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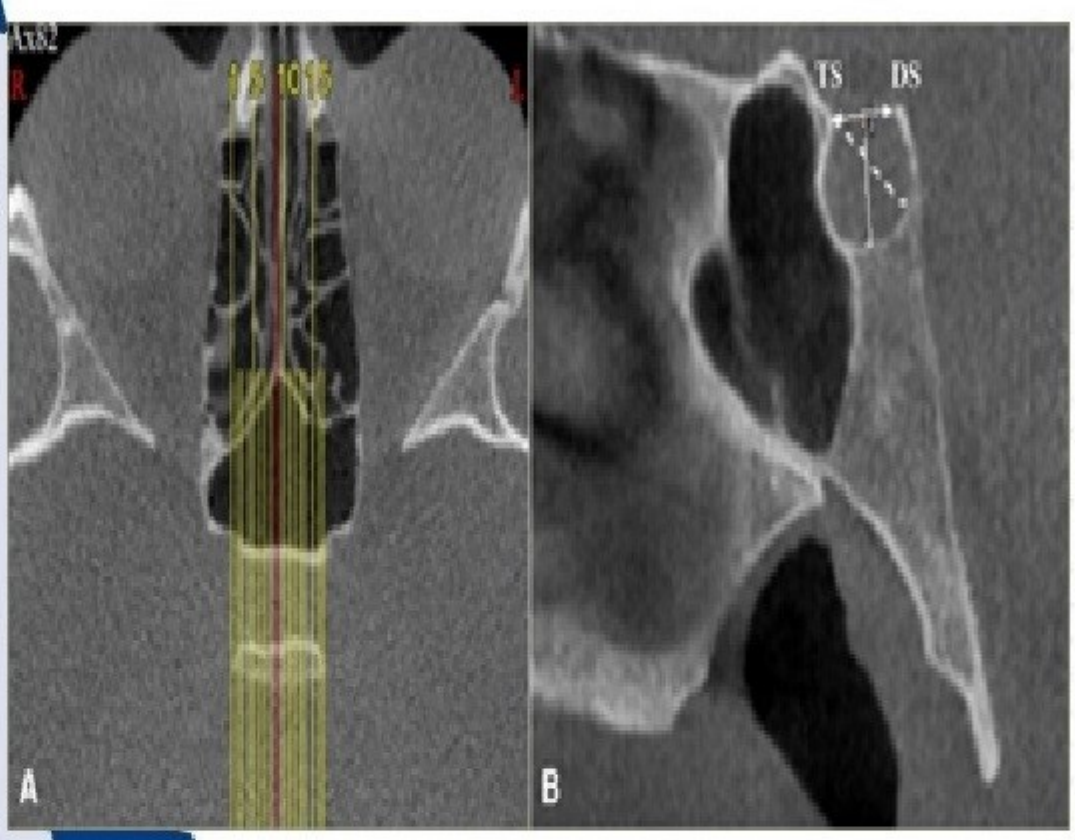

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Aims and Scope

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Comparison of Clinical and Radiographic Healing of Periapical Lesions Using MTA or Conventional Filling Materials: Randomized Controlled Clinical Trial

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Research Article

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ABSTRACT

Objectives: To compare the effect of Mineral Trioxide Aggregate (MTA) versus conventional filling materials on the healing of teeth with periapical lesions.

Materials and methods: Sixty-four teeth with periapical lesions of greater than 5 mm were divided into two groups; G1) MTA (ProRoot MTA; Dentsply Maillefer, Ballaigues, Switzerland) filling, G2) conventional filling materials (n = 32/group). In MTA group, the apical portion of the root canal was filled with ProRoot MTA and the middle and coronal thirds of the root canal were filled with injectable thermoplasticized gutta-percha system. Patients were followed for 15 months. The data were statistically analyzed with Mann-Whitney U and chi-square test.

Results: With a follow-up rate of 89.06% of all patients for 15 months, favorable outcomes were obtained in 100% in ProRoot MTA and 83.3% in conventional technique.

Conclusions: ProRoot MTA showed better results compared to conventional filling materials in teeth with periapical radiolucency.

Keywords: Apical Periodontitis, Necrotic Tooth, MTA, Filling, Large Periapical Lesion.

Periapikal Lezyonların Klinik ve Radyografik İyileşmesinde MTA veya Konvansiyonel Dolgu Materyallerinin Karşılaştırılması: Randomize Kontrollü Klinik Çalışma

Süreç

Geliş: 02/01/2023
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ÖZ

Amaç: Bu çalışmanın amacı, periapikal lezyonlu dişlerin iyileşmesinde Mineral Trioksit Agregat (MTA) ve geleneksel dolgu materyallerinin etkisini karşılaştırmaktır.

Gereç ve Yöntemler: Periapikal lezyonu 5 mm'den büyük olan 64 diş iki gruba ayrıldı; G1) MTA (ProRoot MTA; Dentsply Maillefer, Ballaigues, İsviçre) G2) geleneksel dolgu materyalleri (n = 32/grup). MTA grubunda kök kanalının apikal kısmı ProRoot MTA ile dolduruldu ve kök kanalının orta ve koronal üçte birlik kısmı sıcak gutta perka tekniği ile dolduruldu. Hastalar 15 ay boyunca takip edildi. Veriler Mann-Whitney U ve ki-kare testi ile istatistiksel olarak analiz edildi.

Bulgular: 15 ay sonunda hastaların %89.06'lık takip oranı ile ProRoot MTA'da %100 ve geleneksel dolgu materyallerinde %83,3 başarı elde edildi.

Sonuçlar: ProRoot MTA, periapikal radyolüsensli dişlerde geleneksel dolgu materyallerine kıyasla daha iyi sonuç göstermiştir.

Anahtar Kelimeler: Apikal Periodontitis, Nekrotik Diş, MTA, Dolgu, Büyük Periapikal Lezyon.

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Introduction

Root canal infection is of great effect in the pathogenesis of periapical lesions (PL).[1,2] Root canal infection pursues a natural path in the apical direction, reaches periapical tissues cause inflammation or even destruction of periapical structures.[3] In the management of periapical pathology of endodontic origin, it is important to eliminate bacteria from the root canal system and to prevent re-infection.[4] Therefore, chemo mechanical preparation and obturation of the root canal are important steps for periapical healing by eliminating bacteria and bacterial toxins and preventing their spread.[5]

Since the filling material is in contact with the periodontal tissue, its biocompatibility is substantial.[6] It has been shown that Mineral Trioxide Aggregate (MTA) cement has better biocompatibility and sealing ability compared to conventional filling materials.[7,8] It is an important advantage of MTA that contact of the set MTA with water results in the release of calcium hydroxide as a reaction product without any dissolution of MTA.[9] In one study, apical plug with MTA was applied to 22 immature teeth with PL and it was reported that the clinical success rate accounnts for 95.5%.[10] In another study, MTA and conventional filling materials were compared in mature teeth with chronic apical abscess. Although there were no statistical differences between them, it was shown that MTA is better at the single-visit endodontic treatment.[4]

The aim of this study was to compare ProRoot MTA with conventional filling materials on the healing of PL. The null hypothesis was that there were no significant differences between groups in terms of periapical healing.

Materials and Methods

Current study was planned as a randomized controlled two-armed parallel clinical trial. In this clinical trial, the Preferred Reporting Items for Randomized Trials in Endodontics 2020 guidelines were followed[11,12]. The patients were distributed into two groups using a web site (www.randomizer.org). Randomization, treatment procedures, and data analysis were all done by different blind researchers. Also, the patient was blinded to the treatment group. The Research Ethics Board of University A (no.20/17) and Thai Clinical Trials Registry (no. TCTR20170328001) approved the study protocol.

The G*Power 3.1 software (Heinrich-Heine, Dusseldorf, Germany) was performed to conduct a minimum sample size calculation, considering a type I error (alpha) of 0.05, power (1-beta) of 0.95, and an effect size of 1.0997. The calculated minimum sample size required was a minimum of 27 patients per group. In order to strengthen the statistical power of the study and account for potential patient attrition, each group enrolled 32 patients.

Patients Selection

The inclusion criteria

- healthy patients aged ≥18,
- patient having non-vital single rooted teeth and one root canal with mature apice
- teeth with a periapical lesion score of ≥ 3 according to Ørstavik *et al.*'s[13] classification.

The exclusion criteria

- patients with presence of any systematic disease/allergic reaction,
- patients with smoking habit,
- pregnant females,
- teeth with sinus tract, swelling, palpation,
- teeth with previous root canal treatment,
- teeth with canal curvature of more than 25°,
- teeth with PL of less than 5 mm in diameter,
- teeth with periodontal pocket deeper than 3 mm,
- teeth with developmental anomalies (e.g. dens invaginatus, palate-gingival groove).

The vitality of the teeth was checked by using an electrical pulp test (Digitest 2; Parkell, Inc, Edgewood, Newyork, USA) and cold test (Roeko Endo-Frost spray; Coltene Whaladent, Langenau, Germany) and resulted as negative. Moreover, the absence of bleeding from the root canals during access cavity preparation was also considered as a confirmatory clinical diagnosis. Oral and written consent was obtained from the patients.in which the possible risks and benefits were completely described.

Treatment Protocol

Local infiltration anesthesia was administered to the patients using 4% articaine with 1:100000 mg/mL epinephrine (UltracaineDS ® forte; Aventis, Istanbul, Turkey). All treatments were performed under the rubber dam isolation. Coronal flaring was performed using ProTaper Universal files (SX; Dentsply Maillefer, Ballaigues, Switzerland). Working length (WL) was determined with an apex locator (Raypex 6; VDW GmbH, Munich, Germany) and confirmed by radiographic evaluation. The root canal preparation was performed using K files (Jensen JP-1 K files; Bahadir Dis Malzemeleri, Istanbul, Turkey) up to six sizes larger than the first binding file size. Between each instrument, a size of 10 K-file was used to avoid an apical blockage and 2 mL of 2.5% NaOCl was used for irrigation. Final irrigation was applied as 5 mL 2.5% NaOCl, 5 mL 10% citric acid and 5 mL saline solution for one minute each, respectively. All irrigation stages were performed using a 30-gauge needle (Navitip; Ultradent, South Jordan, UT, USA) which was placed 2 mm shorter than the WL.

MTA Group: White mineral trioxide aggregate (MTA) (ProRoot MTA; Dentsply Maillefer, Ballaigues, Switzerland) was introduced into the canal using a fine-tipped amalgam carrier and was then condensed into the apical third by using gutta-percha. An ultrasonic tip (15,.02) was placed 2 mm shorter than the WL and activated for 2 s. The ultrasonic device (NSK-Varios 750; Nakanishi Inc., Tochigi, Japan) was used at power setting of 3 (28–32 kHz). The following day, the rest of the canal was filled with a backfilling device (BeeFill; VDW) after the canal walls had been sealed with 2Seal sealer (VDW). Since it is necessary to allow the ProRoot MTA to set, root canal treatment was completed in two-visit in this group.

Conventional technique group: Root canal treatments were completed with gutta-percha cones and epoxy resin-based sealer (2Seal; VDW, Munich, Germany) in one-visit using cold lateral compaction technique.

In both groups, a resin-based composite (3M ESPE, St. Paul, USA) was used for restoration. All of the clinical procedures were performed by the same operator. The operator was calibrated in terms of the protocol for each experimental procedure. The subjects were followed up for 15 months and examined clinically and radiographically. Periapical radiographs were taken using the Belmont Phot-X II (Takara-Belmont) with phosphor plates (VistaScan II, Dürr Dental).

Postoperative Examination

A) Clinical Examination

Age, gender, tooth number, pain levels, pain on percussion, palpation sensitivity, swelling, sinus tract were noted. Pre- and post-operative pain levels and percussion pain were measured on a visual analog scale (VAS).

B) Radiographic examination

Periapical intraoral radiographs were taken with paralleling technique. A blinded operator evaluated preoperative and follow-up periapical radiographs. The change of lesion size was calculated using Image J (Version 1.41; National Institutes of Health, Bethesda, MD) previously used by Arslan *et al.*[14] The change in the size of the PL was expressed as a percentage using the pixel calculation.

When the size of PL was smaller in follow-up radiographs than in preoperative radiographs and the tooth was clinically asymptomatic (without sinus tract, swelling, with no spontaneous, palpation or percussion pain), the case was considered as successful. When the size of PL was bigger in follow-up radiographs than in preoperative radiographs and/or the tooth was clinically symptomatic, the case was considered as unsuccessful.

Statistical analyses

The statistical analyses were performed using SPSS version 20 software (IBM SPSS, Chicago, IL, USA). The data of pain level, pain on percussion and age were statistically analyzed using the Mann-Whitney U test. The data of presence of success, radiographic outcome, pain on palpation, presence of swelling or sinus tract, gender and tooth number were analyzed using chi-square tests. The significance level of all statistical analyses set at $p<0.05$.

Results

Fifty-seven patients were included in this study. There were no significant differences in terms of demographic data (age, gender and tooth number) between the groups ($p>0.05$) (Table 1). Out of the total of 57, 39 patients (27 teeth for MTA and 30 teeth for the conventional technique) attended the follow-up clinical and radiographic assessment as shown in Figure 1. The follow-up rate was 89.06 %.

Based on clinical and radiographic examinations (Table 2), 100% of the teeth in the MTA group and 83.3% of the teeth in the conventional technique group were classified as being successfully treated ($p<0.05$) (Figure 2-3). The results showed no statistically significant differences between the groups in terms of pre- and post-operative clinical findings, i.e., palpation, swelling, sinus tract, pain and pain on percussion ($p>0.05$). Four teeth in the conventional technique group were considered unsuccessful due to sinus tract. In the MTA group, sinus tract, swelling, pain on palpation was not observed in any of the teeth (Table 1).

There was no significant differences among the groups in terms of the change in lesion size ($p>0.05$) (Table 2). One tooth in the conventional technique group was considered unsuccessful due to enlargement of PL size in follow-up radiographs.

Discussion

Filling material should be biocompatible as it could be in contact with periodontal tissue. MTA has better biocompatibility and sealing ability than conventional filling materials.[7,8] Consequently, this preliminary study compared the results of filling using MTA and a conventional technique (gutta-percha + root canal sealer) on the clinical and radiographic healing of mature teeth with PL. There were significant differences between the groups in terms of success, and therefore the null hypothesis was rejected.

Ricucci *et al.*[15] showed that conventional filling was successful at the rate of 78.2% in teeth with a PL greater than or equal to 5 mm. Also, Dorasani *et al.*[16] and Saoud *et al.*[17] observed that single or double visit treatments have similar percentages. In the current study, a higher success rate (83.3%) was found with regard to the conventional technique in teeth with PL from the aforementioned studies.[15-17] This could be elucidate by the different preparation sizes used in the studies. In this study, the canals were prepared to six sizes bigger than the first binding file size. Saini *et al.*[18] demonstrated that the rate of healed cases was 48%, 71.43%, 80%, 84.61%, and 92% when the canals were enlarged two, three, four, five and six sizes larger than the first binding file size, respectively. Therefore, in this study the canals were prepared to the maximal limit to obtain a high success rate.

When MTA cement comes into contact with water, calcium hydroxide is released as a reaction product and dissolution does not occur in the MTA surface.[9] A clinical study showed that the application of MTA as an apical plug to teeth with PL resulted in a clinical success of 95.5%.[10] Alsulaimani[4] performed a clinical study comparing the results of MTA and conventional filling materials on root canal treatment success in mature teeth with chronic apical abscess. Although Alsulaimani[4] could not find a statistically significant difference between the two techniques, he showed that single visit filling with MTA was better.

Although favorable clinical results were reported for immature and mature teeth used MTA, one study compared the MTA with the conventional technique[4]. It was concluded that the clinical success of teeth treated with MTA was 100%,

while the clinical success of teeth treated with conventional technique was 83.3%. Similarly, in the present study, 100% of samples in the MTA group and 83.3% samples in the conventional technique group were successful. MTA is a radiopaque Portland cement. MTA can induce and accelerate bone repair in giant cell tumors in bone.[19] MTA influences the differentiation of odontoblasts and bone marrow stromal cells with high expression of some genes such as Alp (alkaline phosphatase), Osx (Sp7, osterix), Bglap (osteocalcin), and Col1a1 (Type I collagen).[20,21] MTA is sterile, and the calcium hydroxide released from the MTA can react with phosphate in the tissues, resulting in the formation of hydroxyapatite.[20,21] This molecular mechanism can explain the 100% success rate found in the MTA group. Also, the sealing ability of MTA is good, and this could be improved by ultrasonic activation.[22] In our study, the 100% success in the MTA group can also be explained by the sealing ability of the MTA.

Some difficulties may arise for the clinician if root canals treated with MTA need to be retreatment. Boutsioukis *et al.*[23] reported that rotary instruments cannot penetrate canals, but ultrasonic tips can. Also, it was reported that MTA could not be completely eliminated from the root canal by the ultrasonic method.[23] It can be a limitation of MTA filling. On the other hand, MTA is more biocompatible and has a better sealing ability than conventional filling materials. Therefore, this is the strength of MTA filling.[7]

Liu *et al.*[24] analysed the healing rate of root canal treatment for teeth with apical periodontitis. They showed that a statistically significant preoperative prognostic factor in the successful was the patient's age. Younger patients had a more favourable outcome. In our study, the mean ages of the groups were 28.55±8.78 and 23.50±4.65, respectively, and there was no statistical difference between the group. This may have favourably affected the periapical healing.

Radiographic assessment of periapical status using Orstavik's periapical index (PAI) is the most frequently cited method in research studies.[25] Cone-beam computed tomography may prove to be an excellent alternative for assessing healing in 3 dimensions since it has been shown to be more sensitive and specific than periapical radiographs in evaluating radiolucent periaical zones.[26] The radiation dose is much higher when using CBCT compared to intraoral radiographs, therefore it is not appropriate to recommend CBCT as a standard method to identify periapical inflammation. Clinical signs and symptoms and intraoral radiographs are the best/recommended way for assessing root canal treatment.[25]

An important limitation of this study is the fact that the follow-ups were conducted at 15 months to obtain detailed information on the healing course of the teeth. The European Society of Endodontology recommends 4 years of follow-up.[27] Huumonen *et al.*[28] showed that teeth with PAI 3, 4, and 5 significant healing was seen at the 3-month control. Also healing of apical periodontitis occured fastest during the first postoperative year in all apical periodontitis groups. This study results may be useful in clinical practice, especially for teeth with extensive lesions requiring prosthetic rehabilitation.[29] To confirm our outcomes, further trials should be performed followed up for a longer period of time.

Table.1 Demographic data, presence of palpation tenderness, swelling, sinus tract, pain level, pain level on percussion according to the groups.

