlenmelidir. Bu işlem, implantın konumunu tasarım yazılımı içinde sanal olarak belirlemek için gereklidir. İmplant tarama gövdelerinin hangi materyalden yapıldığı ve geometrik şekli, tarama doğruluğunu etkileyebilen parametrelerden bazılarıdır. Ayrıca tarama gövdelerine uygulanan sıkıştırma tork değeri, sterilizasyon işlemi, kullanım sayısı gibi faktörler de taramanın hassasiyetini etkileyebilmektedir. Bu makalenin amacı dijital ölçüde kullanılan implant tarama gövdeleri hakkındaki güncel bilgileri sunmak ve implant tarama gövdelerine ait özelliklerin tarama doğruluğu üzerindeki etkisini incelemektir.

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INTRODUCTION

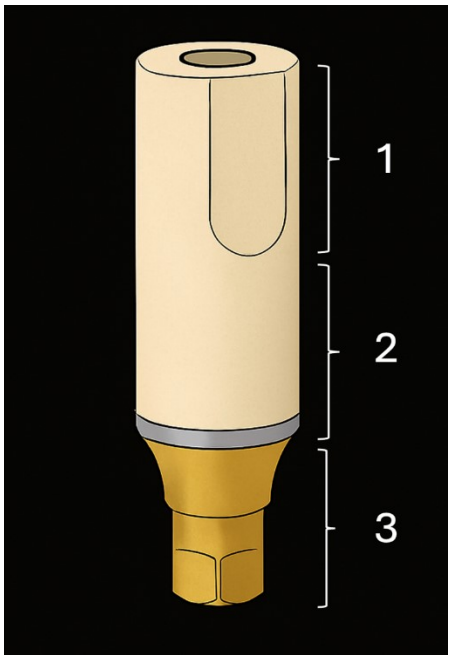
Computer-aided design and computer-aided manufacturing (CAD-CAM) technologies have revolutionized dentistry, with intraoral scanners (IOS) providing an alternative to conventional impressions.[1] Digital impressions can be used for the fabrication of both tooth-supported and implant-supported prostheses (ISP).[2] The virtual model generated from the intraoral scan represents the first step in the digital workflow. Accurate transfer of implant positions to the virtual environment is crucial at this stage.[3] Implant scan bodies (ISB), intermediary components used during digital impression taking, facilitate the transfer of implant positions to the virtual environment.[4] The accuracy of digital impressions is influenced by various ISB characteristics, including connection type, design, dimensions, material, reusability, and compatibility between the scan body surface and the software (Figure 1).[5] Nowadays, most implant manufacturers offer a variety of ISBs to clinicians. While ISBs exhibit variations in design and geometry across brands, they generally consist of three distinct components: the upper scanning area, the middle body section, and the lower base (Figure 2).[5-8] Traditionally, ISBs are connected to the implant body or multi-unit abutment systems. However, recent advancements have introduced multi-purpose ISBs fabricated from biocompatible titanium that can also serve as healing abutment.[9] Understanding the characteristics and scanning implications of ISBs is essential for achieving high-accuracy digital impressions. This review aims to elucidate the fundamental features of ISBs and their roles within the digital workflow.

Scanning and Matching Implant Scan Bodies

In the digital workflow, ISBs are connected to implants or analogs and scanned either intraorally with an IOS or extraorally with a lab scanner. There are also types of ISBs that are not used intraorally but only in the laboratory environment. In CAD software, the real image of the ISB and its copy in the virtual library are matched using reference points, and the implant is positioned in the virtual environment. After this positioning, prosthesis production is started using CAD/CAM technology.[6,10,11]

Figure 1: Scanbodies from different brands with varying geometries and materials.

Figure 2: On the implant scan body , the component designated as '1' is the 'scanning region', component '2' is the 'body', and component '3' is the 'base'.



Another option for transferring ISB positions to the digital environment is photogrammetry devices. Photogrammetry systems are a new system that can be used to take full-arch digital implant impressions.[12-14] Photogrammetry technology is designed to determine the positions of three-dimensional objects from two-dimensional images. ISBs produced for IOS differ from scan bodies produced for photogrammetry systems. Photogrammetry scan bodies are specific to each photogrammetry system and are coded with targets that allow the scanner to correctly determine the position of the implant by converting multiple images. These ISBs can be in the shape of a flag or a rectangular prism. Scan bodies with optical points are usually produced using a contrasting black and white color scheme and these special ISBs are biocompatible, sterilizable and have high dimensional stability.[15,16] These ISBs, combined with a series of two-dimensional photographs taken with extraoral cameras, are used to digitize intraoral implant positions and to produce multi-unit ISPs.[17]

IOS can only capture a portion of the object at a time. They capture raw data in the form of a series of photographs or videos that are then overlapped and merged to create a 3D representation of the digitized surface.[6] The accurate merging of the captured data is primarily dependent on the reference points in the scanned area. Scanning accuracy is affected by the increasing distance between implants. Scans performed on long implant-to-implant distances, such as 40-50 millimeters (mm), have lower accuracy compared to scans performed on shorter distances, such as 6-18 mm.[18] To facilitate scanning in cases with long edentulous spaces and insufficient reference points, additional reference points can be added to the area to be scanned. The scanning area plays a crucial role in transferring the implant position to the virtual environment. A matte, smooth, and opaque surface in this area will facilitate scanning compared to shiny, rough, or translucent surfaces.[19-21] In addition to the surface characteristics, the width and length of the ISB also affect scanning ease. A narrow ISB can make scanning easier in cases with limited interproximal space, while a short ISB can facilitate scanning in patients with complete edentation.[22]