Group	MTA	Conventional	P value	
N	27	30		
Age	28.55±8.78	23.50±4.65	>0.05	
Gender	Female	17 (62.9%)	19 (63.3%)	>0.05
	Male	10 (37.1%)	11 (36.7%)	
Tooth Number	#4	1 (3.7%)	3 (10%)	>0.05
	#6	1 (3.7%)	0 (0%)	
	#7	*4* (14.8%)	4 (13.3%)	
	#8	*8* (29.6%)	5 (16.7%)	
	#9	5 (18.5%)	3 (10%)	
	#10	5 (18.5%)	5 (16.7%)	
	#11	0 (0%)	1 (3.3%)	
	#13	1 (3.7%)	1 (3.3%)	
	#22	0 (0%)	3 (10%)	
	#23	1 (3.7%)	0 (0%)	
	#24	1 (3.7%)	0 (0%)	
	#25	0 (0%)	1 (3.3%)	
	#26	0 (0%)	2 (6.7%)	
	#27	0 (0%)	2 (6.7%)	
Presence of Palpation Tenderness	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	2 (7.1%)	>0.05
Presence of Swelling	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	0 (0%)	>0.05
Presence of Sinus Tract	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	4 (13.3%)	<0.05
Pain level	Preoperative	1.66±8.66	3.20±9.12	>0.05
	Control	0.00±0.00	0.00±0.00	>0.05
Pain level on percussion	Preoperative	2.14±11.16	4.06±12.41	>0.05
	Control	0.00±0.00	0.00±0.00	>0.05

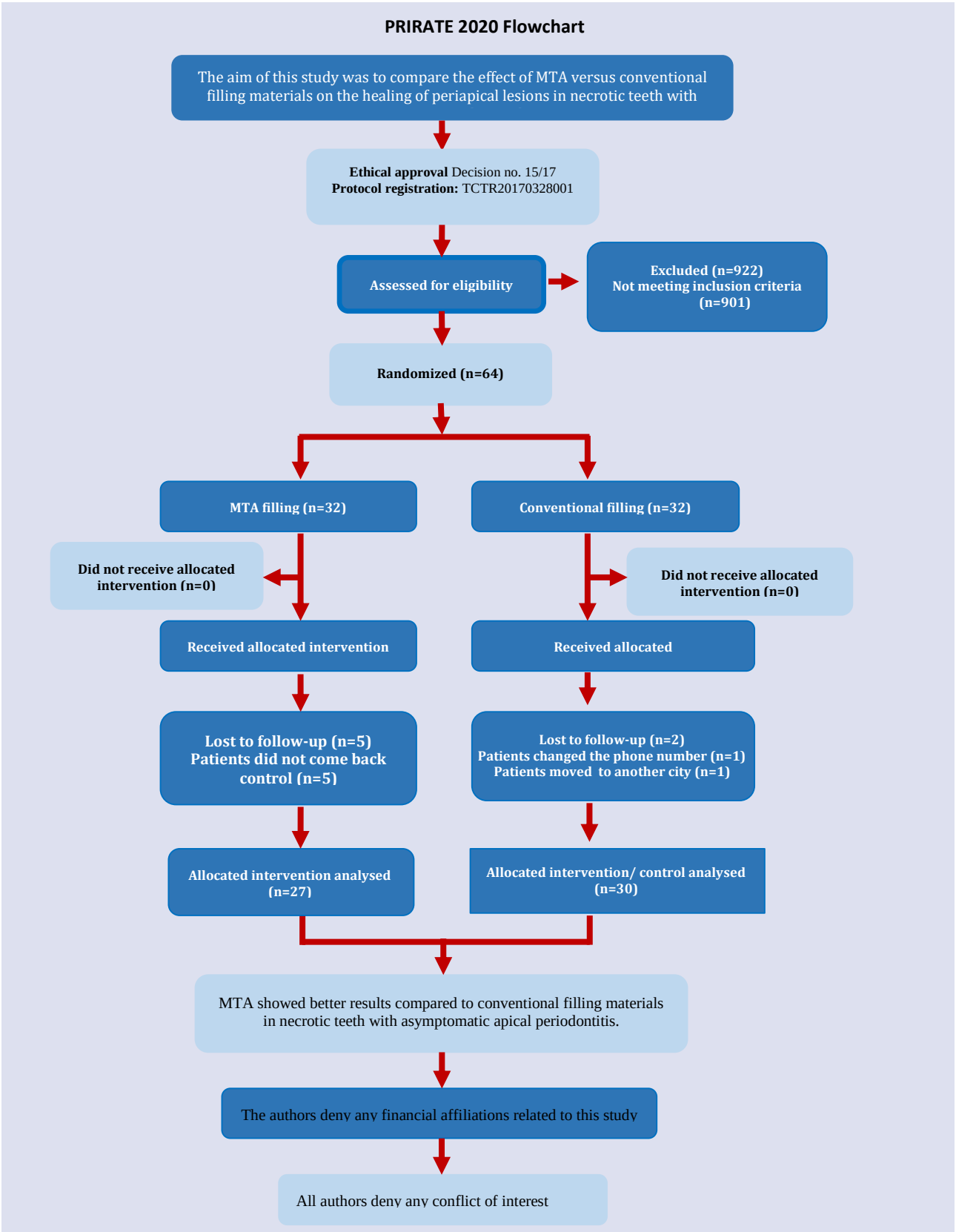

Figure Legends:

Figure 1: Preferred Reporting Items for Randomized Trials in Endodontics 2020 flowchart.

*From: Nagendrababu V, Duncan HF, Bjørndal L, Kvist T, Priya E, Jayaraman J, Pulikkotil SJ, Pigg M, Rechenberg DK, Vaeth M, Dummer P. (2020) PRIRATE 2020 guidelines for reporting randomized trials in Endodontics: a consensus-based development. International Endodontic Journal Mar 20. doi: 10.1111/iej.13294. For further details, visit: http://pride-endodonticguidelines.org/prirate/

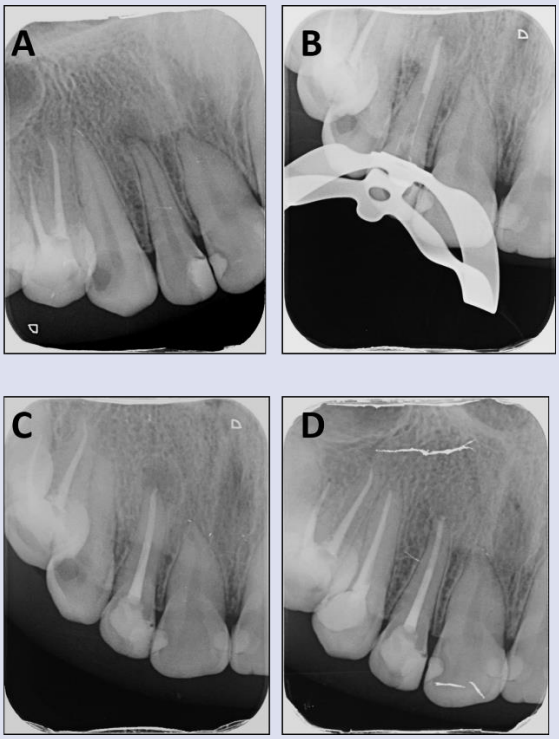

Figure 2: (A) Right lateral incisor tooth with periapical lesion in a 22 year-old female patient. (B) The apical portion of the tooth was obturated with MTA, (C) The middle and coronal thirds of the tooth were obturated with gutta-percha. (D) The 15-month follow-up shows the healing of periapical lesion without clinical symptoms and periapical lesion.

Table.2 Clinical and radiographic assessment of the protocols

Group		MTA	Conventional	P value
Success	N	27	30	
	Successful cases	27 (100%)	25 (83.3%)	<0.05
	Unsuccessful cases	0 (0%)	5 (16.7%)	
Change in lesion size (%)		-78.94±22.47	-73.39±36.58	>0.05

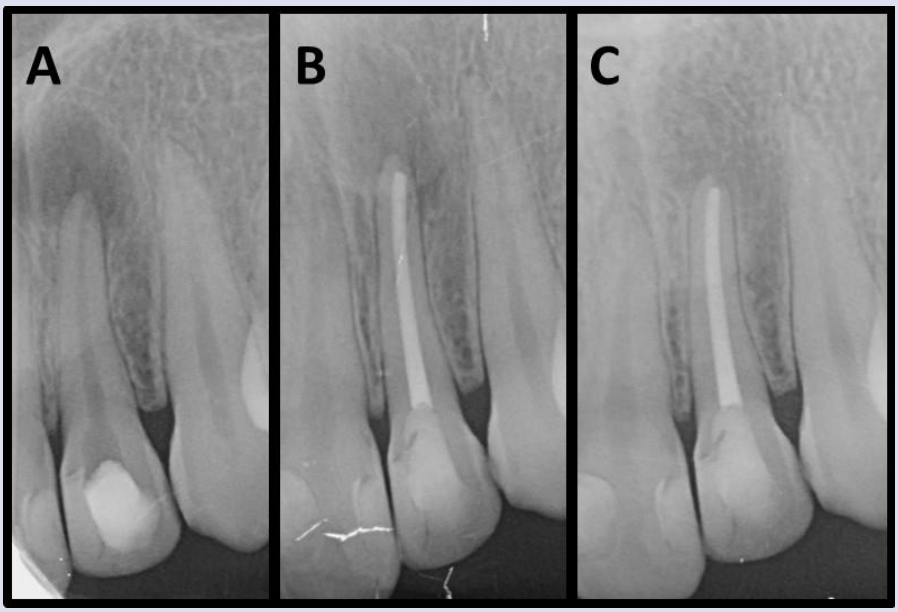

Figure 3: (A) Left lateral incisor tooth with periapical lesion in a 25 year-old female patient. (B) Root canal treatments were completed with gutta-percha cones and epoxy resin-based sealer in one-visit using cold lateral compaction technique. (C) The 15-month follow-up shows the healing of periapical lesion without clinical symptoms and periapical lesion.

Conclusion

Within the limitations of this study, MTA filling has statistically more success rate than conventional obturatin materials in teeth with PL. Further studies with larger sample sizes are needed to verify the outcomes obtained from the current study.

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Evaluation of Parental Awareness and Knowledge Level About Children's Oral Habits: A Survey Study

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ABSTRACT

Objectives: This study aims to determine parents' awareness of malocclusions that may arise from oral habits in their children and the relationship of this awareness with the sociodemographic characteristics of the family.
Materials and methods: The questionnaire consisting of 16 questions was applied to 501 parents who were referred to the pediatric dentistry clinic. The questionnaire consisted of questions about the sociodemographic characteristics of the parents, their level of knowledge about oral habits and the way they accessed information. The questionnaire was created by editing Melo et al.'s questionnaire, it was modified in Turkish according to the Turkish cultural structure. Eight questions included in the scoring. The correct answer score for each question was "1". Comparisons in paired groups were performed with two independent samples t-test, in multiple groups were made with the ANOVA test. Duncan's multiple comparison(post-hoc) test was used in order to determine the groups with a difference.
Results: A significant difference was found between the education level of the parents and the correct answer score(4.9point) of oral habit($p<0.05$). It has been determined that parents don't have adequate information about oral habits. Parents are more knowledgeable about the possible effects of pacifier use(64.1%) in oral habits than other habits. In current study, there is a lack of knowledge about bottle use, clenching, and mouth breathing. 50.7% of the parents were not informed about oral habits before.
Conclusions: Lack of knowledge of parents on oral habits will lead to the need for long and costly orthodontic treatment in the future. Therefore, parent education should be provided during the examinations made by pediatric dentists and pediatricians. It would be beneficial to add this information training to routine public health programs.

Keywords: Public Health Dentistry, Habits, Dentists, Pediatric, Health Knowledge, Attitudes, Practice.

Çocukların Ağız Alışkanlıklarına İlişkin Ebeveyn Farkındalık ve Bilgi Düzeyinin Değerlendirilmesi: Bir Anket Çalışması

Süreç

Geliş: 11/10/2023
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ÖZ

Amaç: Bu çalışmanın amacı, ebeveynlerin çocuklarındaki oral alışkanlıklardan kaynaklanabilecek malokluzyonlara ilişkin farkındalıklarını ve bu farkındalığın ailenin sosyodemografik özellikleri ile ilişkisini belirlemektir.
Gereç ve Yöntemler: Çocuk diş hekimliği kliniğine başvuran 501 ebeveyne 16 sorudan oluşan anket uygulandı. Ankette anne ve babaların sosyodemografik özellikleri, oral alışkanlıkları konusundaki bilgi düzeyleri ve bilgiye ulaşma biçimleri ile ilgili sorular yer almıştır. Anket Melo ve arkadaşlarının anketi düzenlenerek oluşturulmuş olup, Türk kültürel yapısına göre Türkçe olarak değiştirilmiştir. Puanlamada sekiz soru yer aldı. Her soru için doğru cevap puanı "1" idi. Eşli gruplarda karşılaştırmalar Two Independent Samples T-testi ile, çoklu gruplarda ise ANOVA testi ile yapıldı. Farklılık olan grupları belirlemek için Duncan çoklu karşılaştırma (post-hoc) testi kullanıldı.
Bulgular: Anne ve baba eğitim durumu ile ağız alışkanlığı doğru cevap puanı (4,9 puan) arasında anlamlı fark bulundu ($p<0,05$). Anne babaların ağız alışkanlıkları konusunda yeterli bilgiye sahip olmadığı belirlenmiştir. Anne-babalar emzik kullanımının ağız alışkanlığı üzerindeki olası etkileri konusunda (%64,1) diğer alışkanlıklara göre daha bilgilidirler. Mevcut çalışmada biberon kullanımı, diş sıkma ve ağızdan nefes alma konusunda bilgi eksikliği bulunmaktadır. Ebeveynlerin %50,7'si oral alışkanlıklar konusunda daha önce bilgilendirilmemiştir.
Sonuçlar: Ailelerin ağız alışkanlıkları konusunda yetersiz bilgi sahibi olmaları ileride uzun ve maliyetli ortodontik tedavilere ihtiyaç duyulmasına neden olacaktır. Bu nedenle çocuk diş hekimleri ve çocuk doktorları tarafından yapılan muayenelerde aile eğitimi verilmelidir. Bu bilgilendirme eğitiminin rutin halk sağlığı programlarına eklenmesi faydalı olacaktır.

Anahtar Kelimeler: Apikal Periodontitis, Nekrotik Diş, MTA, Dolgu, Büyük Periapikal Lezyon.

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Introduction

Most babies are born without any malocclusion and orofacial anomalies.[1] In the postnatal period, malocclusion may develop in children under the influence of various environmental factors. Untreated oral habits and oral habits are not given up on time are among the factors that cause malocclusion. [2] Oral habits affect the orofacial muscle balance, affecting the growth and development direction, amount, and occlusion of the jaws. This may result in the need for long-term and costly orthodontic treatment in children. The best treatment for these conditions is timely intervention and a protective and preventive approach before malocclusion occurs.[3] It is important to be aware of the conditions that may occur due to oral habits in children and to intervene on time for the prevention and treatment of malocclusion development. Thumb sucking, pacifier sucking, bottle sucking, lip sucking, tongue sucking, tongue thrusting, mouth breathing, nail-biting, lip biting, and clenching are common habits in children that cause deformation in the teeth and surrounding tissue.[4] It has been proven by studies that these habits, which are not given up on time depending on the frequency, duration and intensity, cause dental and skeletal anomalies.[5-7]

Parents are the primary observers of habits formed in children. Knowing the potential negative consequences that oral habits can cause and being aware of the need for treatment may be the first step for the start of treatment. Therefore, it is crucial for parents to have sufficient knowledge about the complications of oral habits and be able to take early preventive measures.

Studies on oral habits in children and parental awareness are mostly related to awareness of the current malocclusion situation. Studies in the literature that question parental knowledge about the negative effects of oral habits are mostly related to non-nutritive sucking habits.[8] In addition to awareness of the current malocclusion situation, awareness of the negative effects of oral habits in general is also important for the oral health of children. The aim of this study is to determine the level of knowledge of parents about oral habits and the effects they may cause, and to evaluate the relationship between parents' knowledge levels and demographic characteristics.

Material and methods

An approval numbered 2021/1575 was obtained from the Inonu University Non-Interventional Research Ethics Committee. The study complied with the Declaration of Helsinki and was designed according to TREND Guidelines. An informed consent form was signed by all participants before the questionnaire. The questionnaire consisted of 16 questions. The questionnaire was created by editing the questionnaire used by Melo *et al.*[9] according to the Turkish cultural structure. However, since it was different from the original, the validity of the questionnaire was again reviewed and tested by 10 pediatric dentists (expert opinion). Changes were made to the survey based on expert reviews. Next, for test-retest reliability and comprehensibility of the questionnaire, the questionnaire was pilot-tested by randomly selecting a sample of 25 parents from among the target participants not included in the main study. Responses were reviewed and items reported as confusing and difficult to answer by parents were addressed. Accordingly, the questionnaire was revised and the final questionnaire was created to avoid misinterpretation of the questions. It includes 6 questions about demographic characteristics, 8 questions about measuring parental awareness and level of knowledge about oral habits, and 2 questions about being informed. The questionnaire was administered to 501 parents. The questionnaire consisted of questions about the possible effects of oral habits on occlusion and parents' access to information on this subject. Parents of children aged 3-13 years in primary and mixed dentition were included in the study. 2 years was accepted as the correct age for pacifier sucking and bottle sucking.[10] The correct answer to the other six questions is "yes", indicating that oral habit will have a negative effect. Each correct question has a correct answer score of 1.

Statistical analysis

The analysis of the data was carried out with the SPSS 25 (IBM Corp, Armonk, NY) software. The normality of the data was determined by the Kolmogorov-Smirnov test. The significance level for comparison tests was taken as $p<0.05$.

Since the assumption of normality was ensured, comparisons in paired groups were performed with two independent samples *t*-test and comparisons in multiple groups were performed with the ANOVA test. Duncan's multiple comparison (post-hoc) test was used since the homogeneity of variance was ensured to determine the groups with a difference as a result of the ANOVA test. Values of the variables are given as a number, percentage, mean, and standard deviation.

Results

Demographic information of the participants was calculated as numbers and percentages (n/%), and given in Table 1. Most mothers (60.9%) were between the ages of 30-39 and graduated from primary school (38.9%). Most fathers (45.1%) were between the ages of 40-49 and graduated from high school (34.5%). The percentages of the answers to the questions are given in table 2.

A statistically significant difference was found in the oral habit awareness scores of those who answered the questions "The effect of mouth breathing on the development of teeth and jaws" correctly ($p<0.001$, Table 3). Likewise, the questions "The effect of sucking, biting or tongue thrusting habits on tooth and jaw development" have a statistically significant effect on awareness scores ($p<0.001$, Table 3).

Table 1: Demographic Data of the Participants.

Mean ± SD	Group	Number(n)	Percentage(%)
Mother Age	20-29 years	60	12
	30-39 years	305	60.9
	40-49 years	128	25.5
	≥ 50 years	8	1.6
Mother Educational Status	Literate	34	6.8
	Primary school	195	38.9
	High school	134	26.7
	University	123	24.6
	Postgraduate	15	3
Father Age	20-29 years	12	2.4
	30-39 years	223	44.5
	40-49 years	226	45.1
	≥ 50 years	40	8
Father Educational Status	Literate	13	2.6
	Primary school	138	27.5
	High school	173	34.5
	University	156	31.1
	Postgraduate	21	4.2
Household Income	0-2500 TL	201	40.1
	2501-5000 TL	190	37.9
	5001-10000 TL	87	17.4
	10001 TL and higher	23	4.6

Table 2: Numbers and Percentages of the Answers by the Participants to the Questions

Mean ± SD	Group	Number(n)	Percentage(%)
Cessation age of pacifier use	≤2 years	321	64.1
	>2 years	180	35.9
Cessation age of bottle use	≤2 years	111	22.2
	>2 years	390	77.8
The effect of mouth breathing on teeth	Yes	189	37.7
	No	312	62.3
The effect of mouth breathing on jaw development	Yes	145	29
	No	356	71
The effect of sucking, biting and tongue thrust on teeth development	Yes	383	76.4
	No	118	23.6
The effect of sucking, biting and tongue thrust on jaw development	Yes	345	68.9
	No	156	31.1
The damage of teeth clenching on teeth	Yes	453	90.4
	No	48	9.6
The effect of teeth clenching on joint and jaws	Yes	417	83.2
	No	84	16.8
The damage of teeth clenching on teeth	Yes	453	90.4
	No	48	9.6
The damage of teeth clenching on teeth	Yes	417	83.2
	No	84	16.8
Previous information about oral habits	Yes	247	49.3
	No	254	50.7
Those who were informed by dentist/ pedodontist	Yes	90	18
	No	411	82
Those who were informed by pediatrician	Yes	62	12.4
	No	439	87.6
Those who were informed by school/teacher	Yes	45	9
	No	456	91
Those who were informed by tv programmes	Yes	49	9.8
	No	452	90.2
Those who were informed by social media	Yes	69	13.8
	No	432	86.2

Table 3: Comparison of oral habit scores according to demographic data and true-false questions answers.

Variables	Group	Mean ± SD	Test Value	*p* value
Mother's age	20-29 years	4.7 ± 1.91	1.364[a]	0.253
	30-39 years	4.98 ± 1.81		
	40-49 years	5.11 ± 1.73		
	≥ 50 years	5.88 ± 0.99		
Mother' educational status	Literate	4.5 ± 2.29[x]	5.774[a]	0.001*
	Primary school	4.72 ± 1.84[x]		
	High school	4.92 ± 1.69[x]		
	University	5.56 ± 1.63[y]		
	Postgraduate	5.73 ± 0.8[y]		
Father's age	20-29 years	4 ± 2.56	1.404[a]	0.241
	30-39 years	5.08 ± 1.73		
	40-49 years	4.97 ± 1.85		
	≥ 50 years	4.95 ± 1.57		
Father's educationa status	Literate	3.85 ± 2.67[x]	5.446[a]	0.001*
	Primary school	4.63 ± 1.96[x]		
	High school	4.94 ± 1.8[xy]		
	University	5.42 ± 1.46[y]		
	Postgraduate	5.43 ± 1.47[y]		
Household income	0-2500 TL	4.76 ± 1.83	2.418[a]	0.065
	2501-5000 TL	5.07 ± 1.75		
	5001-10000 TL	5.33 ± 1.73		
	10001 TL and higher	5.17 ± 1.92		
The effect of mouth breathing on jaw development	No	4.25 ± 1.65	-13.991[b]	0.001*
	Yes	6.22 ± 1.29		
The effect of mouth breathing on teeth development	No	4.37 ± 1.63	-14.504[b]	0.001*
	Yes	6.52 ± 1.16		
Cessation age of pacifier use	>2 years	4.5 ± 1.73	-8.742[b]	<0.001*
	≤2 years	5.87 ± 1.58		
Cessation age of bottle use	>2 years	3.65 ± 1.9	-8.770[b]	<0.001*
	≤2 years	5.38 ± 1.57		
The effect of sucking. biting and tongue thrust on teeth development	No	2.93 ± 1.66	-18.518[b]	<0.001*
	Yes	5.63 ± 1.29		
The effect of sucking. biting and tongue thrust on jaw development	No	3.25 ± 1.68	-19.312[b]	<0.001*
	Yes	5.78 ± 1.18		
The damage of teeth clenching on teeth	No	2.15 ± 1.96	-13.493[b]	<0.001*
	Yes	5.3 ± 1.49		
The damage of teeth clenching on jaw development and jaw	No	2.62 ± 1.7	-16.513[b]	<0.001*
	Yes	5.47 ± 1.39		
Previous information about oral habits	No	4.67 ± 1.81	-4.225[b]	<0.001*
	Yes	5.33 ± 1.72		

[a,b] Test Value cells with different letters have a significant difference compared to each other (*p<0.01).

A statistically significant difference was found between the correct and incorrect answer scores in the "Age of Cessation of Pacifier Use" question in the oral habit scores of the participants included in the study (p<0.05, Table 3).

The oral habit awareness total scores of the participants were compared according to the maternal and paternal age/educational status/income level, the age of quitting the pacifier and bottle, the effects of sucking-teeth-clenching-mouth breathing habits on the teeth and jaws, and the test results are presented in Table 3.

The average oral habit awareness score of the participants was 4.9. It was determined that the scores of the participants were not affected by the age of the mother or father and socioeconomic level. However, the educational status of the parents affected the oral habit awareness scores (Table 3).

A statistically significant difference was found between the parents' educational status (literate, primary school, high school, university, postgraduate) in the oral habit awareness scores of the participants included in the study (p<0.05, Table 3). According to Duncan Multiple Comparison test results, a statistically significant difference was found between the knowledge scores of the literate and university graduates mothers (p=0.017<0.05) and fathers (p=0,018, Table 3). A statistically significant difference was found between primary school graduate and university graduate mothers and fathers in terms of knowledge level (p=0.001<0.05). A statistically significant difference was found between high school graduate and university graduate mothers (p=0.03<0.05).

Discussion

In the present study, parents' awareness of malocclusions that may be caused by oral habits, its relationship with the sociodemographic characteristics of the family, and their information on this subject were questioned. Studies investigating the level of knowledge

of parents about their children's oral health are mostly on oral hygiene.[11,12] This study has added a different perspective to the literature by examining the level of knowledge of parents about oral habits in children's oral health.

It has been proven by studies that the stomatognathic system is affected by the duration, frequency, and severity of oral habits.[10-13] It is crucial to initiate the treatment early and take a preventive approach. The prerequisite for starting treatment early is to be aware of the condition.[14] It is important for the parents to be aware of this issue in terms of treatment timing.[12-15] Parental awareness is associated with education level. Chen *et al.*[16] concluded in their study that families with higher education levels have better oral hygiene knowledge, and their children also have better oral health. In their study, Mishra *et al.*[17] highlighted the importance of parent's education level and awareness of oral health-protective measures in determining the oral health of children. In the present study, the significant difference between the score of all other groups and the score of those with university and graduate education about oral habits and awareness of the possible outcomes highlights the importance of parent education once again. The education of parents is essential for the healthy growth of future generations.

The results of the study of Scarpelli *et al.*[18] in which parents were trained during the developmental period of children with oral habits by applying "Protocol for the Prevention of Malocclusions (PPM)", found no significant relationship between parental education level and giving up oral habits. This may be due to the fact that all parents received training on oral habits during PPM. This situation reveals the necessity of parent's awareness examined in the current study. The reason for the difference between the results of the two studies may be country and geography. It should not be overlooked that Turkish pediatric patients have a parent population whose quality of life is adversely affected due to poor oral hygiene and habits.[19]

Prolonged sucking habits are common in children. Breastfeeding plays an important role in the development of the palate structure of children.[3] Non-nutritive sucking behaviors are acceptable in infants and young children up to a certain age. However, studies have proven that narrow palate, increased overjet and decreased overbite formation are more common in children with non-nutritive sucking habits that continue after the recommended age.[1,2] Studies have shown that continued pacifier use after the age of two has a negative effect on malocclusion and maxillary growth patterns.[20,21] In the present study, 64.1% of the parents gave the correct answer to the question about the cessation of pacifier use. Pediatric dentists and pediatricians may have a role in ensuring that parents have adequate knowledge about the cessation of pacifier use at an appropriate age. In a study conducted in Turkey in 2021, it was reported that pediatricians gave a correct answer with a rate of 92.3% regarding the fact that non-nutritive sucking habits may cause malocclusion.[22] The fact that parents do not neglect the pediatrician's control, especially in children aged 0-2, and that the pediatricians in Turkey are knowledgeable about this issue; It was concluded that it can be effective in raising awareness of families and increasing the correct answer score.

Long-term bottle use causes insufficient perioral muscle development in children.[20] When we question the parental knowledge about bottle use, it is seen that there is a lack of information. The reason for this could be that families cannot give up the convenience and nutritional value of bottle feeding. This condition, which is not noticed and intervened in time, may cause maxillary stenosis, anterior and posterior crossbite, and increased overjet in children, depending on the frequency of habituation.[23-25] When malocclusions that may occur due to the parents' lack of knowledge are not treated on time, it causes the need for time-consuming and costly advanced orthodontic treatment.[21]

It has been determined by studies that mouth breathing habits cause malocclusion in children. [13,26] Most of the parents who participated in the present study considered that mouth breathing did not affect the development of teeth and jaws. The related knowledge score was found to be higher in mothers with a university education than in literate mothers. This finding reveals once again the importance of the education level of the mother.[15] Since the effect of mouth breathing on both teeth and jaws occurs in the long term, it may not be frequently mentioned by physicians. It may not have attracted as much attention as other severe and short-term harmful habits. It would be beneficial for dentists, pediatricians and otolaryngologists to be more inquisitive about this issue in pediatric examinations and to provide more information to families.[3]

The high rate of correct answers by parents to the effect of sucking habits on both teeth and jaw development since this habit attracts the attention of families by causing visible aesthetic problems. Because it was noticed earlier, parents may have accessed information by seeking treatment. In addition, it is among the problems that dentists frequently prioritize and voice.[22]

Various studies have been conducted on the effects of clenching on teeth and jaws. In these studies, it was concluded that clenching has a negative effect and is associated with various oral habits.[15-17] In the present study, it was concluded that the majority of parents were conscious of the effects of bruxism on teeth (90.4%) and jaws (83.2%). These parents were more knowledgeable about bruxism than other oral habits. The fact that it is seen and common in adults and has a physiological effect may have increased awareness. The diagnosis of bruxism in children is quite difficult. Especially for the diagnosis of bruxism in children, the child cannot be able to identify it. Therefore, families need to follow their children, especially in terms of sleep bruxism. The knowledge of parents on this issue is promising in terms of diagnosis and treatment.

When we questioned the way parents were informed about oral habits and their possible effects, 50% of them stated that they had not received any information before, which shows that the awareness of this issue is low. The biggest task in this regard falls on pediatric dentists, family physicians and paediatricians.[22,25] From the moment the first primary tooth erupts, children should be examined by a pediatric dentist. The development of the jaw and tooth structure should be followed at regular intervals. In these appointments, parents should be informed and guided about malocclusions that may occur as a result of breastfeeding, pacifier and bottle use, and possible oral habits.[3] It is also thought-provoking that the total number of parents (22%) whose information sources are social media and television programs is higher than those whose sources are dentists/pediatric dentists (18%) and pediatricians (12%). Considering the impact of social media today, it would be beneficial to increase informative content by physicians so that parents can access the right information.

Parents can be informed by their dentist since the first visit. Dentists, especially pediatric dentists, play an important role in this regard, depending on the age group they are interested in. The situation can be brought under control with the aids and referrals made as soon as the habit is noticed.[24] Preventive-stopping treatments are less costly. This is also very important for families and the country's economy.[14,15] With preventive treatments, treatment time, sessions and cost are reduced. With the decrease in the time spent by the physician, the child, and the family, the child's motivation increases in short-term treatments.[28] When considering communication with children, teachers should also be aware of the subject. In schools, parents can be supported with various educational programs.

In the present study, parents' knowledge levels were measured by means of a questionnaire. This study can be taken to an advanced level by supporting clinical findings and comparing the presence of habit with the eyes of the physician and the parents separately. Studies carried out by completing this deficiency can be more instructive and decisive.

Conclusion

It is believed that many oral health problems can be reduced or even prevented when parents have access to information about oral health. For this reason, informative studies should be emphasized so that parents can access correct information and intervene in oral habits early. The results of the present study clearly show that parents need early and predictive advice. This information could be best provided by pediatricians and family physicians, who are more likely to encounter children before malocclusion occurs, through channels such as community health centers, schools, and social media.

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Evaluation of Quality of Life and Satisfaction in Patients with Implant-Supported Fixed Partial Dentures

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ABSTRACT

Objectives: This study evaluated the satisfaction level of the dental implant-treated patients using the oral health impact profile-14 (OHIP-14) and VAS scale after 6.5 years (±1.5 years) of the treatment.

Materials and Methods: Fifty-six partial edentulous patients were included in this clinical study. A total of healthy 185 implants were selected according to the dental implant health scale accepted by the International Congress of Oral Implantologists Consensus (ICOI) and 122 fixed implant- supported prosthesis were evaluated for this study. The patient-reported effect was prospectively obtained by measuring oral health impact (OHIP-14) and Visual Analogue Scale (VAS) with a follow-up 6.5 years (±1.5 years) period. The distribution of variables was checked using the 0ne-Sample test. SPSS 22.0 programme was used for the analyses.

Results: The patients were defined with high satisfaction results after 6.5 years (±1.5 years) by implant placement. The mean OHIP score was 2.82 (SD ± 5.44) and the Mean VAS-score for the satisfaction percentage with implant-supported restorations was 87.80 % (SD ± 13.79). The results of OHIP 14 and VAS scores indicate that patient satisfaction with fixed implant-supported prosthesis was high in all patients.

Conclusions: The fixed implant-supported restorations served high satisfaction results according to the OHIP 14 and VAS results. These restorations have a positive effect on the quality of life for oral health (OHRQoL).

Key Words: Dental İmplant, Fixed Partial Denture, Oral Health, Quality of Life

İmplant Destekli Sabit Bölümlü Protez Tedavisi Yapılan Hastalarında Yaşam Kalitesi ve Memnuniyetinin Değerlendirilmesi

Süreç

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ÖZ

Amaç: Bu çalışmada ağız sağlığı etki ölçeği olan OHIP-14 (Oral health impact profile-14) ve (VAS) Vizüel analog skala kullanılarak implant tedavisi yapılan hastaların 6.5 (± 1.5 yıl) yıllık tedavi süresinden sonraki memnuniyet düzeyi değerlendirildi.

Gereç ve Yöntem: Bu klinik çalışmaya kısmi dişsizliği olan elli-altı hasta dahil edildi. Uluslararası Oral İmplantoloji Konsensus Kongresi (ICOI) tarafından kabul edilen dental implant sağlığı ölçeğine göre toplam 185 adet sağlıklı implant seçildi ve 122 adet implant üstü sabit destekli protez değerlendirildi. Hasta tarafından bildirilen sonuçlar, 6.5 yıl (±1.5 yıl) bir takip süresiyle ağız sağlığı profili (OHIP-14) ve Vizuel Analog Scala (VAS) sonuçları ile prospektif olarak elde edildi. Değişkenlerin dağılımı 0ne-Sample testi kullanılarak kontrol edildi. Analizlerde SPSS 22.0 programı kullanıldı.

Bulgular: Hastalarda implant yerleştirilmesinden, 6.5 yıl (±1.5 yıl) sonra yüksek memnuniyet sonuçları belirlendi. İmplant destekli restorasyonlardan memnuniyet yüzdesine ilişkin ortalama VAS skoru % 87. 80 (SD ± 13.79) idi. Ortalama OHIP skoru 2.82 (SS ± 5.44) idi. OHIP 14 ve VAS skorları sonuçlarına göre sabit implant destekli protezlerden hasta memnuniyetinin tüm hastalarda yüksek olduğu görüldü.

Sonuçlar: Sabit implant destekli restorasyonlar OHIP 14 ve VAS sonuçlarına göre yüksek memnuniyet sonuçları vermiştir. Bu restorasyonların ağız sağlığı açısından yaşam kalitesi (OHRQoL) üzerinde olumlu bir etkisi vardır.

Anahtar Kelimeler: Dental İmplant, Sabit Protez, Ağız Sağlığı, Yaşam Kalitesi.

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Introduction

Dental implant therapy is fundamental and long-term treatment option for replacing missing teeth.[1,2] Nowadays, it has become a preferable prosthetic treatment method in many conditions because of its high survival percentages over the years.

In the literature, the evaluation of implant treatments was commonly determined by the survival percentages, prosthesis stability, radiographic evaluation, and infection condition in the peri-implant soft tissues.[3-5]

Patient-reported perceptions and evaluations that are deteched with the success reports have become increasingly significant in implant dentistry.[6] The patient outcome measures and clinical findings on implant-supported fixed partial dentures (IFPD) and their evaluation methods and results are still discussed among studies. The varied perspectives and insights from these studies contribute to a better understanding of the efficacy and challenges related to implant-supported fixed partial dentures.

A shortened 14-item questionnaire is used as the oral health impact profile index (OHIP-14).[7] This index has been used to assess the impact of oral health on the quality of life for patient perceptions of success and patient-reported outcome measures. The index reports the patient's perception of the social impact of oral disorders on their well-being. The OHIP-14 determines only negative statements, while some different oral health-dependent quality of life appliances question both positive and negative evaluations. However, it was reported that the best-certificated and commonly used appliance is the OHIP in the literature.[8]

Especially for the IFPD treatment, a few numbers of studies dealt with patients' perceptions of clinical outcomes and level of satisfaction.[9]

This cross-sectional study aimed to evaluate the patients' satisfaction level with the OHIP-14 questionnaire and VAS treated with IFPD in Gaziantep University 6.5 years (±1.5 years) after implant placement.

Materials and Methods

This study was performed after receiving acceptance from the ethics committee of XXX University (2023/110). All patients were informed about the study objectives and protocole.

Study Protocol

The presented study has a retrospective design combined with a prospective long-term re-examination.

All patients were treated at Gaziantep University from 2015 to 2017 by implant placement of at least two-eight by the Straumann® Dental Implant System (Straumann AG, Basel, Switzerland) (185 implants; width 3.5–4.5 mm and length 10–13 mm.) following standardized protocol according to the manufacturer's instructions by specialist clinicians for each for partially edentulous patients with missing single or multiple teeth. All patients were treated by IFDP (n=122) (either being crowns or bridges) with screw-retained or cement-retained metal/zirconia ceramic IFDP.[10]

In the beginning, as a routine treatment protocol, all patients received at least one session of individual hygiene before implants were placed. The specialist clinicians set a peri-implant maintenance recall program. This contained re-instruction and re-motivation to an effective individual plaque control, controlling and obtaining a healthy peri-implanter status. When a peri-implant mucositis or peri-implantitis was detected after implant placement and loading, conventional non-surgical mechanical therapy in conjunction with oral hygiene reinforcement was planned for peri-implant mucositis. If the disease remains after non-surgical therapy, surgical operations were planned.[11]

The partially edentulous with missing single or multiple teeth and implant loaded patients invited from the digital records of the faculty. 6 years (±1.5 years) after implant placement the participiciants (n=56) were re-examined.

All patients had to fulfill the following inclusion criteria:

- The presence of the periapical or panaromic radiograph after the time of implant placement
- Over 18 years patiens
- Not pregnant or breastfeeding
- Patients with healthy implants according to the Dental Implant Health Scale[5]

Exclusion criteria

Smokers received implant treatment if the maximum daily dose did not exceed 10 cigarettes/day. Patients were excluded based on motility disorders, cognitive impairment and having uncontrolled diabetes and systemic diseases.[12]

Clinical examination and Data gathering

All patients were informed about the the objectives of the study and signed the informed consent letter. The patients were examined on generalized and localized health conditions. After complete clinical and radiographic re-examination performed by one independent examiner (MÖ) patients, the clinical examination was based on described in detail in Misch *et al.*[5]

The radiological bone loss was determined by comparing the initial and the final digitalized radiographs. After the clinical and radiologic evaluation, the healthy 185 implants were included in the study according to the Dental Implant Health Scale.[5]

Patient-reported outcome measures (PROMs)

OHIP 14 (the Oral Health Impact Profile (OHIP)

The OHIP-14 scale was adapted into Turkish by Mumcu *et al.*[11] and the questionnaire (OHIP-14) was asked to the patients face to face by one clinician after the clinical examination.[14]

The OHIP-14 questionnaire consists of 7 dimensions. Every 7 dimensions includes two items, achieves 14

questiones (OHIP 1-14). The functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicaps creates the seven dimensions. The five level of the scores determines as never (= 0), hardly ever (= 1), occasionally (= 2), fairly often (= 3) and very often (= 4) with the Likert skale. Higher OHIP scores indicate worse, and lower OHIP scores indicate better oral health-related quality of life.

VAS scale

The patients were asked to sign the Visual Analog Scale (VAS) which is a 100 mm straight horizontal line from "not at all satisfied" to "very satisfied" that was marked as 0-100 mm expressed as percentage (10 mm corresponds to 10%, 20 mm 20%, etc.).

In this study, the patients were asked to mark the prosthetic satisfaction score on the VAS scale from 1 (very unsatisfied) to 10 (very satisfied).

Prosthetic complications evaluation

The major prosthetic complications were evaluated due to the loss/need to replace the prosthesis and leading to laboratory-based repair or replacement of the materials as chipping of the prosthetic material, fracture of framework or abutment.[15]

Chairside without replacing the prosthesis such as minor chipping, wear, loss of screw access hole material, fractured screws, screw loosening and wear of the prosthetic screw were reported as minor complications.[16]

Statistical analysis

The one sample statistics were used to evaluate the participants' scores depending on the study variables. Data were processed using the Statistical Package for the Social Sciences (software v.20) (SPSS/PC+, Inc.; Chicago, IL, USA) (statistical significiance; p = 0.05)

Results

Patient's characters were listed in Table 1. There was a total 185 healthy dental implants and 122 prosthetic restorations in this study.

Maxillary 45.40% (n=84) and mandibulary 54.59% (n=101) implants were evaluated. The number of patients and the number of implants for each patient were listed in Table 2.

The loaded 185 implants were positioned 14.59% (n=27) in the anterior region and 85.40% (n=158) in the posterior region.

Totally 122 prosthetic restorations were treated. The percentage of implant-supported single crowns was 49.18% (n=60) and bridges were 50.81 % (n=62). The percentage of screw-retained restorations was 22.13% (n=27) and cement retained restorations was 77.86% (n=95).

All prostheses were in function after a mean observational period of 6.5 years (±1.5 years) leading to a 100% prosthetic survival rate. Only 109 out of 122 prostheses were free of complications (89.34% of all prostheses).

The most frequently observed major complication was major chipping of the prosthetic material 2.45% (n=3). Minor complication rates of IFDP were 2.45% (n=3) abutment /screw loosening, 3.27% (n=4) debonding (loss of retention) and 2.45% (n=3) minor veneer chipping.

Table 1: Patient's descriptive characteristics

Descriptive characteristics (n=56)		n	%
Gender	Male	25	44.64
	Female	31	55.35
Age	18-65	43	76.78
	Upper 65	13	23.21
Level of education/ schooling	Basic education	11	19.64
	Secondary education	30	53.57
	University education	15	26.87

Table 2: The number of patients and number of implants for each patient

Number of implants for each patient (185)	Number of patients (n=56)
1	10
2	13
3	8
4	12
5	6
6	4
7	1
8	2

Prosthetic complications

Statistical results

High satisfaction with IFDP was seen in all 56 patients after 6.5 years (±1.5 years) years implant placement. The mean OHIP score was 2.82 (SD ± 5.44). The mean VAS score for general satisfaction with IFDP was 87.80 % (SD ± 13.79).

Sampling distributions and one-sample test results of OHİP-14 statements for 56 patients were listed in Table 3 and the one-sample statistics results were listed in Table 4.

Sampling distributions and one-sample test results of VAS Statements for 56 patients were listed in Table 5.

It resulted that the patients were satisfied with their oral health and IFPD due to the OHIP-14 questionnaire and VAS scale and there were no statistically significant differences between patients (p> 0.05).