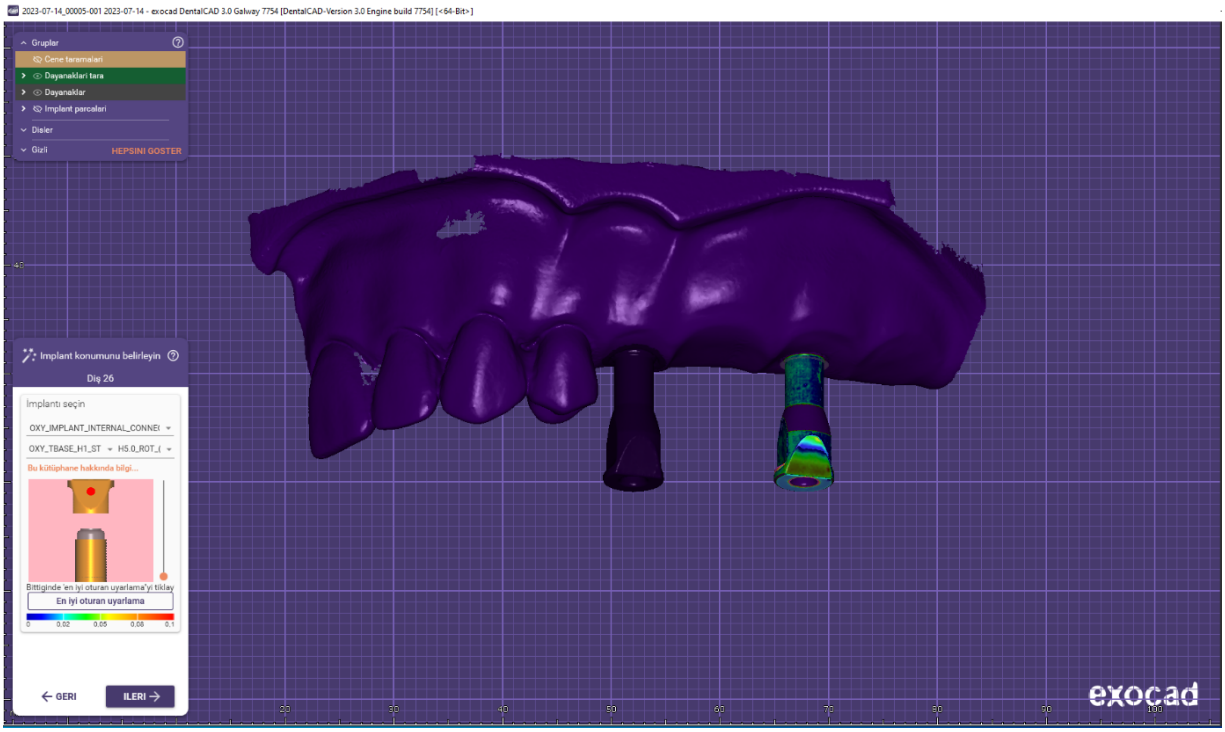
Surfaces that are more difficult to scan include perpendicular, sharp, deep, angled, or complex surfaces and can lead to the generation of less accurate scan data. These difficult-to-scan areas can create missing areas in the scan image.[6] In order to accurately transfer the implant position during digital impression, the ISB must be scanned with less than 10% surface defects.[23] A study found that as the unscannable area in ISB scanning increased, the linear and angular deviations in the implant position transferred to the software increased proportionally. A 15% ISB scan image deficiency caused greater deviations than 5% and 10% deficiencies. The greater the deficiency in the ISB's scan image, the higher

the probability that the produced prosthesis will be ill-fitting.[23]

The heights of the scanned portions of the ISBs are another parameter that can affect scanning accuracy. In a study, ISBs were embedded in a model at 0.5 millimeters (mm), 1.0 mm, 1.5 mm, 2.0 mm, and 2.5 mm. Digital impressions were taken, ISB matching was performed in the software, and impression accuracy was calculated. In the study, the ISBs were embedded in the model in different amounts to mimic the variation in the gingival level surrounding the ISBs in the patient's mouth. As the height of the gingival tissue around the implant increases, the amount of scanned area of the ISB decreases. This situation is effective in the correct performance of the ISB matching and virtual implant positioning stage Burying the ISB more than 1.0 mm into soft tissue can lead to the production of an ill-fitting restoration.[24] Another study reported that partially visible ISBs exhibited significantly higher angular deviations than fully visible ISBs and recommended the use of longer ISBs when scanning deeply placed implants.[25] However, other studies on this topic have not found significant deviations related to implant placement depth.[26-28]

Alignment of ISBs from the digital library and the scan acquired with IOS is performed using the best-fit algorithm based on reference points in the same region. Accurate alignment is essential for a surface matching algorithm to align correctly. It is crucial for the software user to verify this alignment using a color map and manually adjust the overlay if necessary (Figure 3). Errors at this step can lead to clinically unacceptable results.[6,29-31] A study found that a one-point reference matching method resulted in more matching errors than a three-point reference matching method.[32]

Figure 3: The verification of matched scanbodies in CAD software through color map.