Table 3. Sampling distributions and one-sample test results of OHİP-14 Statements for 56 patients

Statement (n=56)	Hardly ever 0 (%)	Occasionally 1(%)	Fairly often 2(%)	Very often 3(%)	Often 4(%)
OH1.Had trouble pronouncing any words	49(86)	4(7)	1 (1.8)	2 (3.5)	0
OH2.Felt sense of taste has worsened	46(80.7)	9(15.8)	1(1.8)	0	0
OH3.Had painful aching	45(80.35)	7(12.5)	3(5.35)	0	1(1.78)
OH4.Found it uncomfortable to eat any foods.	38(66.7)	13(22.8)	2(3.5)	2(3.5)	1(1.8)
OH5.Been self-conscious	52(92.85)	1(1.78)	1(1.78)	2(3.57)	0
OH6.Felt sence	43(75.4)	7(12.3)	5(8.8)	1(1.8)	0
OH7.Felt diet has been unsatisfactory	50(87.7)	3(5.3)	2(1.8)	1(3.5)	0
OH8.Had to interrupt meals	47(82.5)	4(7.0)	4(7.0)	1(1.8)	0
OH9.Found it difficult to relax	46(80.7)	5(8.8)	4(7.0)	1(1.8)	0
OH10.Been a bit embrassed	47(83.92)	8(14.28)	1(1.78)	0	0
OH11.Been a bit irritable	51(89.50)	3(5.30)	1(1.80)	1(1.80)	0
OH12.Had a difficulty doing usual jobs	48(84.2)	6(10.50)	1(1.80)	1(1.80)	0
OH13.Felt life less satisfying	45(78.90)	9(15.80)	1(1.80)	1(1.80)	0
OH14.Been totally unable to function	50(87.70)	4(7.00)	1(1.80)	1(1.80)	0

Table 4: The one-sample statistics results

	n= 56	*Mean*	*std. deviation*
1.Question	56	.2143	.65267
2.Question	56	.1964	.44393
3.Question	56	.3036	.73657
4.Question	56	.4821	.87368
5.Question	56	.1607	.62601
6.Question	56	.3571	.72434
7.Question	56	.1964	.64441
8.Question	56	.2679	.67396
9.Question	56	.2857	.67995
10.Questio	56	.1786	.43095
11.Question	56	.1429	.51974
12.Question	56	.1964	.55333
13.Question	56	.2500	.57997
14.Question	56	.1607	.53178
Totally	56	2.8214	5.44763

Table 5: Sampling distributions and one-sample test results of VAS Scores for 56 patients

Vas Scores	Frequency	Percent	Valid Percent	Cumulative percent
40.00	1	1.8	1.8	1.8
50.00	2	3.5	3.6	5.4
60.00	1	1.8	1.8	7.1
70.00	2	3.5	3.6	10.7
75.00	9	3.5	3.6	14.3
80.00	1	15.8	16.1	30.4
85.00	1	1.8	1.8	32.1
90.00	17	29.8	30.4	62.5
95.00	1	1.8	1.8	64.3
99.00	3	5.3	5.4	69.6
100.00	17	29.8	30.4	100.0
Total	56	98.2	100.0	

Discussion

The level of patient satisfaction, methods of evaluations and clinical findings on fixed single- and multiple-unit implant restorations and their effects are still under investigation across various studies. Prosthetic evaluations, implant survival, and patient-related outcomes were only infrequently reported and primary discussed and evaluated findings were about marginal bone levels or loss.[17]

In most of these included studies, the clinical evaluation and a radiographic examination were performed to measure marginal bone level changes. In many cases, merely panoramic radiographs were compared.[18]

According to ICOI Pisa Consensus Criteria, the probing of healthy implants was defined as unnecessary for the periodic controls especially if the presence of other symptoms and/or signs is indicated. It was reported that probing depths were not examined in the success or satisfactory health conditions, but were included in the compromised survival condition [5] and in this study, we included the success health conditions of the implants.

The implant based dentures can be treated by a screw-retained or cement- retained dentures for fixed partial dentures.[19] Castillo-Oyagüe at all compared the screw-retained and cement-retained IFDP and resulted that the retention system did not affect the OHRQoL[20] and the Ohip 14 and Vas scores were not affected by the retention system in our study.

A recent 5-year retrospective study classified the major or minor prosthetic complications depending on the need to perform the repair by removing the prosthesis.[15] The loss of screw access hole material (5.18%/year) was reported more frequently seen as a minor complication and the wear of the prosthetic material (5.85%/year) was the major complication. In this study, the percentage of the cemented restorations was higher than screwable prosthesis and the chipping was the most frequently observed complication for all restorations.

In implant dentistry, patient's perceptions and psychological parameters are turning into more important issues in determining the treatment outcomes in implant tretaments.[21,22]

In the literature, Tonetti and Palmer[23] suggested that implant dentistry should not only determine the biological and technical problems but also focus on patient's satisfaction and aesthetic consequences at the VIII. European Workshop on Periodontology. For example, Wang *et al.*[24] in a cross-sectional study in 2021 resulted that patients XIVE and Frialite implants treated with mostly IFPD restorations served a very high patient satisfaction concerning the functional and aesthetical parameters 10-year after implant treatments in 95 patients. The percentage of VAS scores for general satisfaction for IFDP was 93.0% (SD ± 9.4) and mean OHIP score was 11.3 (SD ± 10.8). In our study we investigated 6.5 (±1.5 years) after Straumann implants loading and patient satisfaction and oral health-related quality of life supporting the results with this study.

Pjetursson *et al.'s*[25] prospective cohort study asked to apply a questionnaire containing 13 expressions and to mark a VAS after 5-15 years after ITI implant treatment. More than 90% of the patients were highly satisfied with their implant treatment functionally and esthetically as the supporting results for our study.

Simonis *et al.*[26] investigated the degree of satisfaction of 55 patients with 131 implants. The patients were examined by clinically and radiographically after 10-16 years after implant treatment and questioned for degree of satisfaction. The general satisfaction percentage was 93.48% and the esthetic results were 91.31%. The complications were biological (16.94%) and technical (31.09%) complications.

Filius *et al.*[27] treated oligodontia patients with IFPD and at the 10-year follow up, clinical and radiographic data were collected. Patients completed the OHIP-NL49 to rate OHQoL and patients' satisfaction (8.3 ± 1.5) and OHIP-NL49 scores (32.6 ± 30.1) were served favourable results although peri-implant mucositis and peri-implantitis are commonly reported.

The OHIP-14 questionnaire results in this study were similar in the John *et al.*'s[28] cross-sectional study that investigated German population with natural teeth without dentures also considered a positive deal with the implant-supported restorations for patients.

The patient's data were collected in a single university dental clinic and more classification parameters are needed for further investigations.

Limitations

The major limitation in this cross-sectional study is the absence of the baseline data to assess changes due to the treatment 'implant placement'. The patient's expectation at baseline regarding the treatment outcome may also affect satisfaction.[29]

To overcome these limitations, prospective studies may be investigated in the future.

Conclusions

This study showed that the patients had high satisfaction levels according to the OHİP- 14 and VAS scores with implant-supported fixed partial dentures. More research is needed to comprehensively understand the outcomes, benefits, and potential concerns associated with this type of dentures.

Acknowledgments

Author contributors

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Written informed consent was obtained from all subjects before the study.

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The authors declare that there is no conflict of interest.

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Effect of Music Therapy on Dental Anxiety in Periodontal Surgery

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ABSTRACT

Introduction: Pharmacological or non-pharmacological methods are applied to eliminate fear and anxiety problems related to dental treatments in many patients. As a non-invasive, non-pharmacological method with an anxiolytic effect, music therapy is preferred in the management of anxiety and fear. This study aimed to investigate the effect of music therapy on dental anxiety in patients scheduled to undergo periodontal surgery.

Material and Method: The study included a total of 46 patients, 23 in the study group and 23 in the control group, who were scheduled to undergo periodontal surgery. During the surgical procedure, the patients in the study group listened to music using in-ear headphones that isolated ambient sounds. The patients in the control group wore in-ear headphones to isolate ambient sounds, but they did not listen to any music. All patients were asked to complete the Modified Dentistry Anxiety Scale (MDAS), the State-Trait Anxiety Inventory-State (STAI-S), and the Dental Fear Survey (DFS) before and after surgery. Systolic blood pressure (SBP) and diastolic blood pressure were measured as vital signs before and after surgery, and the Visual Analog Scale (VAS) scores were recorded twice (at the end of and 30 minutes after the surgical procedure).

Results: In the study group, the post-test MDAS, STAI-S, and DFS measurement values showed statistically significant decreases compared to the pre-test measurement values (P<0.001, P=0.009, and P<0.001, respectively), but there was no statistically significant difference in the control group (P=0.093, P=0.923, and P=0.460, respectively). In both the study and control groups, the post-test VAS measurement values statistically significantly decreased compared to the pre-test measurement values (P=0.002 and P=0.019, respectively). While the post-test SBP values decreased statistically significantly in the study group compared to the pre-test measurement values (P=0.020), there was no statistically significant difference in the control group (P=0.705). No statistically significant difference was found between the pre-test and post-test measurement values of the DFS scores in the study or control group (P=0.083 and P=0.160, respectively).

Clinical significance: This study is the first clinical study to evaluate the effect of music on anxiety in periodontal surgery simultaneously with four different scales. Music therapy was found to be effective in reducing dental anxiety and fear during periodontal surgery.

Key Words: Dental Anxiety, Music Therapy, Periodontal Surgery, Systolic And Diastolic Blood Pressure, MDAS, STAI-S, DFS, VAS.

Periodontal Cerrahide Müzik Terapinin Dental Kaygıya Etkisi

Süreç

Geliş: 10/11/2023
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ÖZ

Giriş: Birçok hastada diş tedavilerine bağlı korku ve kaygı sorunlarını ortadan kaldırmak için farmakolojik veya farmakolojik olmayan yöntemler uygulanmaktadır. Anksiyete ve korku tedavisinde noninvaziv, farmakolojik olmayan, anksiyolitik etkiye sahip bir yöntem olan müzik terapisi tercih edilmektedir. Bu çalışmada periodontal cerrahi planlanan hastalarda müzik terapisinin dental anksiyeteye etkisinin araştırılması amaçlandı.

Gereç ve Yöntem: Çalışmaya periodontal cerrahi planlanan 23'ü çalışma grubunda, 23'ü kontrol grubunda olmak üzere toplam 46 hasta dahil edildi. Cerrahi işlem sırasında çalışma grubundaki hastalar ortam seslerini izole eden kulak içi kulaklık kullanarak müzik dinlediler. Kontrol grubundaki hastalar ortam seslerini izole etmek için kulak içi kulaklık taktılar ancak herhangi bir müzik dinlemediler. Tüm hastalardan ameliyat öncesi ve sonrası Modifiye Diş Hekimliği Anksiyete Ölçeği'ni (MDAS), Durumluk-Sürekli Kaygı Envanteri-Durumunu (STAI-S) ve Dental Korku Anketini (DFS) doldurmaları istendi. Ameliyat öncesi ve sonrası vital bulgular olarak sistolik kan basıncı (SKB) ve diyastolik kan basıncı ölçüldü ve Görsel Analog Skala (VAS) skorları iki kez (cerrahi işlem sonunda ve ameliyattan 30 dakika sonra) kaydedildi.

Bulgular: Çalışma grubunda son test MDAS, STAI-S ve DFS ölçüm değerleri ön test ölçüm değerlerine göre istatistiksel olarak anlamlı düşüşler gösterdi (sırasıyla P<0,001, P=0,009 ve P<0,001), ancak kontrol grubunda istatistiksel olarak anlamlı bir fark yoktu (sırasıyla P=0.093, P=0.923 ve P=0.460). Hem çalışma hem de kontrol gruplarında son test VAS ölçüm değerleri ön test ölçüm değerlerine göre istatistiksel olarak anlamlı düzeyde azaldı (sırasıyla P=0,002 ve P=0,019). Çalışma grubunda son test SKB değerleri ön test ölçüm değerlerine göre istatistiksel olarak anlamlı derecede azalırken (P=0,020), kontrol grubunda ise istatistiksel olarak anlamlı bir fark saptanmadı (P=0,705). Çalışma ve kontrol grubunda DFS puanlarının ön test ve son test ölçüm değerleri arasında istatistiksel olarak anlamlı bir fark bulunmadı (sırasıyla P=0,083 ve P=0,160).

Klinik önemi: Bu çalışma, periodontal cerrahide müziğin anksiyete üzerindeki etkisini dört farklı ölçekle eş zamanlı olarak değerlendiren ilk klinik çalışmadır. Müzik terapisinin periodontal cerrahi sırasında diş kaygısını ve korkuyu azaltmada etkili olduğu bulundu.

Anahtar Kelimeler: Diş Kaygısı, Müzik Terapisi, Periodontal Cerrahi, Sistolik ve Diyastolik Kan Basıncı, MDAS, STAI-S, DFS, VAS.

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Introduction

Dental anxiety, which is frequently encountered in patients undergoing dental treatment as a more specific situation than general anxiety, occurs as a result of negative experiences gained in the personal, family, or social environment and can cause problems for both the physician and the patient. Dental anxiety can result in patients delaying their appointments for dental treatments and not attending their control visits regularly or et al.[1] This situation increases the incidence of dental diseases.[2] Not knowing what to expect in dental treatments and the possibility of pain during or after dental procedures usually cause anxiety and fear in patients. When anxiety and fear are observed in patients, these emotional states must be controlled by the physician in order for the process to progress appropriately. Among the effective methods in anxiety management are providing the patient with information about the treatment procedure, pharmacological options, behavioral management, biological feedback, and hypnosis. Pharmacological options offer short-term solutions. However, patients receiving pharmacological therapy are at increased risk due to drug interactions and potential overdose. Applications such as hypnosis should only be performed by professionals. Behavioral management is another method preferred in individuals with dental anxiety to reduce the use of anxiolytic drugs and relieve or decrease anxiety and fear. It has been reported that individuals with high anxiety levels prefer non-pharmacological interventions more in their dental treatments. Listening to music is the easiest non-invasive alternative to pharmacological intervention for the control of anxiety during the procedure. In particular, the anxiolytic effects of music have been investigated in various fields, including surgical, cardiac, and oncology patients.[3] Appropriate music has been shown to have a strong effect on brain waves, leading people to a state of deep relaxation, and music is currently accepted as a therapeutic application with scientifically proven beneficial psychological and physiological effects.[4–5]

Periodontal surgical procedures are frequently performed under local anesthesia and can increase the level of anxiety of patients upon their arrival at the dental unit and seeing materials to be used during surgery, and while in the operating room. However, in the literature, there is no study evaluating the effect of listening to music on anxiety in patients undergoing periodontal surgery. Therefore, this study aimed to evaluate the effects of music therapy on dental anxiety in patients scheduled to undergo periodontal surgery, using the Modified Dentistry Anxiety Scale (MDAS), the State-Trait Anxiety Inventory-State (STAI-S), the Dental Fear Survey (DFS), and the Visual Analog Scale (VAS).

Material and Method

This research was designed as a randomized prospective cohort study and included individuals who presented to the Department of Periodontology of Kirikkale University Faculty of Dentistry. The study was conducted in accordance with the ethical rules of the Declaration of Helsinki and approved by the Non-Interventional Research Ethics Committee of the university (**meeting date:** 12/01/2022, **meeting number:** 2022/01, **decision number:** 2022.01.03). Prior to the study, all individuals participating in the study were given detailed information about the purpose and methodology of the study, and their consent was obtained using an informed consent form.

Patients who required periodontal surgery (frenectomy, gingivectomy, gingivoplasty, mucogingival surgery, implant surgery, and sinus lifting) were included in the study. The sample consisted of a total of 46 individuals, of whom 23 were included in the music therapy group (study group) and 23 did not listen to any music (control group). Each patient who agreed to participate in the study was allocated to one of the two groups using the lottery method, in which the first patient undergoing the same type of surgical procedure drew his/her group, and the next patient was assigned to the other group.

Pre-surgical Process

The consent form was completed by each patient. The patients participating in the study were informed that they could withdraw from the study at any time and were not attempted to be persuaded in any way to continue the study. The pre-surgical measurement of blood pressure values and the completion of the anxiety and fear scales were undertaken in the waiting room.

Surgical Procedure

The surgical procedure was standardized for each periodontal surgery. After the surgical dressing was covered, infiltration anesthesia was induced by administering an Ultracaine solution containing articaine and epinephrine (1: 100,000). Five minutes after the application, the level of numbness in the relevant area was checked, and the surgical procedure was initiated when this level was deemed sufficient. Pre-surgical procedures and surgery were performed by a single physician. If the patient complained of pain or discomfort during the procedure, an additional anesthetic solution was administered, and the procedure was resumed once the patient's complaint subsided. Additional anesthesia requirements were recorded. Post-surgical instructions concerning wound care, hemostasis, and the use of prescribed drugs were provided for each patient after the procedure.

Application of Music Therapy

Before the surgical procedure, the participants in both groups were asked to bring in-ear headphones that they routinely used to isolate external sounds. During surgery, the study group listened to classical Western music (Bach, Beethoven, and Chopin), choosing the tracks themselves. During surgical preparation, the patients were asked to

put on the headphones before the sterile dressing was placed. The patients were allowed to control the volume or stop the music using the music player. Thus, each patient was able to adjust the sound to a personally appropriate level, allowing them to communicate with the physician. Music was played until the end of the procedure. When it was necessary to communicate with the patient during the procedure, the music was temporarily stopped and resumed by the patient after communication was over.

Monitoring of Vital Signs and Evaluation of Anxiety, Fear, and Pain

The blood pressure values of the patients were first recorded in the waiting room. The anxiety values were measured before and after the procedure using the MDAS and STAI-S, fear levels were measured before and after the procedure using the DFS, and pain levels were recorded twice (at the end of and 30 minutes after the procedure) using the VAS. In order to record the VAS scores, the patients were asked to evaluate their current pain intensity on a scale of 0 to 10. Blood pressure values were measured again after the procedure.

After the patients had rested for a while in the waiting room for postoperative observation, they were asked, "Would you undergo the same procedure again?", and their responses were recorded.

Statistical Analysis

The G*Power (ver. 3.1.9.2, Franz Faul, Êniversität Kiel, Germany) package program was used to calculate the sample size and power required for the study. It was determined that at least 46 sample units were needed to achieve an effect width of f = 0.25 with a type 1 error probability of $\alpha = 0.05$ and power of 0.91.

The statistical analyses of the data obtained from the study were undertaken using the SPSS (version 22.0, SPSS Inc., Chicago, IL, USA) package program. Descriptive statistics were reported using mean ± standard deviation values for normally distributed numerical data, and median (minimum-maximum) values for continuous data that did not comply with the normal distribution. The descriptive statistics of categorical variables were reported using numbers and percentages (%). Correlation analyses and ratio comparisons between categorical variables were performed with either the chi-square test or Fisher's exact test, depending on the sample sizes in the cross-tab boxes. The conformity of data to the normal distribution was evaluated using the Shapiro-Wilk test. Independent-samples t-test (Student's t-test) was used to compare numerical data between two normally distributed independent groups, and the Mann-Whitney U test was used to compare non-normally distributed data. The dependent-samples t-test (paired t-test) was used to compare numerical variables between two normally distributed repeated measures, and the Wilcoxon signed rank test to compare two non-normally distributed repeated measures. The two-way mixed analysis of variance was performed to test whether the research groups had an effect (interaction effect) on the changes in the repeated measurements of MDAS, STAI-S, DFS, and VAS scores measured at two different times. During this analysis, the Bonferroni correction was applied for the intra-group and inter-group comparisons. The homogeneity of variances was evaluated with Levene's test. The assumption of the homogeneity of covariance matrices was evaluated using Box's M test. In cases where the assumption of the homogeneity of covariance matrices was not met, Pillai's trace test was employed as a multivariate analysis method. $P < 0.05$ was accepted as the limit of significance in all statistical comparisons.

Results

The study included a total of 46 patients, of whom 23 were in the control group and 23 were in the study group. Of all the patients, 67.4% (n=31) were female, and 32.6% (n=15) were male. The mean age of the patients was 39.26 ±15.19 (min-max: 18-67) years. Statistical findings concerning the comparison of sociodemographic characteristics between the groups are shown in Table 1. Gender distribution and mean age were statistically similar between the study and control groups (*P*=.753 and *P*=0.879, respectively). The patients were similarly distributed between the groups according to their place of residence (*P*=0.846). Income status, employment status, and education level were also similar in the two groups (*P*=0.552, *P* =0.422, and *P* =0.753, respectively).

Table 2 presents the statistical findings on the comparison of the study and control groups in terms of other characteristics that could have an effect on anxiety. The rate of additional anesthesia requirements was statistically similar between the groups (*P*=0.730). The rates of patients with companions and those with a history of previous dental treatment were statistically similar (*P*= .555 and *P*=1.000, respectively). The patients in both groups also had similar thoughts about undergoing the same procedure again (*P*=0.116). Lastly, there was no statistically significant difference between the operative times of the study and control groups (*P*=0.991).

The intra-group and inter-group comparisons of the MDAS scores measured at two different times are shown in Table 3. Accordingly, the time x group interaction effect was not statistically significant [F (1;44) = 2.615, *P*=0.113]. The main effect of time was statistically significant [F (1;44) = 16.342, *P*<.001]. However, when the main effect of group was evaluated, the MDAS scores did not statistically differ between the groups [F (1;44)=0.276, *P*= 0.602]. In the control group, the change in the MDAS score from the pre-test to the post-test was not statistically significant (*P*=0.093). In the study group, the decrease in the post-test MDAS score was statistically significant compared to the pre-test score (*P*<.001). Figure 1 presents the line chart of the inter-group comparison of the changes in the MDAS scores measured at two different times.