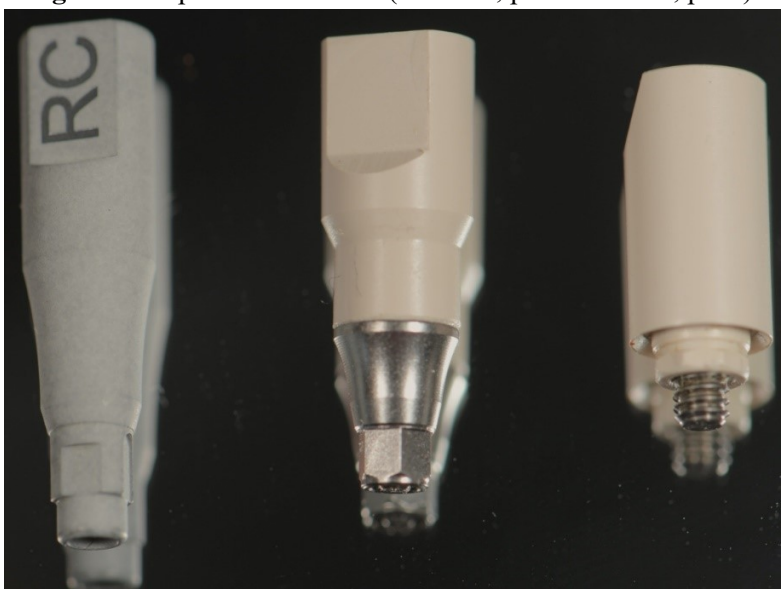
Material and Geometry of Implant Scan Bodies

The material, length, width, shape, and surface quality of ISBs can significantly affect the ISB matching process in CAD software, potentially leading to the recording of incorrect implant positions.[33] The majority of ISBs are made from two different materials,

polyetheretherketone (PEEK) and titanium, but they can also be made from aluminum alloys and various resins.[3] They can also be one or two-piece, single-use or multiple-use, screw-retained or friction-fit, radiolucent or radiopaque, sandblasted or coated, long or short, wide or narrow.[34] These differences can play a role in the accuracy of digital impression.[7,35,36]

The surface properties of the material used in the scanning area can affect the optical digital detection of the IOS, while the base material can affect the wear resistance of the ISB during screwing onto the implant, especially during re-use.[19,37] While titanium ISBs have the advantages of being made from a durable material, being reusable, and being autoclavable, they also have the disadvantage of reflecting light. This can make intraoral scanning difficult. In hybrid ISBs, the part that connects to the implant body is made of titanium, while the scanning area is made of PEEK, which makes scanning easier than with titanium because it does not reflect light. However, the connection between the titanium base and the PEEK superstructure can lead to some scanning problems. The research findings highlight that using ISBs made of PEEK leads to more accurate scanning results (Figure 4).[37]

Figure 4. Implant scan bodies (titanium, peek-titanium, peek).



In a study, ISBs were produced using three-dimensional printers employing stereolithography (SLA) and digital light processing (DLP) technologies, and their accuracy was compared with that of original ISBs. The original ISBs provided more accurate results than those produced using SLA and DLP technologies. While DLP technology offers a sensitivity comparable to that of original ISBs, the use of ISBs produced from three-dimensional printers requires further investigation.[38] Another aspect requiring attention in the study is the ISB attachment system. The impact of different ISB attachment systems, such as screw-retained, snap-on, and magnetic attachments, on scanning accuracy remains unknown due to the lack of research in the literature.[1]

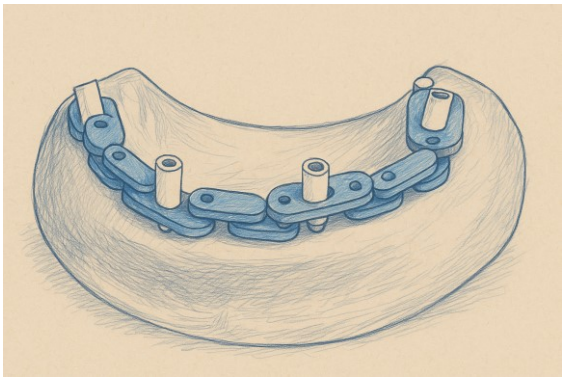
Numerous studies in the literature have indicated that the geometry of ISBs also affects accuracy of digital impression.[9,39,40] It is investigated that a short and simply designed ISB may perform better in terms of both scanning time and scanning accuracy.[22] Some researchers have suggested that ISB design should feature well-rounded borders and asymmetrically shaped flat surfaces.[40] Most manufactured ISBs are single-piece cylindrical or conical designs, often lacking similarity to

the natural tooth's emergence profile.[6] Furthermore, in the presence of thick mucosa, it may be challenging to correctly position the ISB over an implant placed in a deep position, and in such cases, the repeated removal and placement of the healing abutment may pose a risk to the integrity of the soft tissues surrounding the implant.[6] A solution for this soft tissue challenge is offered through a combined scanning piece system. This system integrates a healing abutment and an ISB, which is connected to the screw access hole of the healing abutment and defined in the digital library. The combined healing abutment system allows simultaneous acquisition of the implant position and soft tissues, reducing the number of appointments required for delivering the final restoration and making the digital impression process easier by minimizing soft tissue trauma caused by the attachment and removal of the healing abutment. Additionally, the potential soft tissue collapse during the removal of a special healing abutment used to anatomically shape the soft tissues around the implant or during the removal of a temporary prosthesis is eliminated.[41-44]