Table 1. Statistical findings on the comparison of sociodemographic characteristics between the groups

			Study Group (n = 23) n (%)	Control Group (n = 23) n (%)	*P* value
Gender	Male		7 (30.4%)	8 (34.8%)	0.753a
	Female		16 (69.6%)	15 (65.2%)	
Place of residence		Province	17 (73.9%)	19 (82.6%)	0.846b
		District	5 (21.7%)	3 (13%)	
		Village	1 (4.3%)	1 (4.3%)	
Income status		Below 5,500 TL	14 (60.9%)	12 (52.2%)	0.552a
		5,500 TL and over	9 (39.1%)	11 (47.8%)	
Employment status		Employed	9 (39.1%)	5 (21.7%)	0.422a
		Unemployed	10 (43.5%)	12 (52.2%)	
		Student	4 (17.4%)	6 (26.1%)	
Education level		İlliterate	2 (8.7%)	0 (0%)	0.753b
		Primary school	8 (34.8%)	10 (43.5%)	
		High school	6 (26.1%)	6 (26.1%)	
		University	7 (30.4%)	7 (30.4%)	
Age (years)			**Mean ± SD** 39.61 ± 15.09	**Mean ± SD** 38.91 ± 15.61	0.879c

a: Chi-square test b: Fisher's exact test c: Independent-samples t-test (Student's t-test) SD: Standard Deviation

Table 2. Statistical findings on the comparison of groups in terms of other characteristics with possible effects on anxiety

		Study Group (n = 23) n (%)	Control Group (n = 23) n (%)	*P* value
Additional anesthesia	Applied	6 (26.1%)	5 (21.7%)	0.730a
	Not applied	17 (73.9%)	18 (78.3%)	
Patient companion	Present	13 (56.5%)	11 (47.8%)	0.555a
	Absent	10 (43.5%)	12 (52.2%)	
History of dental treatment	Present	23 (100%)	22 (95.7%)	1.000b
	Absent	0 (0%)	1 (4.3%)	
Thoughts about future procedure	Positive	18 (78.3%)	13 (56.5%)	0.116a
	Undecided	5 (21.7%)	10 (43.5%)	
Operative time		**Mean ± SD** **Median (min-max)** 80.43 ± 31 85 (35-130)	**Mean ± SD** **Median (min-max)** 80 ± 31.15 75 (45-150)	0.991c

a: Chi-square test b: Fisher's exact test c: Mann-Whitney U test SD: Standard Deviation

Table 3. Statistical findings on the intra-group and inter-group comparisons of the MDAS, STAI-S, DFS, and VAS scores measured at two different times.

	Group	Pre-test	Post-test	P value
		Mean ± SS	**Mean ± SS**	
MDAS	Control	10.48 ± 2.99	9.96 ± 2.83	0.093
	Study	10.30 ± 4.19	18 (78.3%)	<0.001
	P value	0.872	0.366	Interaction effect F (1;44) = 2.615 P = 0.113
STAI-S	Control	36.22 ± 9.15	36.04 ± 8.97	0.923
	Study	37.96 ± 6.75	33.04 ± 6.72	0.009
	P value	0.467	0.206	Interaction effect F (1;44) = 3.491 P = 0.068
DFS	Control	37.09 ± 19.02	36.26 ± 12.09	0.460
	Study	37.48 ± 11.41	32.17 ± 7.01	<0.001
	P value	0.918	0.168	Interaction effect F (1;44) = 8.169 P = 0.006
VAS	Control	3.39 ± 1.80	2.52 ± 1.78	0.019
	Study	2.87 ± 1.68	1.70 ± 0.82	0.002
	P value	0.316	0.049	Interaction effect F (1;44) = 0.366 P = 0.548

MDAS: Modified Dentistry Anxiety Scale, STAI-S: State-Trait Anxiety Inventory-State, DFS: Dental Fear Scale, VAS: Visual Analog Scale, SD: Standard Deviation

The intra-group and inter-group comparisons of the STAI-S scores measured at two different times are given in Table 3. The time x group interaction effect was close to the statistical significance limit [F (1;44) = 3.491, *P* = .068]. The main effect of time was at the limit of statistical significance [F (1;44) = 4.023, *P* = .051]. When the main effect of the group was evaluated, the STAI-S scores did not statistically significantly differ between the groups [F (1;44) = .101, *P* = .752]. In the control group, the pre-test and post-test measurement values of the STAI-S variable were not statistically different (*P* = .923). However, in the study group, there was a statistically significant decrease in the post-test STAI-S score compared to the pre-test value (*P* = .009). Figure 1 shows the line chart of the inter-group comparison of the changes in the STAI-S scores measured at two different times.

Table 3 shows the intra-group and inter-group comparisons of the DFS scores measured at two different times. According to the results, the time x group interaction effect was statistically significant [F (1;44) = 8.169; *P*=.006]. In the control group, there was no statistically significant difference between the pre-test and post-test measurement values related to the DFS variable (*P*=.460). In the study group, the post-test DFS value significantly differed from the pre-test value (*P*< .001). The inter-group comparison of the pre-test and post-test DFS values did not reveal any significant difference (*P*=.918 and *P*=.168, respectively). Figure 1 presents the line chart of the changes in the DFS scores measured at two different times, according to the group.

The intra-group and inter-group comparisons of the VAS values measured at two different times are given in Table 3. The time x group interaction effect was not statistically significant (F=0.366, *P*=0.548). The main effect of time was statistically significant (F = 16.519, *P* < .001).

When the main effect of group was evaluated, the VAS scores did not statistically significantly differ between the groups [F (1;44) = 2.970, *P*=0.092). The pre-test and post-test measurement values of the VAS variable were statistically significantly different when compared between the control and study groups (*P*=0.019 and *P*=0.002, respectively). While the pre-test VAS scores of the two groups did not statistically significantly differ, there was a statistically significant difference in the post-test VAS scores (*P*=0.316 and *P*=0.049, respectively). The line chart of the changes in the VAS scores measured at two different times is presented in Figure 1.

In the control group, the pre-test and post-test measurement values of systolic blood pressure were not statistically different (*P*=0.705; Table 4). However, in the study group, there was a statistically significant difference between the pre-test and post-test measurement values of systolic blood pressure (*P*=0.020). The inter-group comparison of the pre-test and post-test systolic blood pressure values did not indicate any significant difference (*P*=0.515 and *P*=0.385, respectively). Figure 2 shows the line chart of the changes in the systolic blood pressure values of the groups measured at two different times.

No statistically significant differences were found between the pre-test and post-test measurement values of diastolic blood pressure in the control group (*P*=0.160) or the study group (*P*=0.083) (Table 4). There were also no statistically significant differences in the pre-test and post-test values of diastolic blood pressure between the two groups (*P*=0.629 and *P*=0.133, respectively). Figure 2 presents the line chart of the changes in diastolic blood pressure values measured at two different times, according to the group.

Table 5 shows the statistical findings concerning the comparison of the study and control groups in terms of the pre-test to post-test changes in the MDAS, STAI-S, DFS, and VAS scores and systolic and diastolic blood pressure values. Accordingly, the time-dependent decrease in the MDAS and STAI-S values was greater in the study group. The difference between the groups was close to the statistical significance limit but not significant (*P*=0.056 for MDAS and *P*=0.068 for STAI-S). Although the time-dependent decrease in the VAS score and systolic and diastolic blood pressure values was greater in the study group than in the control group, there was no statistically significant difference between the groups (*P*=0.548, *P*=0.123, and *P*=0.397, respectively). Lastly, the time-dependent decrease in the DFS value was statistically significant in both groups (*P*=.001).

Discussion

Controlling anxiety and fear in dental treatments is important for the physician, the patient, and the success of the procedure. Pharmacological or non-pharmacological options with anxiolytic effects are preferred to control anxiety. Studies have reported that patients with dental anxiety prefer non-pharmacological methods more. Music therapy, a non-pharmacological method that has been applied for centuries across the world in different types of diseases, is more suitable than pharmacological options in terms of applicability, side effects, and cost, and is positively received by patients. Music therapy is also preferred in surgical procedures that increase anxiety. Bradt and Teague (2018) found music therapy to be an effective tool in controlling patients' anxiety levels during surgical procedures. [6] Specifically, the anxiolytic effects of music have been investigated in various fields, including surgical, cardiac, and oncology patients. [3] Considering the advantages of music therapy related to its application, ability to reduce surgical stress and sedative requirement, and provision of relief by eliminating feelings of anxiety and fear without any side effects compared to pharmacological alternatives, we investigated the effects of this therapy on the anxiety levels of patients undergoing surgical procedures by comparing patients that did receive this therapy and controls.

Many studies involving music interventions suggest that some types of music decrease activity in the sympathetic nervous system, provide relaxation, and reduce anxiety in patients. Music therapy relieves feelings

of anxiety, fear, and stress.[7] Listening to music affects the limbic system by stimulating the right hemisphere of the cerebrum, creating a psychophysiological response. [8] Enkephalin and endorphin are released through the activation of the parasympathetic system.[9] The resulting psychophysiological response decreases the pain and stress levels of patients and has positive effects on their vital signs and pain intensity. It has been found that listening to music reduces blood pressure, normalizes arrhythmias, and induces relaxation in surgical procedures performed under local anesthesia.[10]

For determining dental fear and anxiety levels in patients, behavioral and physiological changes are observed, or questionnaires and standard scales are used.[11] Many scales have been developed to assess anxiety levels, and each stands out with different features. In a study comparing six different scales, Schuurs and Hoogstraten (1993) reported that none of the scales fully reflected the concept of dental anxiety; therefore, more than one scale should be used in studies on dental anxiety.[12] Hakeberg and Berggren (1997) stated that one or more scales should be used in clinical studies to ensure data reliability and evaluate dental anxiety.[13] In another study, the completion of such scales before the procedure did not have any negative effects on anxiety and fear levels.[14] In our study, anxiety and fear levels were evaluated using different scales (MDAS, STAI-S, and DFS). As a short, comprehensible, and simple instrument, the MDAS is one of the most commonly used scales to measure dental anxiety. In addition to containing questions related to traditional treatment, the MDAS has the advantage of being completed easily and quickly.[15] The STAI-S is another easy-to-apply and easy-to-assess scale that can be used to assess instantaneous feelings of anxiety, tension, and nervousness, as well as susceptibility to anxiety. It is widely accepted in the literature, is well tolerated by patients, and has also been found to be reliable and valid for the Turkish population. The VAS is the most commonly used oral scale to assess pain. It is one of the preferred pain measurement tools due to its ease of use, independence of language, and simple structure for the participant and researcher.

Many studies have shown the curative effect of classical music on various diseases. In the current study, the patients listened to pieces of classical western music through in-ear headphones. During the procedure, the control to change, stop, or resume the music or adjust the volume was left to the patients. This allowed the patients to use the volume that was most comfortable for them, and they welcomed the idea of having this control. Sound level control by the patient is also recommended in order not to distract the surgical team during surgery.[16] With the provision of external sound insulation, the sounds related to surgical materials and medical conversations between the surgical team members about the procedure did not reach the patient, preventing an associated increase in anxiety levels.

In a study conducted with 80 (52 female and 28 male) patients, Zorba *et al.*[17] (2004) investigated the effects of age, gender, and education level on anxiety [Dental Anxiety Scale (DAS) and DFS]. The authors determined that age and education status were not significantly related to either scale score, whereas gender provided significant results for DAS but non-significant results for DFS. On completion of the study, it was concluded that female patients were more prone to anxiety. In a study by Holtzman and Berg (1997), DFS was administered to 398 adults, and scores were calculated.[18] Age and gender differences were noted, and it was reported that the significance of fear and anxiety decreased with increasing age. Anxiety was mostly seen in young female participants, while age and physiological response had no relationship with fear and anxiety among men. Concerning the studies evaluating the effects of age and gender on anxiety in the literature, it is generally suggested that the significance of fear and anxiety decreases with increasing age and that women have higher anxiety levels than men. In the current study, mean age and gender distributions were similar between the groups, and their effects on anxiety were negligible.

In a study conducted by Erakman and Bayram (2019), the anxiolytic effect of listening to music and changes in vital signs were examined during the extraction of impacted mandibular wisdom teeth.[3] There was no statistically significant difference in the MDAS scores between the group that received the music intervention and the control group. In another study, Packyanathan *et al*.[19] (2019) evaluated the MDAS scores and systolic and diastolic blood pressure values before and after tooth extraction in a total of 50 patients randomly allocated to the test (music therapy) and control (no intervention) groups and found reductions in all these variables in the test group. In contrast, these variables increased in the control group. Rubalcava *et al*.[20] (2015), examining the effect of music therapy on the changes in physiological parameters in individuals with dental anxiety, observed a decrease in the MDAS scores, systolic and diastolic blood pressure values, and salivary cortisol concentration. Similarly, in our study, we determined that the MDAS scores and blood pressure values decreased in the study group. We consider that this is due to the effect of music on the psychophysiological or autonomic nervous system.

Bradt *et al*.[21] (2016) conducted a study to evaluate and compare the effects of music therapy on psychological and physical outcomes in individuals with cancer and found that this therapy reduced the STAI scores, heart rate, respiratory rate, and blood pressure. Lai *et al*.[22] (2008) explored the effects of music on state anxiety and physiological indices in patients who underwent root canal treatment. The authors reported that significant improvements in the anxiety values measured before and after the procedure and the heart rate and blood pressure values measured during the procedure in the music therapy group, while there was no significant difference in the blood pressure and heart rate values in the control group. Similarly, in our study, the STAI-S scores and blood pressure values decreased in the group that listened to music during the procedure. This can be explained by the

effect of music therapy on reducing the activity of the neuroendocrine and sympathetic nervous systems.

In this study, the pre-test DFS scores of the study and control groups were statistically similar. There was a decrease in the DFS scores over time, with this change being found to be statistically significant in the study group and non-significant in the control group. The post-test DFS scores were lower in the study group than in the control group. There was a statistically significant difference between the two groups in terms of the pre-test to post-test changes in the DFS scores. Music creates positive effects on the patient's endocrine and nervous systems, enabling meaningful reactions to occur in emotions and thoughts. Studies have shown that music positively affects hormones such as serotonin, dopamine and adrenaline, which regulate people's emotional state; It has been observed that it regulates physiological functions such as blood pressure and respiratory rhythm and ensures the balance of oxygen and blood supply in the brain. [23] Similar to the results of other studies, our study demonstrated the physiological and psychological effectiveness of music and its reduction in dental fear levels.

In a study that aimed to measure the effect of music on sedative requirement and hemodynamic values and compare the anxiolytic effects of music and self-administered midazolam, Lepage *et al.*[24] (2001) found that listening to music was associated with a decrease in midazolam requirement. Similarly, in another study, it was reported that music provided deep relief from anxiety and reduced the amount of medication required for sedation and analgesia.[25]

Gümüş *et al*. (2020) conducted a study to examine the effect of music as a non-pharmacological pain relief method in the post-operative period in children and found it to be effective in reducing the pain felt during this period.[26] Şen *et al.* (2010) investigated the effect of music therapy on post-operative pain and the duration of its efficacy and observed that this therapy reduced post-operative analgesic requirement and pain intensity.[27] In our study, the VAS scores were found to be lower in the group that listened to music during the procedure. The additional anesthesia requirement during the procedure was also lower in the music therapy group. These findings can be attributed to the anxiolytic effects of music therapy. A limitation of our study may be that the in-ear headphones are not standard. It added to the end of the last paragraph in the discussion section.

Our study is the first clinical research to evaluate the effect of music on anxiety during periodontal surgery using four different scales simultaneously. The fact that many surgical procedures were performed may be one of the weaknesses of the study. Reducing surgical variability may further demonstrate the effectiveness of music.

The results of our study are also supported by different studies in the literature evaluating the efficacy of music therapy in reducing anxiety.[28]

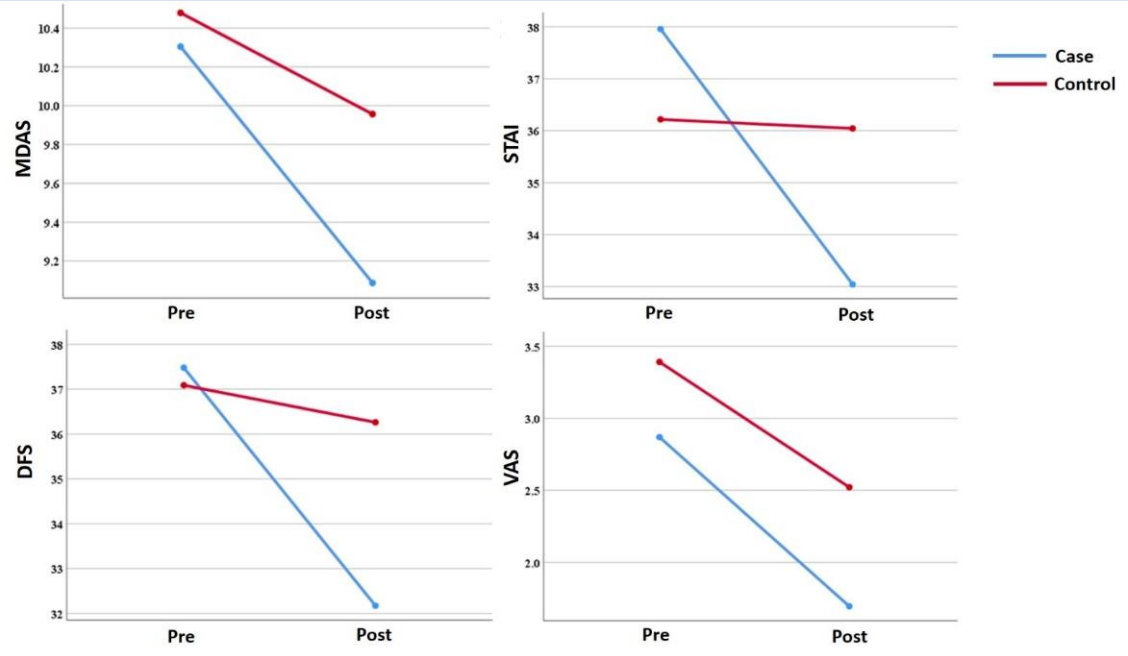

Figure 1. Line graph of the inter-group comparison of the changes in the MDAS, STAI-S, DFS, and VAS scores measured at two different times.

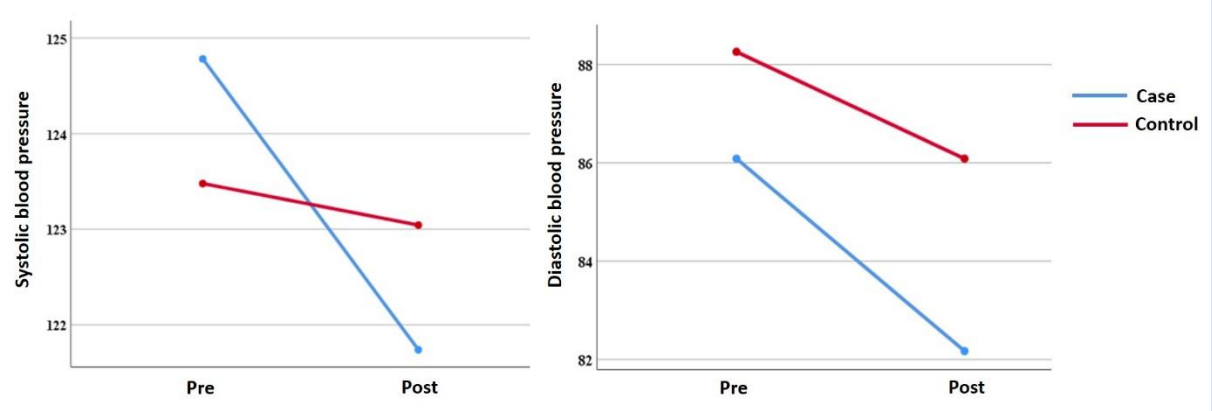

Figure 2. Line graph of the inter-group comparison of the changes in the systolic and diastolic blood pressure values measured at two different times.

Table 4. Statistical findings on the intra-group and inter-group comparisons of the systolic and diastolic blood pressure values measured at two different times.

	Group	Pre-test	Post-test	*P* value
		Mean ± SS	**Mean ± SS**	
Systolic blood pressure	**Control** Median (min-max) (123.48 ± 6.47)	120 (120-140)	120 (120-130) (123.04 ± 4.7)	0.705a
	Study Median (min-max) 124.78 ± 7.3	120 (120-140)	120 (110-130) 121.74 ± 4.91	0.020a
	P value	0.515b	0.385b	
Diastolic blood pressure	**Control** Median (min-max) 88.26 ± 11.54	80 (80-110)	36.04 ± 8.97 86.09 ± 9.88	0.160a
	Study Median (min-max) 86.09 ± 8.91	80 (80-110)	80 (70-100) 82.17 ± 5.99	0.083a
	P value	0.629b	0.133b	

Table 5. Statistical findings on the comparison of the groups in terms of the pre-test to post-test changes in the investigated variables.

	Group n		Pre-test	Post-test	Pre-test to post-test change	*P* value
			Mean ± SD	**Mean ± SD**		
MDAS	Study	23	10.3 ± 4.19	9.09 ± 3.57	1.21 ± 1.62	0.056b
	Control	23	10.48 ± 2.99	9.96 ± 2.83	0.52 ± 1.27	
STAI-S	Study	23	37.96 ± 6.75	33.04 ± 6.72	4.91 ± 6.52	0.068a
	Control	23	36.22 ± 9.15	36.04 ± 8.97	0.17 ± 10.26	
DFS	Study	23	37.48 ± 11.41	32.17 ± 7.01	5.30 ± 5.93	0.001b
	Control	23	37.09 ± 14.02	36.26 ± 12.09	0.82 ± 4.60	
VAS	Study	23	2.87 ± 1.68	1.70 ± 0.82	1.17 ± 1.49	0.548a
	Control	23	3.39 ± 1.8	2.52 ± 1.78	0.86 ± 1.89	
Systolic blood pressure	Study	23	124.78 ± 7.3	121.74 ± 4.91	3.04 ± 5.58	
	Control	23	123.48 ± 6.47	123.04 ± 4.7	0.43 ± 5.62	0.123b
Diastolic blood pressure	Study	23	86.09 ± 8.91	82.17 ± 5.99	3.91 ± 9.4	0.397b
	Control	23	88.26 ± 11.54	86.09 ± 9.88	2.17 ± 7.35	

a: Independent-samples t-test (Student's t-test)
b: Mann-Whitney U test

Conclusion

Our study is the first clinical research to evaluate the effect of music on anxiety during periodontal surgery using four different scales simultaneously. We found music therapy to be effective in reducing dental anxiety and fear levels during periodontal surgery. Music therapy is a non-pharmacological anxiolytic method that can be used to provide anxiolytic activity during periodontal surgery, and it can be applied before or during the procedure in individuals with high levels of anxiety and fear to protect them from side effects that may develop due to drug use. It is recommended that the anxiolytic

effects of music therapy be further evaluated in larger samples.

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The Effects of Home and Over-The-Counter Whitening Agents on Surface Roughness and Microhardness of High Aesthetic Composites

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Research Article

History

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ABSTRACT

Introduction: The aim of this in-vitro study is to compare the effect of the newly released peroxide-free over-the-counter whitening products and the home whitening material containing carbamide peroxide, on high aesthetic composites.
Materials and methods: In our study, 4 different composites were used: supra-nano(Tokuyama Estelite Asteria), submicron hybrid(Brilliant Ever Glow), nanofil(Filtek Universal Restorative) and finally nano-ceramic(Ceram.x SphereTEC one). A total of 200 disc-shaped composite specimens with 2 mm thickness and 8 mm diameter were prepared using metal molds(n=10). One surface of the samples was polished using Sof-Lex™ XT discs. Composite groups were divided into 5 subgroups as 4 experimental and 1 control groups (n=10) . Four whitening products, namely Opalascence Home Type, Mr. Blanc, I-White, Cali White, were used in the experimental groups. It was kept in a drying oven at 37°C to imitate the temperature of the mouth on certain days and hours in accordance with the instructions written in the whitening products prospectus. The surface roughness of the samples was measured with a profilometer and the microhardness values were measured with a fully automatic Micro Hardness Tester. The surfaces were examined with a Scanning Electron Microscopy. Data were evaluated with two-way Variance Analysis and Tukey Test as statistical methods.
Results: According to the surface roughness data, Filtek Universal Restorative's I-White subgroup showed the highest average surface roughness value, and Tokuyama Estelite Asteria's I-White subgroup showed the lowest value. There was a significantly difference between the composite main groups and the experimental subgroups($p<0.05$). According to microhardness data, I-White subgroup of Tokuyama Estelite Asteria showed the highest average microhardness value and the lowest value was Brilliant Ever Glow's I-White subgroup. A significantly difference was observed between the composite main groups and the experimental subgroups($p<0.05$). Although OTC whitening products did not significantly change the surface roughness and microhardness values of composite resins, when SEM analyses were examined, it was observed that all OTC whitening products caused more cleft, crack and defect-like changes on the composite surfaces compared to Opalescence home whitening agent.
Conclusions: It can be stated that Filtek Universal Restorative material is the composite that is most negatively affected by whitening materials, while Tokuyama Estelite Asteria composite is the least affected.

Keywords: Aesthetic composite, microhardness, surface roughness, whitening.

Yüksek Estetiğe Sahip Kompozitlere Uygulanan Ev Tipi ve Tezgah Üstü Beyazlatma Ajanlarının Yüzey Pürüzlülüğü ve Mikrosertlik Üzerine Etkisi

Süreç

Geliş: 03/01/2024
Kabul: 31/01/2024

ÖZ

Giriş: Bu in-vitro çalışmanın amacı, piyasaya yeni çıkan, peroksit içermeyen tezgah üstü beyazlatma ürünleriyle, karbamid peroksit içerikli ev tipi beyazlatma materyalin, yüksek estetiğe sahip kompozitler üzerindeki etkisini karşılaştırmaktır.
Gereç ve Yöntemler: Çalışmamızda supra-nano(Tokuyama Estelite Asteria), submikron hibrit(Brilliant Ever Glow), nanofil(Filtek Universal Restorative) ve son olarak nano-seramik(Ceram.x SphereTEC one) olmak üzere 4 farklı kompozit kullanıldı. Metal kalıp kullanılarak 2 mm kalınlığında 8 mm çapında toplam 200 adet disk şeklinde kompozit örnek hazırlandı(n=10). Örneklerin bir yüzeyine Sof-Lex™ XT diskler kullanılarak polisaj işlemi uygulandı. Kompozit grupları 4 deney ve 1 kontrol grubu olmak üzere 5 alt gruba ayrıldı (n=10). Deney gruplarında Opalascence Ev Tipi, Mr.Blanc, İ-White, Cali White, olmak üzere dört adet beyazlatma ürünü kullanıldı. Beyazlatma ürünleri prospektüsünde yazan talimatlar doğrultusunda belirli gün ve saatlerde ağız sıcaklığını taklit edecek şekilde 37°C'de etüvde bekletildi. Örneklerin yüzey pürüzlülüğü profilometre cihazı, mikrosertlik değerleri tam ttomatik Mikro Sertlik Ölçüm Cihazı ile bakıldı. Taramalı Elektron Mikroskobu ile yüzeyleri incelendi. Veriler, istatistiksel yöntem olarak iki yönlü Varyans Analizi ve Tukey Testi ile değerlendirildi.
Bulgular: Yüzey pürüzlülüğü verilerine göre, en yüksek ortalama yüzey pürüzlülüğü değerini Filtek Universal Restorative'in İ-White alt grubu, en düşük değeri Tokuyama Estelite Asteria'ın İ-White alt grubu gösterdi. Kompozit ana grupları ve deney alt grupları arasında fark anlamlı bulundu($p<0,05$). Mikrosertlik verilerine göre, en yüksek ortalama mikrosertlik değerini Tokuyama Estelite Asteria'ın İ-White alt grubu, en düşük değeri Brilliant Ever Glow'un İ-White alt grubu gösterdi. Kompozit ana grupları ve deney alt grupları arasında fark anlamlı bulundu($p<0,05$). OTC beyazlatma ürünleri, kompozit rezinlerin yüzey pürüzlülük ve mikrosertlik değerlerini anlamlı derecede değiştirmemesine rağmen, SEM analizleri incelendiğinde tüm OTC beyazlatma ürünlerinin Opalescence ev tipi beyazlatma ajanına göre kompozit yüzeylerinde daha fazla yarık, çatlak ve defekt benzeri değişimlere uğrattığı görülmüştür.
Sonuçlar: Beyazlatma materyallerinden olumsuz yönde en çok etkilenen kompozit Filtek Universal Restorative materyali iken, beyazlatma ürünlerinde en az etkilenen materyal ise Tokuyama Estelite Asteria kompozitin olduğu söylenebilir.

Anahtar kelimeler: Beyazlatma, estetik kompozit, mikrosertlik, yüzey pürüzlülüğü.

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Introduction

In recent years, with the increasing desire for whiter teeth, teeth whitening has become a popular treatment option among patients. Today, teeth whitening options include professional in-office whitening performed by a dentist, home whitening performed at home under the supervision of a dentist, and self-administered whitening with over-the-counter (OTC) products.[1] The availability and easy access to OTC whitening products have increased their popularity. This option is less time-consuming, more cost-effective, and eliminates the need for extra appointments with the dentist compared to a professionally prescribed home whitening product.[2] Unattended whitening with an OTC whitening product can have potentially harmful effects on general health and dental health in particular.[3-5]

Today, composites are among the most commonly used restorative materials. There are different types of composites on the market, which vary mainly according to filling technologies. Among these, micro-filled (MF), micro-hybrid (MH) and recently nano-hybrid (NH) composites are widely used in the clinical setting.[6] Whitening products can also change the roughness, hardness, flexural strength and colour stability of restorative composites.[7] Since whitening products cannot affect the optical properties of restorative materials, they should be replaced in anterior teeth if they are not aesthetically satisfactory.[8]

Most whitening products use hydrogen peroxide as the active ingredient.[9] Home whitening has become a preferred treatment method for patients and dentists due to its excellent clinical efficacy, easy application, low cost and safety of the materials used. One of the products used for this procedure is carbamide peroxide at concentrations of 10-16%, which converts to free radicals (OH-) when it comes into contact with saliva.[7] During the whitening process, carbamide peroxide is separated into hydrogen peroxide and urea, with the concentration of hydrogen peroxide being approximately one third of the original carbamide peroxide concentration. Therefore, a 15 percent carbamide peroxide product is approximately 5 per cent hydrogen peroxide.[10]

EU Council Directive 2011/84/EU entered into force on 31 October 2012. It states that products containing more than 0.1% or less than 6% hydrogen peroxide present or released in tooth whitening agents shall only be sold to dentists. As a result of Directive 2011/84/EU, there has been an increase in "non-hydrogen peroxide" products entering the market. These products contain a range of active ingredients with limited research on their safety and efficacy.[11]

Teeth whitening systems that do not contain peroxide are available as over-the-counter products in the form of gels, mouthwashes, chewing gums, toothpastes, and whitening strips.[9] Other concerns about over-the-counter products are the risk of misuse, overuse and abuse due to self-administration.[11]

The aim of this study was to evaluate in vitro the effects of home whitening and three different peroxide free over-the-counter (OTC) whitening products on the surface roughness and microhardness of composites applied to four different high aesthetic composite materials.

Materials and Methods

Preparation of Composite Samples

The study was started with the approval of Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee dated 18.03.2020 and decision number 2020-03/12. The composites samples were prepared using a metal mould made of stainless steel with a diameter of 8 mm and a depth of 2 mm to ensure standardisation (Figure 3.10). The colour of all composites was chosen A2 for standardization. A total of 200 discs were prepared, 10 discs for each group. Sof-Lex™ XT polishing discs (3M ESPE, St. Paul, USA) were used for polishing the prepared samples and only one surface of the samples was polished. All prepared samples were placed in white containers with distilled water, out of sunlight, with 10 composite samples in each container. To prevent dehydration of the composite samples, distilled water was placed on the bottom of the cell culture dishes with a 5 mm syringe. The white containers were labeled to indicate which group they belonged to.

Experimental Groups

The composites used were divided into 4 main groups according to their content. For each main group, 50 samples were used. In this study, the composites tested and their composition information are given in Table 1.

Asteria Composite Group: Tokuyama Asteria composite (Tokuyama Dental Tokyo, JAPAN) specimens were prepared using cylindrical metal molds and subjected to processes as described above.

Filtek Universal Restorative Group: Filtek Universal Restorative composite (3M ESPE, St.Paul, MN, USA) specimens were prepared using cylindrical metal molds and subjected to processes as described above.

Brilliant Ever Glow Group: Brilliant Ever Glow composite (Coltene/Whaledent AG Altstatten, Switzerland) specimens were prepared using cylindrical metal molds and subjected to processes as described above.

Ceram.x SphereTEC Group: Ceram.x SphereTEC one composite (Dentsply Sirona, Germany) specimens were prepared using cylindrical metal molds and subjected to processes as described above.

Table 1. Composites tested and their composition

Trade Name	Type	Color	Content	Manufacturer
Estelite Asteria	Supra-nano spherical	A2	**Matrix:** Bis-GMA, Bis MPEPP, UDMA, TEGDMA **Filler:** Silica and Zirconia (200 nm) Weight 82%, Volume 71	Tokuyama Dental, Tokyo, Japan
Brilliant Ever Glow	Submicron hybrid	A2	**Matrix:** Bis-GMA, Bis-EMA, TEGDMA **Filler:** Silica glass,Zinc oxide 0.02-1.5 µm Weight 74%, Volume 56%	Coltene/Whaledent AG Altstatten, Switzerland
Filtek Universal Restorative	Nanofil	A2	**Matrix:** AUDMA, AFM, Diurethane-DMA, 1,12-dodecane-DMA **Filler:** Clustered and non-clustered zirconia/silica 20nm silica, 4-11 nm zirconia 100 nm stacked ytterbium trifluoride Weight 76.5%, Volume 58.4	3M ESPE, St. Paul, MN, USA
Ceram.x SphereTEC one	Nano-seramic spherical	A2	**Matrix:** Poly-urethane methacrylate, Bis EMA, TEGDMA **Filler:** Prepolymerized spherical fillers (15 µm), 0.6 µm barium glass fillers, 0.6 µm ytterbium fluoride, silicon dioxide nano fillers (10 nm). Weight 77-79%, Volume 59-61	Dentsply Sirona, Germany

Table 2. Whitening products used in the study and their ingredients.

Whitening Product	Type	Ingredient	Manufacturer
Opalescence teeth whitening gel PF	Home Whitening Agent	16% Carbamide Peroxide, Deionized Water, 0.5% Potassium Nitrate, 0.11% Sodium Fluoride, Carbopol, Glyceri	Ultradent Products Inc, South Jordan, Utah, USA
Mr Blanc Teeth Professional Teeth Whitening Kit	Over-the-Counter Whitening Product	Whitening Gel, Glycerin, Aqua, Cellulose Gum, Sodium Chloride, EDTA, Citric Acid, DlMenthol	Mr Blanc Teeth LTD, United Kingdom
Cali White Botanical Whitening System	Over-the-Counter Whitening Product	Glycerin, Sodium Bicarbonate, Chondrus Crispus (Irish Moss) Powder, Xylitol, Sorbitol, Mentha Piperita (Organic Peppermint) Oil, Vaccinium Macrocarpon (Cranberry) Seed Oil, Aloe Barbadensis Leaf Juice, Chamomile Flower Extract, Cocamidopropyl Betaine, Lemon Extract	Cali White LLC, USA
i-White Instant Teeth Whitening	Over-the-Counter Whitening Product	Aqua, Hydrated Silica, Glycerin, Sorbitol, Phthalimido Peroxy Capronacid (PAP), Chondrus Crispus (Irish Moss), Aroma Powder/Hydrated Silica, PEG-40, Xylitol, Hydrogenated Castor Oil, Citric Acid, Acrylates/ Arcylamide Copolymer and Mineral Oil and Polysorbate 85, Methyl Paraben, Calcium-Lactate-Gluconate, Potassium Acesulfame	Sylphar, Belgium

Each composite group was divided into 5 subgroups, as 4 experimental groups and 1 control group, according to the whitening products to be tested (n=10). The material properties and manufacturers of the whitening products used in the study are given in Table 2.

Sub-group 1: Control group; No treatment was applied and kept in distilled water throughout the experimental phases.

Sub-group 2: i-White Whitening Material; i-White Whitening Product whitening set consists of 10 pieces of soft bendable transparent plaques, each of which is already applied and made in accordance with the curve of the mouth. The same procedure was repeated for a total of 5 days with 20 minutes of application per day. Each 20-minute application was kept at 37°C in an oven to mimic the mouth temperature.

Sub-group 3: *Cali White Lighted Whitening Kit*; Cali White Light Whitening Kit whitening set includes a 5 ml tube containing 2 whitening gels and a transparent plaque suitable for the curve of the mouth that emits blue light that activates the whitening agent. The same procedure was repeated for a total of 10 days with 30 minutes of application per day. Each 30-minute application was kept at 37°C in an oven to mimic the mouth temperature.

Sub-group 4: *Opalescence Home Whitening Gel*; Opalescence Home Whitening Gel was kept in an oven at 37°C for 4-6 hours a day to mimic oral temperature. This procedure was repeated for a total of 14 days.

Sub-group 5: Mr. Blanc Lighted Whitening Kit; Mr. Blanc Light Whitening Kit whitening set includes 3 tubes of 5 ml each containing whitening gel and a transparent plaque, called universal, suitable for the curve of the mouth, which emits blue light that activates the whitening agent. The same procedure was repeated for a total of 15 days with 30 minutes of application per day. Each 30-minute application was kept at 37°C in an oven to mimic the mouth temperature.

Measurement of Surface Roughness

A profilometer (Mitutoyo Surftest/SJ-301, Tokyo, Japan) was used for surface roughness measurements. Each sample was placed on the table of the profilometer with a 90 degree contact angle with the reader tip. The surface scan length on the surface profilometer was set to

4 mm and the surface cut length value was set to 0.25 mm. The profilometer was recalibrated before and after the measurements in each group. Measurements were taken from three different areas of each sample and the average surface roughness (Ra) value was calculated by taking the arithmetic mean of the data obtained.

Measurement of Microhardness Values

Qness Q10A/A+ Fully Automatic Microhardness Tester was used for the microhardness test. The microhardness measurement process involved applying 200 gr weight to 3 separate areas of the sample for 20 seconds for a total of 1 minute, with an application speed of 5 seconds. The 3 separate points were selected as follows; The start point was selected as 0.10 mm, the distance x was selected as 2.00 mm and the maximum path length was set as 4.20 mm. For each sample, the numerical value of the 3 separate regions was recorded and then the arithmetic mean of these values was taken.

SEM Analysis

The surfaces of the restorative materials were examined using an SEM device (TESCAN MIRA3, Czech Republic). Before SEM analysis, 1 sample of each restorative material was coated with gold-palladium at a thickness of 90 A° using a coating device (Quorum Q150R ES, UK) in an airless environment and then examined under magnifications of 2-5-10-20-50 thousand respectively.

Statistical Analysis

The data obtained from our study were evaluated with SPSS (Statistical Package for the Social Sciences) 22.0 program. Normality of the data was checked by Kolmogorov-Smirnov Test. In our study, two-way Analysis of Variance (ANOVA) was used to evaluate the data obtained from microhardness and surface roughness tests since parametric test assumptions were fulfilled, and Tukey test was used to determine which group was different from the others. The error level was taken as 0.05.

Tablo 3. Mean values, standard deviation values and statistical comparison of surface roughness tests of composite materials used in the study.

Whitening Materials	Tokuyama Estelite Asteria *Mean (SD)*	Filtek Universal Restorative *Mean (SD)*	Brilliant Ever Glow *Mean (SD)*	Ceram.x SphereTEC one *Mean (SD)*
Subgroup 1 Control	0.27 (0.06)$^{A.a}$	0.51 (0.10)$^{A.B}$	0.40 (0.12)	0.30 (0.11)$^{B.c}$
Subgroup 2 i-White	0.22 (0.05)$^{C.D.b}$	0.56 (0.11)$^{C.E}$	0.26 (0.07)^{E}	0.40 (0.09)^{D}
Subgroup 3 Cali White	0.33 (0.04)^{F}	0.52 (0.12)$^{F.G.H}$	0.35 (0.18)^{G}	0.35 (0.09)^{H}
Subgroup 4 Opalescence	0.47 (0.11)$^{a.b}$	0.45 (0.08)	0.35 (0.14)	0.46 (0.09)^{c}
Subgroup 5 Mr. Blanc	0.31 (0.05)	0.44 (0.09)	0.39 (0.09)	0.41 (0.07)

F=8.736, P=0.000 (p<0.05)

^{A,B,C,D,E,F,G,H} In the same row; the same upper index symbolizes the groups where there is a difference between the composite groups indicated by capital letters.

^{a,b,c} In the same column; the same upper index symbolizes the groups where there is a difference between the whitening groups indicated by lower case letters.

Tablo 4. Mean values, standard deviation values and statistical comparison of the composite resin materials used in the study for the microhardness test.

Whitening Materials	Tokuyama Estelite Asteria *Mean (SD)*	Filtek Universal Restorative *Mean (SD)*	Brilliant Ever Glow *Mean (SD)*	Ceram.x SphereTEC one *Mean (SD)*
Subgroup 1 Control	80.78 (3.21)^{a}	68.15 (3.84)^{A}	58.68 (4.27)^{B}	62.13 (5.02)$^{A.B}$
Subgroup 2 i-White	81.99 (3.029)^{b}	73.36 (5.41)	56.30 (5.14)	63.69 (2.73)
Subgroup 3 Cali White	79.65 (2.98)^{c}	73.66 (3.11)	59.42 (4.89)^{C}	64.62 (3.56)^{C}
Subgroup 4 Opalescence	70.98 (2.16)$^{D.E.a.b.c.d}$	71.39 (3.89)$^{D.F}$	57.23 (2.55)	66.86 (1.57)$^{E.F}$
Subgroup 5 Mr. Blanc	77.60 (2.68)^{d}	70.78 (2.81)	58.63 (2.08)^{G}	63.16 (4.13)^{G}

F=51.018 P=0.000 (p<0.05)

^{A,B,C,D,E,F,G} In the same row; the same upper index symbolizes the groups with no difference between the composite groups indicated by capital letters.

^{a,b,c,d} In the same column; the same upper index symbolizes the groups with differences between the whitening groups indicated by lower case letters.

Results

Table 3 displays the mean values, standard deviation (SD) values, and statistical differences in the surface roughness test between the bleaching groups and the four different composite materials that were bleached as a result of the statistical evaluations.

When the average surface roughness values of all groups were analyzed, the i-White subgroup of the Filtek Universal Restorative composite group showed the

highest average surface roughness value, while the I-White subgroup of the Tokuyama Estelite Asteria group showed the lowest average surface roughness value.

Table 4 displays the mean values, standard deviation (SD) values, and statistical differences between the bleaching groups and the four distinct composite materials that underwent the Vickers microhardness test as a consequence of the statistical evaluations.