ISBs typically consist of one or more scannable regions designed to optimize scanning.[45] Regardless of the brand, many ISBs feature an asymmetrical design on one side, making it easier for the CAD software to detect them.[6] The placement of the matching surface in the CAD software on the ISB, whether facing buccal, lingual, or other areas within the oral cavity, remains uncertain regarding its impact on scanning accuracy. However, a study revealed that positioning the reference point of the ISB on the lingual side significantly yielded higher accuracy compared to placement on the buccal, mesial, distal, or random locations.[46]

Extensional structures on ISBs have the potential to increase scanning accuracy by providing additional reference points for the matching procedure, although sharp shapes can lead to optical noise and scanning errors.[39,47,48] Studies on the added extensional structures aimed at enhancing scanning accuracy have yielded controversial results, and their impact has not been fully established.[49] In some studies, auxiliary geometry parts have been added to ISBs to facilitate scanning during full-arch digital impressions of the edentulous maxilla, and these auxiliary parts have been shown to improve accuracy of digital impression.[49,50] Cases with long edentulous spaces between implants challenges for maintaining scanning continuity. Particularly in the mandible, where soft tissues are mobile, problems arise with image matching and merging due to insufficient common data capture. When inadequate common data are acquired, IOS software may encounter difficulties in matching and merging newly acquired data.[6,7,51] Certain studies have been conducted to facilitate scanning continuity by adding characteristic reference points on the ISBs. These reference points can be created by adding rigid extension pieces onto ISBs. It has been observed that rigid pieces can significantly enhance scanning accuracy and minimize cumulative errors arising from software merging processes.[47] To enhance scanning accuracy, the effect of splinting ISBs using dental floss or thermoplastic resin, apart from rigid extension pieces, is being investigated.[52] In a study, it was demonstrated that connecting dental floss between ISBs creates angular and linear deviations, thereby reducing impression accuracy.[22] For full arch digital impressions, it has been observed that splinting ISBs with chains produced by three-dimensional printers, especially in posterior implant positions, reduces linear and angular deviations (Figure 5).[53]

Figure 5. Schematic illustration of a model with implant scan body splinting.



In the literature, it is observed that ISB splinting studies are generally conducted in vitro. The aim of a retrospective clinical study conducted in vivo is to present clinical outcomes obtained with an intraoral scanning technique called the "Continuous Scanning Strategy", which relies on splinting ISBs through thermoplastic resin. With this splinting technique, the distance between ISBs will be reduced, and the occurrence of missing reference points during scanning, leading to jumps, will be prevented. In the study, a total of 45 zirconia-based ISPs were produced for 40 patients using a complete digital workflow, including 10 partial fixed ISPs and 35 full arch ISPs. After a two-year follow-up, the implant survival rate was 100%, prosthetic success rate was 93.3%, and complication rate was 6.7%. Considering these values, the use of the "Continuous Scanning Strategy" technique appears suitable for the production of implant-supported restorations in cases lacking sufficient reference points for scanning. However, longer-term follow-up studies are needed due to the short follow-up period of the study.[54]

Tightening Torque Value, Sterilization and Reuse

Regardless of the material they are made of, ISBs are typically placed by screwing them onto the implant body before scanning; however, vertical displacement in ISBs may occur due to wear on rough surfaces during screw tightening.[6,55] A study was conducted to investigate the effect of tightening torque values, sterilization, and their combination on the accuracy of PEEK ISBs. The study found that autoclave sterilization caused some deformation on the surface of ISBs. However, repeatedly reconnecting and disconnecting ISBs under a tightening torque value of 15 Newton centimeters (Ncm) did not make a significant difference. From a clinical perspective, one of the outputs of the study is the information that sterilization can be applied to PEEK ISBs before reuse.[56] It should be noted that deformation resulting from the high tightening torque value when screwing a single-piece PEEK ISB can lead to vertical displacement. Following the tightening torque values recommended by manufacturers is essential.[11]

A study in literature applied tightening torques of 5 Ncm, 10 Ncm, and hand force to varied brands of ISBs and examined the displacement amounts of ISBs. It was reported that at 5 Ncm and 10 Ncm torque, displacements were below 100 micrometers (μm), while in most groups where hand force was applied, displacements larger than 100 μm were observed. As a result, it is recommended to apply a torque of 5 Ncm using a ratchet instead of hand force when tightening ISBs.[57]

ISBs commonly used in clinical practice are usually not disposable. While there are studies on the reuse of implant components, the effect of repeated use of ISBs on scanning accuracy has not been sufficiently investigated. In a study evaluating the reuse of implant impression posts and ISBs, it was recommended to apply sterilization procedures before their reuse. Despite the expected deformation of PEEK ISBs due to reuse and sterilization, it was observed to perform better than titanium ISBs after 10 cycles of reuse.[58,59] In some studies, it has been reported that PEEK material is adversely affected by the sterilization process, with PEEK shrinking in size after repeated

autoclave sterilization cycles.[60,61] This potential dimensional instability limits the repeated use of PEEK ISBs.

The results of the study, which examined the linear displacements occurring in ISBs during screw tightening using digital image correlation analysis, can be summarized as follows: Single-piece titanium ISBs may be preferred over single-piece PEEK ISBs for less linear displacement. Tightening torque of 15 Ncm is not recommended as it increases the displacement of the tested PEEK ISBs. Tightening torque values of 10 Ncm or lower can be applied in clinical practice, but it should be noted that even a tightening torque of 10 Ncm can cause mesiodistal displacement in PEEK ISBs. It is recommended not to reuse PEEK ISBs that have undergone multiple sterilization cycles due to the possibility of causing displacement during screw tightening.[62]

It should be noted that repeated use and sterilization of ISBs, leading to wear and dimensional changes, can result in digital impression errors and incorrect positioning of implants in the digital environment.

CONCLUSION

For the successful production of implant-supported prostheses, it is crucial to transfer implant positions to CAD software with a high degree of precision and accuracy using digital impression. Thorough understanding of the characteristics of ISBs, which enable the transfer of implant positions to the virtual environment, will contribute to preventing errors that may occur during scanning. To produce a well-fitting prosthetic restoration, it is essential to be familiar with the material properties of the ISBs being used, follow the guidelines for usage provided by the manufacturer and carefully consider the scanning considerations during the scanning of the components. A standardized approach to ISBs is essential to reduce inaccuracies in impressions and increase the precision of digital dental models, ultimately leading to more predictable prosthetic outcomes. A global consensus on this matter could substantially elevate the quality of clinical outcomes.

Ethical Approval

An ethics statement was not required for this study type and no human or animal subjects or materials were used.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: DBA, Data collection or access: DBA, Analysis and comments: DBA, AAE, Literature search:DBA, AAE, Writing: DBA, AAE.

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Management of Acute Maxillary Sinusitis After Sinus Augmentation Procedure; A Case Report

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ABSTRACT

In cases of long-term tooth loss, the development of atrophy in the posterior maxilla can present substantial challenges during implant surgery. One common surgical approach employed to address this issue is sinus floor elevation surgery, which facilitates the placement of dental implants in atrophic maxillary regions. While sinus floor elevation surgery is generally regarded as a safe procedure, it is noteworthy that various complications have been documented both intraoperatively and in the postoperative period. This particular case report pertains to a patient who underwent external sinus floor elevation with simultaneous graft placement and implant surgery in the posterior maxilla, resulting in the onset of a sinus infection and its subsequent management. Remarkably, the patient's sinus infection was treated through medication means without necessitating further surgical intervention. The implant treatment proceeded successfully and reached completion. As a result, the surgeon should possess sufficient knowledge in the management of infections. In some cases, initiating treatment directly invasively with the idea of removing the etiological source may be unnecessary, while in others, aggressive treatment may be indicated. Accurate identification of the etiological source and the appropriate choice of treatment are crucial in combating infections. This way, the patient is protected from potential unsuccessful outcomes or unnecessary surgical procedures resulting from incomplete treatment.

Sinüs Ogmentasyonu Sonrasında Oluşan Akut Maksiller Sinüzit Tablosunun Yönetimi; Olgu Sunumu

Makale Bilgisi

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Antibiyotik tedavisi.

ÖZET

Uzun süreli dişsizlik durumlarında, maksillanın posterior bölgesinde gelişen atrofi, implant cerrahisi sırasında önemli zorluklar oluşturabilir. Sinüs tabanı yükseltme operasyonu, atrofik maksillada implant yerleştirilebilmesine olanak sağlayan, sık kullanılan cerrahi yöntemlerden biridir. Sinüs tabanı yükseltme cerrahisi genellikle güvenli bir prosedür olarak kabul edilse de, ameliyat sırasında ve sonrasında çeşitli komplikasyonlar görülebilir. Bu özel vaka raporu, eksternal sinüs tabanı yükseltme işlemi ile aynı anda implant cerrahisi yapılan bir hastada gelişmiş postoperatif akut sinüzit tablosunu ve vaka yönetimini anlatmaktadır. Dikkat çekici bir şekilde, hastanın sinüs enfeksiyonu, ek bir cerrahi müdahale gerektirmeksizin sadece ilaç verilerek tedavi edilmiş ve implantasyon başarıyla tamamlanmıştır. Sonuç olarak; cerrah, enfeksiyon yönetimi konusunda yeterli bilgi sahibi olmalıdır. Bazı vakalarda etiyolojik kaynağın kaldırılması düşüncesiyle, tedaviye direkt invaziv şekilde başlamak gereksiz olabilirken bazılarında agresif tedavi endike olabilir. Enfeksiyonla mücadelede etiyolojik kaynağın doğru belirlenmesi ve doğru tedavi seçimi oldukça önemlidir. Böylelikle hasta eksik tedavi sonucu yaşanacak başarısız sonuçtan veya gereksiz cerrahi işlemlerden korunmuş olur.