When the average microhardness values of all groups are analyzed, the i-White subgroup of the Tokuyama Estelite Asteria composite group showed the highest average microhardness value, while the i-White subgroup of the Brilliant Ever Glow composite group showed the lowest average microhardness value.

SEM Analysis

SEM Images of Tokuyama Estelite Asteria Composite Groups (Figure 1)

In the Cali White group, zirconium particles were observed, while in the Mr.Blanc group, the whitening agent caused the composite particles to break off from the surface in places, resulting in the appearance of irregular pits. In the Opalascence group, zirconium particles appeared on almost the entire surface, while the melting of the surrounding inorganic matrix led to the appearance of a rough surface.

SEM Images of Filtek Universal Restorative Groups (Figure 2)

Crater-shaped pits in the i-White group, abundant zirconium particles on the surface in the Cali-White group, numerous indentations and protrusions with the dissolution of the inorganic matrix on the surface in the Opalescence group, and larger pits in the Mr.Blanc group were observed.

SEM Images of Brilliant Ever Glow Groups (Figure 3)

Deep regular cracks in i-White group, irregular cracks in Cali-White group were observed. In the Opalescence group, dense silica glass particles were found only on the surface, while deep and irregular pits were observed on the surface when Mr.Blanc whitening was applied.

SEM Images of Ceram.x SphereTEC.one Groups (Figure 4)

In the i-White group, irregular cavities in the form of deep caves were observed, in the Cali-White group, a rough surface with more ceramic particles on the surface compared to the control group was observed, in the Opalescence group, many irregular large and small pits were observed and in the Mr.Blanc group, small pits were observed due to the rupture of spherical nanoceramics in places compared to the control group.

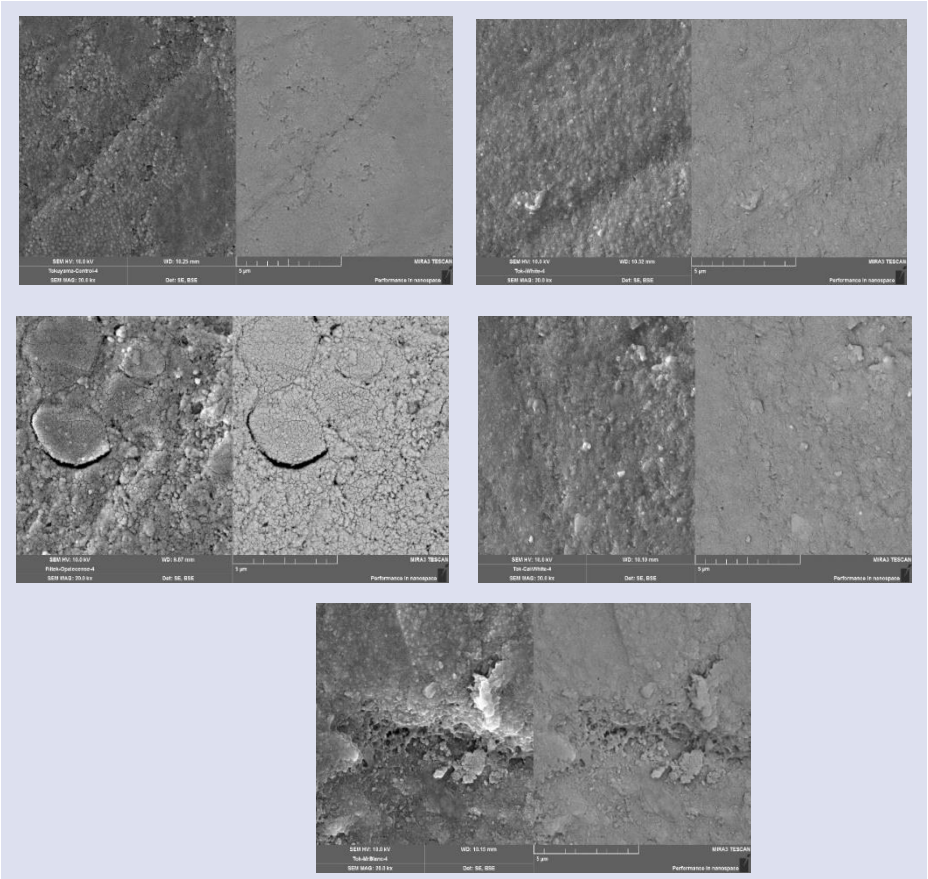

Figure 1. SEM Images of Tokuyama Estelite Asteria Composite Groups a) Control, b) i-white, c) Cali White, d) Opalescence, e) Mr.Blanc

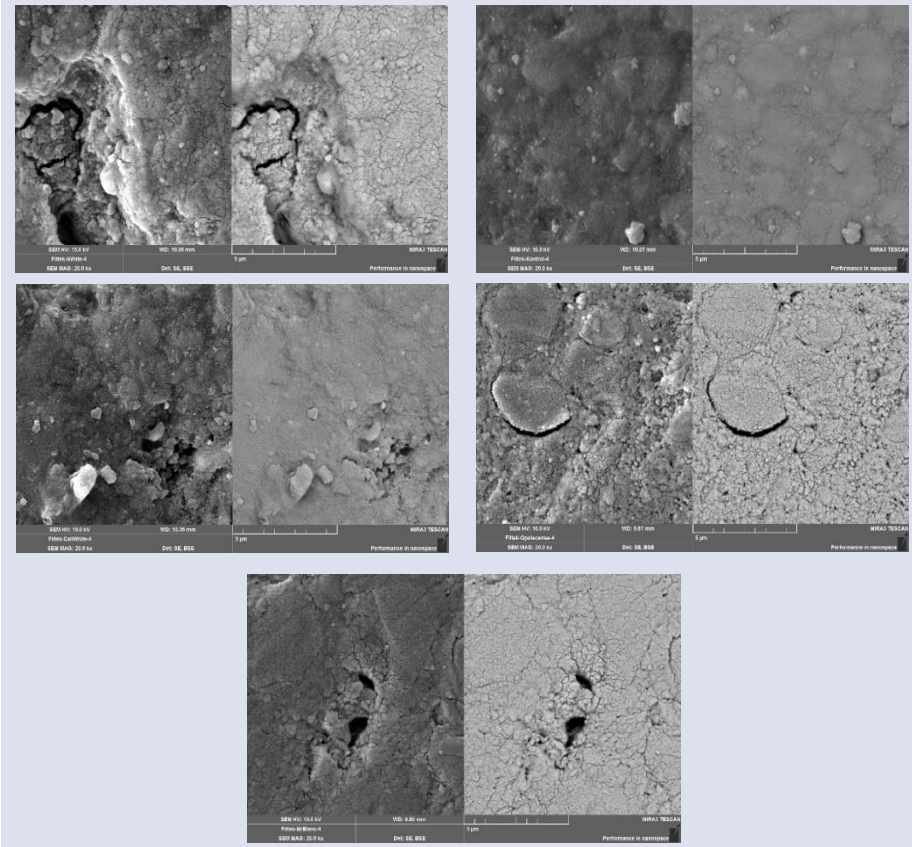

Figure 2. SEM images of Filtek Universal Restorative Groups a) Control, b) i-white, c) Cali White, d) Opalescence, e) Mr.Blanc

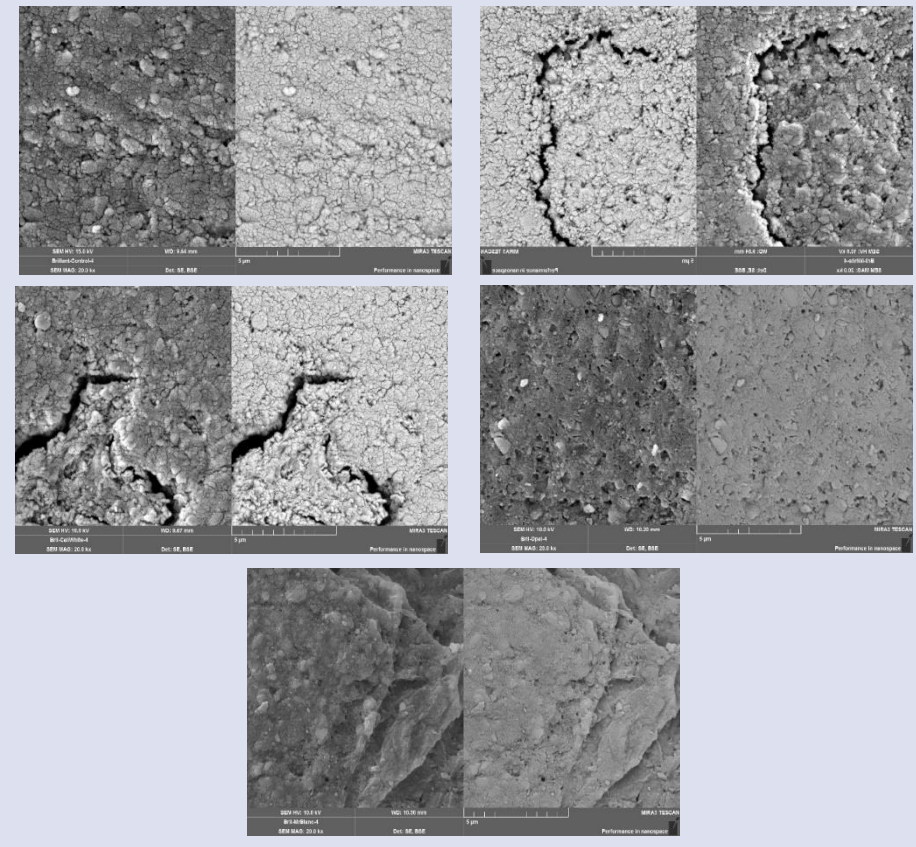

Figure 3. SEM Images of Brilliant Ever Glow Groups a) Control, b) i-white, c) Cali White, d) Opalescence, e) Mr.Blanc

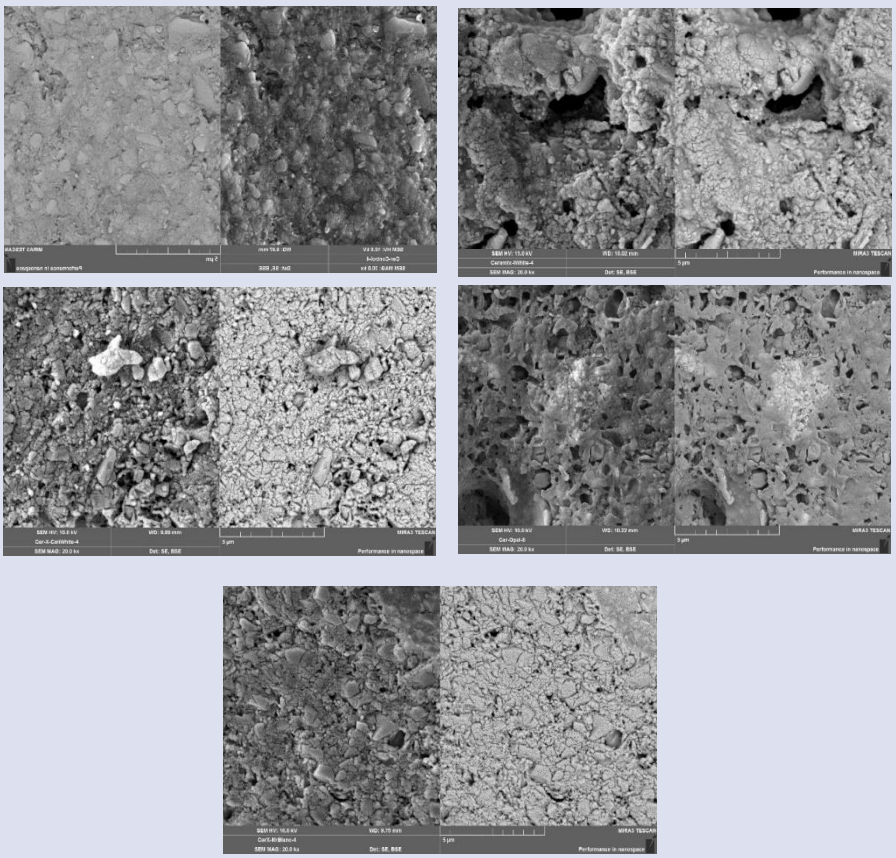

Figure 4. SEM Images of Ceram.x SphereTEC.one Groups a) Control, b) i-white, c) Cali White, d) Opalescence, e) Mr.Blanc

Discussion

Nanofiller composites are differentiated from microfiller composites by the fact that nanotechnology allows for a higher level of control than conventional microfiller technology, resulting in the polishability of a microfiller composite and the strength and wear resistance of a hybrid composite. The difference between nanofiller composites and nanohybrid composites is that nanofiller composites use nanometer-sized particles throughout the resin matrix, while nanohybrid composites take the approach of combining nanometer-sized particles with more traditional filler technology.[12] In this study, we used composites with different particle size fillers (supra-nano, submicron hybrid, nanofilament, nanoceramic) with high aesthetic properties thanks to nanotechnology.

Due to the decreasing incidence and severity of caries in aesthetic dentistry, clinicians have turned their attention to conservative and non-invasive treatments such as tooth whitening.[13] Home teeth whitening with special trays under the supervision of a dentist is the most common whitening procedure performed by dentists on patients. In this treatment method, a customized mouth tray is made and a whitening gel, usually containing 10% carbamide peroxide, is applied to the patient at night for 2 weeks.[14] Auschill et al.[15] compared an over-the-counter bleaching system, a home bleaching system containing 10% carbamide peroxide, and a system containing 38% hydrogen peroxide and applied by physicians in the office in an in vivo study and found that the home bleaching system was more effective. In another study, they reported that the most effective and safe whitening technique was home bleaching because it reduced the possibility of side effects.[16]

Many studies have shown that the use of whitening agents containing carbamide peroxide is safe and effective when performed in accordance with dentist recommendations and under dentist control.[17] We preferred to use Opalescence home whitening gel containing 16% carbamide peroxide in our study because home whitening is preferred more frequently and the side effects related to self-administration are similar to the side effects related to self-administration in OTC (over-the-counter) products.

Most whitening products use hydrogen peroxide as the active ingredient. However, whitening treatments with peroxide can cause local side effects such as oral mucosal irritation, pulp sensitivity, pulpitis or changes in the enamel surface.[18] On the other hand, whitening is a relatively safe procedure that causes serious side effects on hard tissue, soft tissue and restorative materials predominantly only at high concentrations of hydrogen peroxide.[14] The efficacy of products containing hydrogen peroxide is usually based on cumulative and repeated treatments. There are not enough in vitro and clinical studies on non-peroxide whitening products. One study examined a non-peroxide home whitening product based on sodium chloride in vitro and reported adverse effects on tooth enamel.[19]

In the light of this information, in our study, we investigated the efficacy of 3 different OTC whitening products, which are new to the market and promise to be safe and effective whitening because they do not contain peroxide, on 4 different composites in vitro.

The surface roughness and hardness of composite restorations are affected by the structural properties of the material such as monomer type, filler type and percentage.[20] Carbamide peroxide is unstable and breaks down immediately upon contact with tissue and saliva, decomposing first to hydrogen peroxide and urea and then to oxygen, water and carbon dioxide.[21,22] The apparent mechanism of action of whitening agents on tooth structures is the oxidation of dentin molecules, which causes discoloration. This oxidation reaction can disrupt the structural integrity of restorative materials.[23] Some studies have shown that exposure of hard dental tissue and restorative materials to whitening agents can cause changes in their surfaces and reduce their microhardness.[24,21,22,25,26] Other studies have shown only minor or no changes in restorative materials and tooth tissues.[21,27-29] The results of these studies suggest that the effect of whitening gels may depend on the composite material.[21,30]

AlQahtani [31] compared the micro-hybrid (Filtek Z250), nanofiller (Filtek Z350), fluid (Filtek P90) and hybrid (Valux Plus) composites with different contents after 14 days of whitening with 10% KP (Opalescence PF). He reported a significant decrease in microhardness in composites with nanofillers (Filtek Z350), fluid (Filtek P90) and hybrid (Valux Plus). The researcher stated that this result may be related to the higher amount of TEGDMA in the nanofilament (Z350) and hybrid (Valux Plus) composite and the absence of TEGDMA in Z250. The inclusion of diluent monomers of TEGDMA in the resin matrix may make the resin matrix less resistant to whitening agents and increase the softening of the resin composite material. He also reported that the decrease in the microhardness of the nanofiller composite (Z350) was higher than that of the hybrid composite (ValuxPlus) due to the higher molecular weight and lower filler content of the resin matrix in the nanofiller (Z350). Among the composites we used in our study, only Filtek Universal Restorative does not contain TEGDMA. After Opalescence home whitening with 16% KP content, Filtek Universal Restorative showed the highest value in microhardness values among all composites. The study showed that the absence of TEGDMA in the matrix of Filtek Universal Restorative composite showed resistance to the whitening agent.

Malkondu et al.[32] compared the microhardness values of two nanocomposites (Filtek Supreme XT and Premise), leucite-reinforced glass ceramic (Empress Esthetic), glass ceramic (Empress 2 layering) and feldspathic porcelain (Matchmaker MC) on esthetic dental materials using a home whitening agent (Opalescence PF) containing 20% KP and an OTC whitening product (Treswhite Supreme) containing 10% HP. They reported that Opalescence with 20% KP content increased the microhardness of Filtek Supreme XT composite and significantly decreased the microhardness of all other materials, while OTC Treswhite Supreme with 10% HP content significantly decreased the microhardness of Premise nanocomposite. They said that the organic matrix of Filtek Supreme XT consists of UDMA, Bis-EMA, and a small amount of TEGDMA. UDMA and Bis-EMA resins have a higher molecular weight and therefore fewer double bonds per weight unit. They stated that the higher molecular weight of the resin results in less shrinkage, less aging and a slightly less soft resin matrix. The increase in the microhardness values of the Ceram.x SphereTEC one composite, which we used in our study, after all whitening applications, is due to the fact that both Bis-EMA and UDMA resin are present in its content together, we think that it reacts less with whitening products and the microhardness of the composite samples increases as time passes. We believe that these results are similar to the study of Malkondu et al.

Cohen et al.[11] examined the microhardness values of 10% KP whitening agent (PolaNight) and 5 different OTC whitening materials (Brilliant 5 minute kit, Smile Science Harley Street professional teeth whitening kit, i-White instant teeth whitening, Mr Blanc Teeth, Janina Ultra White) on human enamel. They also investigated the effectiveness of samples colored in green tea with 6 different whitening agents. They stated that the greatest decrease in microhardness values was in Brilliant 5 minute kit and i-White groups, while there was an increase in microhardness values in negative control (distilled water), Smile Science Harley Street professional teeth whitening kit groups. They stated that i-White and Smile Professional had less whitening effect than the negative control group. They also stated that Brilliant 5 minute kit and i-White were the whitening products that showed the most changes in the enamel in SEM analysis, and although the active ingredient of both products was different, citric acid in the content of both products could cause surface changes. The i-White OTC whitening product we used in our study increased the microhardness values of all composites (except Brilliant Ever Glow). In addition, SEM analysis showed that i-White and Mr.Blanc Teeth were the OTC whitening products that caused the most deformation in composites. The reason for this is due to the citric acid content of both OTC whitening products.

Cengiz et al.[33] evaluated the surface roughness after application of 10% HP (Opalescence Treswhite) and KP (Opalescence PF) whitening agents on 5 different composites including nano hybrid, micro hybrid and orcomer based nano hybrid (Reflexions XLS, Grandio, Gradia Direct, Clearfil Majesty Esthetic, Ceram-X Mono). They applied KP for 8 hours a day for 14 days and HP for 60 minutes a day for 14 days. They reported that the roughness values of all bleached composite groups were higher than the control group (distilled water). They stated that there was no significant difference in roughness values after 10% KP and HP application. After whitening, they reported that the orcomer-based nano-hybrid showed the lowest surface roughness values, while the nano-hybrid (Reflexions XLS) composite showed the highest roughness values. Reflexions XLS and Clearfil Majesty Esthetic showed higher Ra values than other composites after KP application. The researchers stated that both composites were based solely on Bis-GMA as the organic matrix, and that water uptake

for this hydrophilic monomer may be higher than for TEGDMA and UDMA, which may cause disruption of the resin matrix and particle/matrix interface. In our study, after 16% carbamide peroxide treatment, the surface roughness of supra-nano (Tokuyama Estelite Asteria) and nano-ceramic (Ceram.x SphereTEC one) composites decreased.

Bizhang et al.[9] evaluated the whitening efficacy of a peroxide-free OTC product (i-White Instant) and a placebo product without a whitening product in-vivo. They measured color before, after and 24 hours after treatment. They reported that the OTC whitening product was significantly more effective in whitening than the placebo group. The researchers also evaluated tooth sensitivity and gingival irritation. During the whitening application; although there were patients in the test group who experienced gingival irritation, they stated that none of the patients experienced tooth sensitivity. In the placebo group, they reported both gum irritation and tooth sensitivity. After the treatment, they reported that although gingival edema, tooth sensitivity and gingival irritation occurred in the test group, there were no complaints in the placebo group. The researchers believe that the ready-to-use mouth trays in the i-White Instant whitening kit may cause uncontrolled whitening and gingival irritation.