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INTRODUCTION

The loss of maxillary molars leads to bone atrophy in this region, and the downward shift of sinus pneumatization is induced by respiratory pressure.[1] The bone quality in this area is often weaker, typically classified as type IV, compared to other regions.[2] Therefore, surgical procedures such as maxillary sinus floor elevation and/or grafting may be necessary when placing implants in the maxillary posterior region.[3]

The sinus floor elevation procedure aims to create a "submucoperiosteal pocket" for the placement of a graft consisting of autograft, allograft, or alloplastic material at the base of the maxillary sinus.[4] In the literature, there are two main approaches for this procedure: the lateral window technique (external sinus lift) and the osteotome technique (internal sinus lift).[5] The internal sinus lift technique is considered a less invasive method to increase bone volume in the posterior maxilla. It yields optimal results when minimal gain in bone height is required, and there is sufficient bone for implant stabilization. This technique not only elevates the sinus but also compresses the bone laterally using osteotomes of increasing diameters.[6] On the other hand, the external sinus lift technique renders the atrophic maxilla more conducive to additional bone augmentation but necessitates larger surgical access.[7] Although sinus lift operations are relatively safe, various complications may arise during this process.[8,9] Following maxillary sinus lift surgery, complications such as acute maxillary sinusitis,[10] flap dehiscence,[11] and perforation of the Schneiderian membrane [12] can occur. These complications may lead to the spread of graft material within the sinus cavity.[13]

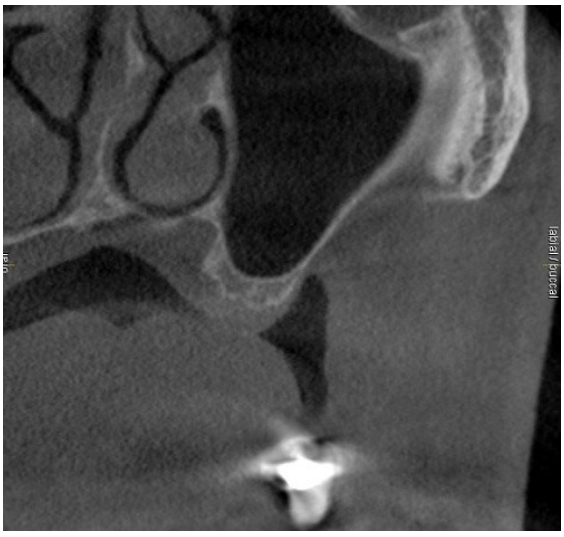
Implants placed in the region through maxillary sinus lift surgery may be unsuccessful due to infected maxillary sinuses, even if no complications occur during surgery.[14] Therefore, dental implants should be closely monitored post-surgery. Early diagnosis and treatment of maxillary sinusitis that develops after implant placement are crucial for the success of the implant.[14]

In this study, the occurrence of maxillary sinus infection following simultaneous dental implant placement with maxillary sinus lift and its treatment are described.

CASE REPORT

A sixty-four-year-old male patient, systemically healthy, was referred to our clinic for implant-supported prosthetic restoration. In the intraoral examination, bilateral edentulous spaces were identified in the maxillary posterior regions. Following consultation with the prosthodontic department, it was deemed appropriate to place implants in the teeth regions numbered 13, 14, 16, 24, 25, and 27. Preoperative cone-beam computed tomography (CBCT) examination revealed radiolucent images of the maxillary sinuses, indicating no signs of infection or other sinus pathologies (Figure 1). Due to insufficient vertical bone height in the patient's left maxillary posterior region, it was planned to perform an external sinus lift operation and simultaneously place implants in the same area. Informed consent form was obtained from the patient.

Figure 1. Healthy sinus appearance in preoperative CBCT image.



The surgical procedure was performed under local anesthesia. In the edentulous area, a flap was prepared with horizontal incisions over the crest and vertical incisions in the posterior region. Using a piezoelectric surgical motor, a window was created in the external wall of the maxillary sinus. The buccal bone wall was left on the membrane, and the sinus membrane was elevated. Following elevation, the sinus membrane was carefully preserved, and the implantation drilling process was completed. Maxillary sinus agumentation was planned to be performed using a mixture of allograft and Injectable Platelet Rich Fibrin (i-PRF). To prepare i-PRF (Injectable Platelet-Rich Fibrin), two tubes of venous blood were collected. Anticoagulant-free tubes were placed in the centrifuge. When the centrifugation process was completed (1500 rpm, 7 minutes), the top platelet-rich part of the plasma layers in the tube was carefully collected. The prepared i-PRF was mixed with the allograft material (Maxxeus, Solvita, Dayton, Ohio). A portion of allograft material, enriched with i-PRF, was then placed in the bone void at the base of the sinus. Subsequently, the planned implant (4,1,10; Bilimplant, Turkey) for region 27 was inserted into the prepared area, achieving primary stability. The remaining graft material was adapted to the area without leaving any gaps. A resorbable collagen membrane (Collagene AT®, Italy) was placed over the grafted area. Two dental implants (both 4,1,10; Bilimplant, Turkey) was placed in the 24 and 25 tooth regions. The flap was primarily closed without tension. Postoperatively, the patient was prescribed antibiotics (1000 mg Amoxicillin + Clavulanate, twice daily), non-steroidal anti-inflammatory medication (25 mg dexketoprofen, twice daily), chlorhexidine-containing mouthwash (three times daily), and an antihistamine (1 mg cetirizine dihydrochloride, once daily).

At the one-week follow-up, the sutures were removed, and no complications were observed in the surgical area. Three days after suture removal, the patient presented to the clinic with extensive swelling and intense pain in the left buccal region. Intraoral examination revealed purulent drainage in the area where external sinus lift and implant placement were performed. CBCT images showed that the graft material remained stable in the implanted area without spreading within the sinus, and there was a filling extending to the ostium (Figure 2, 3). A preliminary diagnosis of sinusitis was made.

Figure 2. CBCT image of infected sinus and graft material on the 10th day after the operation.

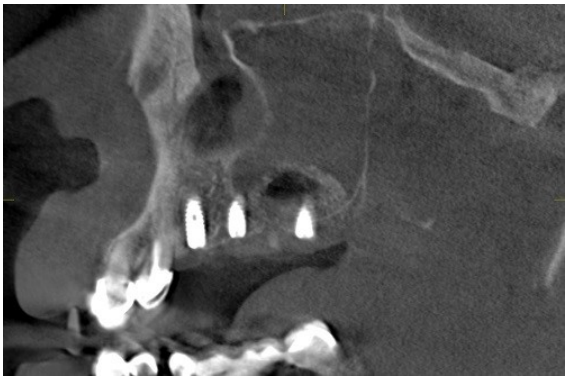
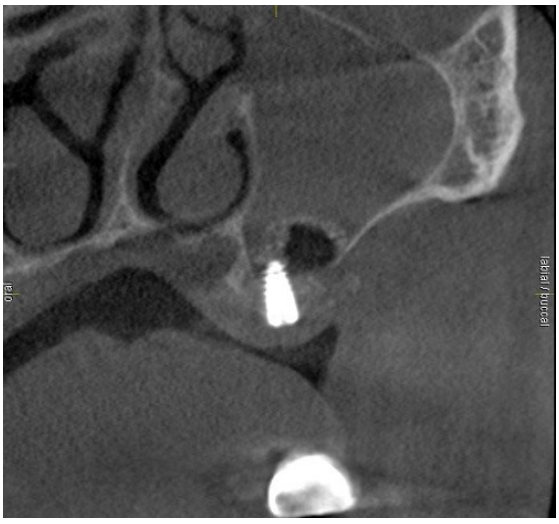


Figure 3. CBCT image of infected sinus and graft material on the 10th day after the operation.



The region with intraoral purulent drainage was irrigated with a mixture of 1/5 povidone-iodine and saline solution. The patient was started on combined antibiotic

therapy (Amoxicillin + Clavulanate 1000 mg, twice daily, and Metronidazole 500 mg, twice daily). Improvement in the patient's symptoms was observed after one week. Antibiotic treatment continued for an additional two weeks.

CBCT images taken at the 4th postoperative week showed a healthy sinus and graft material (Figure 4, 5). The patient was periodically called for follow-up appointments to monitor the possibility of recurrent infection.

Figure 4. CBCT image of healing maxillary sinus and graft material on the 4th postoperative week

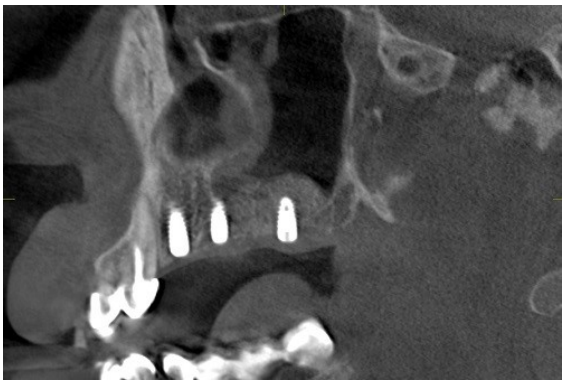


Figure 5: CBCT image of healing maxillary sinus and graft material on the 4th postoperative week.

At the end of the 4th postoperative month, healing abutments were placed on the implants. No bone loss was observed in the intraoral and radiographic examinations.

DISCUSSION

Sinus elevation procedures may lead to various complications, which can occur before treatment, during surgery, immediately after surgery, before implant loading, after implant loading, and even many years later.[15] The most common postoperative complication after sinus lift surgery is sinusitis.[16,17] Postoperative infection can develop in two different ways: directly as a sinus infection or by infecting the implanted implant or graft material. The probability of graft material becoming infected during the postoperative period is higher than the likelihood of direct sinus infection.[18] It is important to realize that the placed graft is not inside the sinus but is located beneath the elevated sinus membrane. Therefore, the term "subantral augmentation" is used.[19,20] While direct sinus infections are less common, they can lead to more widespread consequences, such as pansinusitis cases, and pose a greater risk of serious complications like cavernous sinus thrombosis due to their proximity to many vital structures.[21,22] This situation requires aggressive treatment.[15] In our case, infection developed due to the graft material and led to sinusitis. Thanks to early intervention and regular follow-up, the infection was controlled with medical treatment without the need for aggressive therapy.

The use of autologous blood products such as PRF is one of the most effective methods to increase the concentration of growth factors at the site of bone regeneration.[23] Growth factors are a group of protein molecules that are crucial in the healing of injuries by promoting angiogenesis, cell proliferation, and differentiation.[23] Leukocytes and cytokines present in PRF can induce antimicrobial activity and immune regulation at the regeneration site. Angiogenesis, the immune/inflammatory response, circulating stem cells, and the formation of epithelial tissue over the wound are all pivotal factors in tissue healing.[24] This

process is profoundly influenced by PRF, which facilitates earlier wound healing, accelerates scar tissue remodeling, and leads to significant reductions in postoperative infections.[25] The combination of these properties has contributed to the increasing popularity and wide use of PRF in oral surgery.[26] Zahedi et al.[27] compared the combination of FDBA (freeze-dried bone allograft) + i-PRF with the use of FDBA alone and showed that there was less connective tissue in the bone formed in the FDBA + i-PRF group, indicating a more favourable healing environment and potentially promoting better bone regeneration outcomes. In the present case, allograft and i-PRF material were mixed considering all these features.

It has been shown that patients with a preoperative history of sinusitis are more prone to postoperative sinus infection. Testori et al.[28] reported that failure to accurately diagnose pre-existing chronic sinusitis before sinus augmentation surgery could lead to acute graft infection. The patient presented in this case report did not have a preoperative history of sinusitis. Factors such as membrane tears during surgery, contamination of the material used with saliva, wound exposure, inadequate aseptic technique, and poor oral hygiene of the patient can trigger graft infection.[21] Symptoms of graft infection include tenderness, oroantral fistulization, suppuration, severe pain in the maxillary sinus area, swelling in the region, abscess, fever, and loss of graft particles through fistulous pathways.[29] Similar to these symptoms, the patient in our case had extraoral swelling, redness, pain in the left buccal region, and intense purulent drainage in the grafted area.

Precautions to reduce the incidence of sinus infection should be strictly followed. Poor aseptic technique is a major cause of acute sinusitis after sinus augmentation procedures. Care should be taken to minimize the risk of membrane perforation during sinus membrane elevation, avoiding the placement of implants into the sinus, and maintaining a strictly aseptic surgical field. Scarano et al.[30] randomly assigned 30 cases into two groups, which were given the lateral window technique respectively by traditional rotary instruments or piezoelectric tools, finding a significantly higher perforation rate in the rotary instrument group. Piezoelectric tools conduct osteotomy by low-frequency ultrasonic vibration, allowing precise removal of bone tissue without injuring soft tissue like the sinus membrane.[31] In a recent meta-analysis, the perforation rate of traditional instruments was estimated to be 24%, while that of piezoelectric tools was 8%, with statistical significance ($p<0.05$), which proves that the application of piezoelectric tools could reduce the risk of perforation.[32] In the present case, piezoelectric surgery was used to reduce the risk of sinus perforation. Saliva contamination creates a suitable environment for bacteria and sinusitis infection.[15] Depending on the wound healing condition, sutures are usually removed around one week after surgery, and a second appointment for control purposes is planned in the second week postoperatively to monitor the potential risk of infection. Generally, if no infection is observed within the first two weeks, the likelihood of later infection is relatively low.[33] Surgeons should have sufficient knowledge of infection management. Determining the etiological source will be crucial in choosing the treatment protocol.

In the case of postoperative sinusitis development, if necessary, CBCT or CT scans should be performed initially to assess the severity of sinusitis. The treatment protocol for acute sinusitis typically includes the use of broad-spectrum antibiotics, endoscopic sinus examination, sinus surgery, and/or sinus lavage. Amoxicillin or amoxicillin + clavulanic acid is usually prescribed as antibiotics, and nasal decongestants are utilized for the continuation of ostium patency and ensuring sinus

drainage.[34,35] Hernandez et al.[36] showed in their systematic review that antibiotic treatment had a small but significant reduction in the risk of treatment failure in patients with acute maxillary sinusitis. Postoperative infections that can be managed solely with pharmacological treatment are well-defined graft infections limited below the sinus membrane.[19] However, if the infection has progressed, graft removal may be necessary. If the graft provides a well-defined CBCT image under the Schneiderian membrane but symptoms persist for more than 3 weeks and additional symptoms (tenderness, nasal congestion, pain, fistulization, purulent discharge from the nose and throat, flap opening, and suppuration) are present, partial or complete removal of the graft, in addition to pharmacological treatment, is recommended.[19] If the graft is not well-defined under the sinus membrane and graft material is present inside the sinus, a multidisciplinary approach is required to manage the complication. Functional endoscopic sinus surgery (FESS) and an oral approach for the removal of the graft and dental implants may be suggested.[37] In our case, 3 weeks of combined antibiotic use proved to be sufficient for treatment. The source of the complication was accurately identified, and treatment steps were applied in the appropriate sequence. As a result, the patient was treated without the need for additional surgical procedures (removal of the graft and implant and sinus lavage).

CONCLUSION

The risk of developing maxillary sinusitis should always be considered after an external sinus lift operation. In cases where maxillary sinusitis develops, early diagnosis and the appropriate treatment approach can lead to a successful outcome without causing graft and implant loss. Careful clinical and radiographic evaluation before and after the external sinus lift procedure is crucial for the success of the operation.

Ethical Approval

Ethics committee approval was not required for this case report. Written informed consent was obtained from the patient for publication of this case and any accompanying images.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: EAS, Analysis and comments: EAS, BB, Literature search: EAS, BB, Writing: EAS.

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