Although the OTC whitening products we used in our study did not create a statistically significant difference in the surface roughness and microhardness values of the composites, SEM analysis shows that especially i-white and Mr.Blanc whitening products caused cracks and defects on the composite surfaces.

Conclusion

Although OTC whitening products did not significantly change the surface roughness and microhardness values of composites, SEM analysis showed that all OTC whitening products caused more splits, cracks and defect-like changes on composite surfaces than Opalescence home type whitening agent. Since peroxide-free OTC whitening products cause surface changes on composite surfaces similar to or more than carbamide peroxide, the use of peroxide-free OTC products without a physician's control may cause greater irreversible damage. Therefore more in-vitro and clinical studies with newly released OTC products are needed.

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Conflict of Interest Statement

None.

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Examination of the Relationship Between Sella Turcica and Impacted Maxillary Canine Teeth: A Retrospective Study

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ABSTRACT

Objectives: In the present study, we aimed to compare the morphological shape and linear dimensions of the sella turcica (ST) between individuals with and without impacted maxillary canines (IMC).
Materials and Methods: Cone-beam computed tomography scans of 120 individuals with IMC (study group) were obtained, retrospectively. This study group was divided into three subgroups: group I (n=40), right IMC; group II (n=44), left IMC; and group III (n=36), bilateral IMC. A control group of 40 individuals without IMC were included in this study from the same archive. The study group was divided into three subgroups: group I (n=40), right IMC; group II (n=44), left IMC; and group III (n=36), bilateral IMC. The shape and the linear dimensions of the ST were evaluated in all groups. Data were analyzed using an independent sample t-test and the chi-square test. The significance level was assigned as $p<0.05$.
Results: The linear dimensions –length, depth, and diameter– of the ST in the control group were significantly different from those in group I (p=0.050, p=0.001, and p=0.018, respectively), group II (p=0.040, p=0.048, and p=0.006, respectively), and group III (p=0.014, p=0.039, and p=0.007, respectively). In addition, there were no statistically significant associations among ST types in the control and study groups.
Conclusions: The length, depth, and diameter of the ST were greater in the control group than in the individuals with unilateral or bilateral IMC. Also, no relationship was found between the morphological shapes of the ST in individuals with and without IMC.

Keywords: Cone-Beam Computed Tomography, Impacted Canines, Sella Turcica.

Gömülü Maksiller Kanin Dişleri ile Sella Tursika Arasındaki İlişkinin İncelenmesi: Retrospektif Bir Çalışma

Süreç

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ÖZ

Amaç: Bu çalışmada, gömülü maksiller kanin dişleri (GMKD) gömülü olan ve olmayan bireyler arasında sella tursikanın (ST) morfolojik şeklini ve doğrusal boyutlarını karşılaştırmayı amaçladık.
Gereç ve Yöntemler: GMKD olan 120 bireyin (çalışma grubu) konik ışınlı bilgisayarlı tomografi görüntüleri retrospektif olarak elde edildi. Bu çalışma grubu üç alt gruba ayrıldı: grup I (n=40), sağ GMKD olan bireyler; grup II (n=44), sol GMKD olan bireyler ve grup III (n=36), iki taraflı GMKD olan bireyler. Aynı arşivden GMKD olmayan 40 bireylik bir kontrol grubu çalışmaya dâhil edildi. ST'nin şekli ve doğrusal boyutları tüm gruplarda değerlendirildi. Veriler bağımsız örneklem t testi ve ki-kare testi kullanılarak analiz edildi. Anlamlılık düzeyi $p<0,05$ olarak belirlendi.
Bulgular: Kontrol grubundaki ST'nin doğrusal boyutları –uzunluk, derinlik ve çap– grup I (sırasıyla p=0,050, p=0,001 ve p=0,018), grup II (sırasıyla p=0,040, p=0,048 ve p=0,006) ve grup III'tekilerden (sırasıyla p=0,014, p=0,039 ve p=0,007) önemli ölçüde farklıydı. Ayrıca kontrol ve çalışma gruplarında ST tipleri arasında istatistiksel olarak anlamlı bir ilişki bulunamamıştır.
Sonuçlar: ST'nin uzunluğu, derinliği ve çapı, kontrol grubunda tek taraflı veya iki taraflı GMKD olan bireylere göre daha büyüktü. Ayrıca GMKD olan ve olmayan bireylerde ST'nin morfolojik şekilleri arasında bir ilişki bulunamamıştır.

Anahtar Kelimeler: Konik Işınlı Bilgisayarlı Tomografi, Gömülü Kanin Dişler, Sella Tursika.

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Introduction

The sella turcica (ST), where the pituitary gland is located, is an important anatomical structure of the middle cranial fossa.[1,2] This structure develops through a complex process with different origins. The anterior part of the ST predominantly develops from neural crest cells, while the posterior part develops from the paraxial mesoderm, which is adjacent to the notochord.[3-7] The morphology of the ST ocur during the early embryonic period and retained throughout life.[8,9] However, dimensions of the ST increase during growth and remain constant around 15 years old.[9] To date, many studies have examined the relationship of the ST shape and dimensions with craniofacial dimensions and conditions in the literature.[1,8,10-22] The structural changes in the ST are associated with craniofacial deviations,[11,23] maxillary length,[21] and mandibular prognathism.[22]

ST (especially the sella point) plays a considerable role in orthodontic cephalometric analyses, the determination of the type of skeletal malocclusion, the evaluation of growth changes, and orthodontic treatment results.[17,21,24,25] It has been suggested that the morphology of ST is also related to skeletal malocclusion, craniofacial dimensions, and various congenital and dental anomalies.[1,8,10-18,21,22,24,26-34] This relationship appears to arise from the joint embryological origin of the anterior part of the ST, pituitary gland, and dental epithelial progenitor cells, specifically neural crest cells.[35,36] ST is the main region for migrating these neural crest cells to the maxillary, palatal, and frontonasal developmental zones.[37] Thus, it is of considerable importance to examine the relationship between ST and dental anomalies, especially in the midfacial region. In studies investigating the relationship of ST with various dental anomalies (microdontia, transposition, impaction, hypodontia, hyperdontia), salient differences were observed in morphology and dimensions of ST, and it was stated that there was a clear relationship between these two.[31-34]

Impacted teeth remain completely or partially embedded in the bone or mucosa for over two years beyond the physiological eruption time.[26,38,39] Although there are individual variations in impacted teeth, third molars are the most common, followed by maxillary canines.[40] In the literature, the relationship of impacted maxillary canines (IMC), especially with the morphology and dimensions of ST, attracts attention.[15,17,18,41-44] It is noteworthy to investigate the relationship of the morphological shapes and linear dimensions of ST to these teeth based on possible common embryological or genetic origins of ST and IMC, such as the HOX gene and neural crest cells.

In this research, we aimed to compare the morphological shapes and linear dimensions of the ST among the control group and individuals with IMC with cone-beam computed tomography (CBCT).

Materials and Methods

Study Design

This present study was planned to use CBCT scans from the radiological archives of the Faculty of Dentistry, Atatürk University, retrospectively. After design and planning, the research was approved by the Atatürk University Faculty of Dentistry Ethics Committee (decision number: 2018/1/4), and conducted in eligibility with the Helsinki Declaration as revised in 2013.

Subjects

We included individuals aged 15 years and above in our study. We used CBCT scans of 120 individuals (95 females, 25 males, mean age=31.75) with IMC. The study group was divided into three subgroups: group I (n=40), individuals with right IMC; group II (n=44), individuals with left IMC; and group III (n=36), individuals with bilateral IMC. As a control group, we also included 40 individuals (26 females, 14 males, mean age=26.78) without IMC from the same archive, retrospectively.

CBCT Analysis

All measurements and analyses in this study and control groups were performed with NNT Viewer software (QR-NNT, Quantitative Radiology, Verona, Italy) on CBCT (NewTom FP QR-DVT 9000, Verona, Italy; 110 kVp, 15 mA, 36 s scan time, 21x19 cm field of view-FOV) views in the midsagittal plane (Figure 1a). All evaluations were performed by a dentomaxillofacial radiologist with at least four years of CBCT experience. In case of a conflict in decision making, consensus was reached after discussions with an expert with 10 years of experience at CBCT. All of the CBCT views in this study were re-assessed one mont after the initial assessments by the same observer under the same conditions.

The localization of IMC was classified according to Archer's[45] in our study. Linear dimensions, including the length, depth, and diameter of the ST, were calculated with the methods used by Silverman[46] and Kisling.[47] The length of the ST was calculated as the distance from the tuberculum sellae to the hill of the dorsum sellae (two-pointed arrow in Figure 1b). The depth of the ST was calculated as the perpendicular distance from the arrow joining the tuberculum sellae and the hill of the dorsum sellae to the deepest point on the floor of the fossa (the straight-line in Figure 1b). Finally, the diameter of the ST was measured as the distance among the tuberculum sellae to the farthest point on the posterior inner wall of the fossa (dashed-line in Figure 1b).

The morphology was analyzed according to the classification of basic shapes (oval, round, and flat) by Camp[48] and the classification into six types (type I, normal morphology of ST; type II, oblique anterior wall; type III, ST bridging; type IV, the double contour of the floor; type V, irregularity in the posterior part of the dorsum sellae; and type VI, pyramidal shape of the dorsum sellae) by Axelsson *et al.*[24]

Statistical Analysis

The SPSS ver. 20 (IBM, SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. The agreement between the intra-observer measurements was evaluated using weighted kappa statistics. An independent sample t-test was used to compare the ST dimensions among the study and the control groups. The associations among the morphological shapes of ST were analyzed with the chi-square test. When the p-value was below 0.05, the relationship among the control and study groups was considered statistically significant.

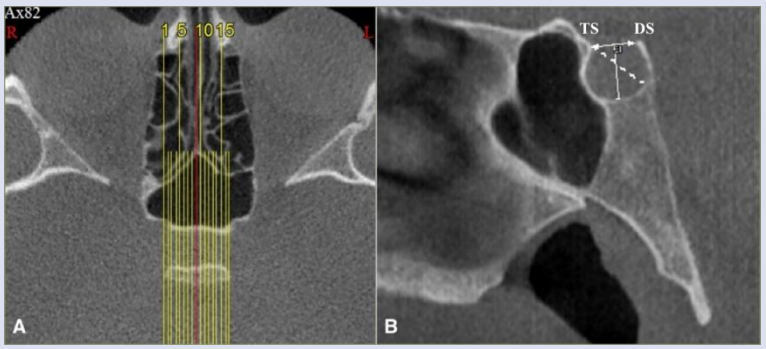

Figure 1. The red line viewed the midsagittal plane selected as a reference CBCT scan for measurements and analysis (a). Reference lines used for measuring the ST sizes on the midsagittal plane (two-pointed arrow, the length of ST; straight-line, the depth of ST; dashed-line, the diameter of ST) (b). TS: Tuberculum Sellae, DS: Dorsum Sellae.

Results

The kappa value for the intra-observer reliability was 0.81. This value indicates good agreement and reliability between the intra-observer measurements. IMC was located in the palatal in 94 (60.25%) of 156 impacted teeth, the vestibule in 19 (12.20%), in both buccal and palatal bone in 21 (13.45%), centrally between the lateral and first premolar teeth in the alveolar process in 17 (10.90%), the edentulous jaw in five (3.20%) (Table 1).

The length, depth, and diameter of the ST in the control group were significantly different from those in group I (p=0.050, p=0.001, and p=0.018, respectively) (Table 2), group II (p=0.040, p=0.048, and p=0.006, respectively) (Table 3), group III (p=0.014, p=0.039, and p=0.007, respectively) (Table 4). The length of the ST in the control group (10.46±1.66 mm) was greater than that in groups I (9.76±1.48 mm), II (9.77±1.37 mm), and III (9.54±1.54 mm) (Tables 2-4). The depth of the ST in the control group (8.76±1.09 mm) was greater than that in groups I (7.86±1.00 mm), II (8.24±1.26 mm), and III (8.18±1.34 mm) (Tables 2-4). The diameter of the ST in the control group (13.28±1.71 mm) was greater than that in groups I (12.46±1.29 mm), II (12.35±1.30 mm), and III (12.28±1.40 mm) (Tables 2-4).

According to the classification of basic shapes, a flat ST was the most common type in groups I and II and the control group, whereas a round ST was the most common type in group III. Oval ST was the least common type in all groups (Table 5). There were no significant differences in ST shape among the control and study groups (p > 0.05).

According to the second classification (Axelsson *et al.*[24]), type I was the most common, with a frequency of 47.5% (n=19) in the control group, 57.5% (n=23) in group I, 50% (n=22) in group II, and 47.2% (n=17) in group III. The second most common type of ST was type V in the control and study groups. Type IV ST was detected in only two individuals in the control group and no individual in the study group (Table 6). There were no significant associations among ST types in the control and study groups (p>0.05).

Table 1. The localization of IMC according to Archer's.[45]

	n	%
Palatal	94	60.25
Vestibule	19	12.20
Both buccal and palatal bone	21	13.45
Between the lateral and first premolar	17	10.90
The edentulous jaw	5	3.20
Total	156	100

Table 2. Comparison of the ST dimensions (mm) among the study group I and the control group.

	Control Group		Study Group I		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	40	9.76±1.48	1.990	0.050**
Depth	40	8.76±1.09	40	7.86±1.00	3.856	0.001***
Diameter	40	13.28±1.71	40	12.46±1.29	2.415	0.018****

* Independent sample t-test
**p = 0.05
***p = 0.01
****p < 0.05

Table 3. Comparison of the ST dimensions (mm) among the study group II and the control group.

	Control Group		Study Group II		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	44	9.77±1.37	2.085	0.040**
Depth	40	8.76±1.09	44	8.24±1.26	2.008	0.048**
Diameter	40	13.28±1.71	44	12.35±1.30	2.779	0.006***

* Independent sample t-test
**p < 0.05
***p < 0.01

Table 4. Comparison of the ST dimensions (mm) among the study group III and the control group.

	Control Group		Study Group III		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	36	9.54±1.54	2.517	0.014**
Depth	40	8.76±1.09	36	8.18±1.34	2.103	0.039**
Diameter	40	13.28±1.71	36	12.28±1.40	2.767	0.007***

* Independent sample t-test
**p < 0.05
***p < 0.01

Table 5. Comparison of the morphological shape of the ST among the control and study groups, according to basic shapes classification of Camp.[48]

	Control Group		Study Group I		Study Group II		Study Group III	
	n	%	n	%	n	%	n	%
Oval	9	22.5	8	20.0	12	27.3	4	11.1
Round	15	37.5	14	35.0	15	34.1	18	50.0
Flat	16	40.0	18	45.0	17	38.6	14	38.9
x^2			0.211		0.269		2.124	
P*			0.900		0.874		0.346	

* Chi-square test

Table 6. Comparison of the morphological shape of the ST among the control and study groups, according to six types of classification of Axelsson et al.[24]

	Control Group		Study Group I		Study Group II		Study Group III	
	n	%	n	%	n	%	n	%
I	19	47.5	23	57.5	22	50.0	17	47.2
II	1	2.5	3	7.5	2	4.5	2	5.6
III	4	10.0	6	15.0	4	9.1	6	16.7
IV	2	5.0	0	0.0	0	0.0	0	0.0
V	11	27.5	6	15.0	13	29.5	7	19.4
VI	3	7.5	2	5.0	3	6.8	4	11.1
x2			5.452		2.535		3.676	
P*			0.363		0.771		0.597	

* Chi-square test

Discussion

It has been suggested that structural differences in ST are related to the facial skeletal class,[1,8,16,27] skeletal and dentoalveolar dimensions,[21,22,26,28] systemic diseases,[7] and specific anomalies of the midfacial region, such as craniofacial anomalies,[13,24] cleft lip and palate,[11,12,29] and various dental anomalies.[10,14,15,17,18,30] The ST, within which the pituitary gland is situated, mainly develops from neural crest cells, and dental epithelial progenitor cells differentiate from neural crest-derived mesenchyme stem cells.[35,36] Previous studies have reported the relationship of ST with dental anomalies, such as hypodontia,[14,30] dental transposition,[10] and impacted canines.[15,17,18] IMC are one of the most crucial dental anomalies of the midfacial region. Despite the possible common embryological or genetic origin of the s ST and teeth, such as the HOX gene and neural crest cells, a few studies have explored the relationship between the ST morphology with these teeth.

Of the 120 individuals with IMC in our study group, 25 (20.8%) were males and 95 (79.2%) were females. Thus, IMC were more common among females. Many studies have found that age[14,15] and sex[1,8,11,14-16,24,49] do not affect the linear dimensions (length, depth, or diameter) of the ST. However, some studies have reported that age is significantly associated with the size of the ST.[8,17,27] According to Silverman's studies, the dimensions of the ST become nearly stable around 15 years of age in both genders.[46] Additionally, previous research showed that there was no remarkable change in the morphology of the ST after 12 years old.[50] Given the development of the ST, for the ST not to be affected by age-related size changes, we included individuals aged 15 years and above in the present study.

IMC in the palatal position may occur three to six times more often than vestibule position.[26,38,39] In our study, also, 60.25% of all impacted maxillary teeth were located in the palatal. Based on lateral cephalograms, Ali *et al.*[15], Tepedino *et al.*[43] and Vitali *et al.*[42] reported that the length of the ST significantly reduced in patients with impacted palatal canines. Canigur Bavbek *et al.*[44] showed that the diameter of ST was significantly smaller in the bilateral impaction group than in unilateral impaction and control groups. Baidas *et al.*[17] reported significant differences in the three linear dimensions of the ST among individuals with and without impacted canines. On the contrary, in the study of Omastova *et al.*[41], the linear dimensions of ST were significantly higher in subjects with IMC than in controls. Uğurlu *et al.*[25], in CBCT images, reported no among-group differences in the ST measurements of individuals with unilateral or bilateral impacted canines and without impacted canines, other than the right sella length. In the present study, based on CBCT scans, we observed significant differences in the linear dimensions – length, diameter, and depth– of the ST among the control and study groups. Specifically, the length, depth, and diameter of the ST were greater in the control group than in the study groups. This may support the theory that these structures have the same embryological origin. Advanced imaging techniques, such as CBCT, can generate precise information about the ST. The conventional radiographic techniques, which indicate the two-dimensional structure of the ST, cannot provide detailed information about this structure.[12] El Wak *et al.*[20] found significant differences in findings between CBCT scans and lateral cephalograms of the ST. Therefore, we used CBCT scans from archives in our assessments.

According the classification of basic shapes[48] based on CBCT scans of 177 subjects, Yasa *et al.*[49] reported that the ST was round in 69.5%, flat in 16.4%, oval in 14% subjects. Furthermore, Axelsson *et al.*[24] classified the ST shapes into six different types –type I, normal ST; type II, oblique anterior Wall; type III, ST bridging; type IV, double contour of the floor; type V, irregularity in the posterior part of the dorsum sellae, and type VI, pyramidal shape of the dorsum sellae–. In addition, Alkofide[19] examined the shape of the ST in lateral cephalometric radiographs of 180 patients according to the classification of Axelsson *et al.*[24] and revealed that the ST was abnormally shaped in majority of patients with unilateral or bilateral cleft lip/palate compared with that in the individual without this anomaly. Yasa *et al.*[11] found that the shape of the ST significantly differed between patients with and without cleft lip/palate. Valizadeh *et al.*[1] showed a significant association between the facial skeletal class and ST shape, for example, the ST bridging was frequent in class III patients. Omastova *et al.*[41] and Vitali *et al.*[42] reported a higher prevalence of ST bridging in subjects with IMC, and the impaction status was positively associated with the presence and severity of ST bridging. Baidas *et al.*[17], found the ST morphology was normal in 56.4% of individuals with palatally impacted canines, and no significant associations between impaction with the ST shape. In the study by Canigur Bavbek *et al.*[44], normal ST was the most common morphological type in all groups (with and without IMC). It was followed by irregularity (notching) in the posterior part of the dorsum sella. On the other hand, Tepedino *et al.*[43] reported differences in sella morphology between patients with IMC and controls. In our study, according to the classification of basic shapes, a flat ST was the most common type in groups I and II and the control group, whereas a round ST was the most common type in group III. Also, concerning the second classification (Axelsson *et al.*[24]), normal ST (type I) was seen as the most common in the control and study groups. The second most common type of ST also was "irregularity in the posterior part of the dorsum sellae" (type V) in all groups. There were no significant associations among ST shapes in the control and study groups, although the prevalence of various shapes according to the two classifications used differed among the groups. Although few studies have investigated the connection between ST and IMC in the literature, the findings obtained in our study are consistent with the result of Baidas *et al.*[17] and Canigur Bavbek *et al.*[44]

Although this study fulfilled its aims, this study has some limitations. First, the study population could have been designed to be relatively larger. Second, no

evaluation was made regarding ST volume, in addition to linear dimensions. Finally, IMCs were classified according to location, but their relationship with ST was not examined. Further studies should be conducted with a larger sample size and other parameters (e.g., volume and the localization of IMC) should be added.

Conclusions

The linear dimensions of the ST differed between individuals with and without IMC in our study. The length, depth, and diameter of the ST were greater in the control group than in the study groups. Therefore, it can be suggested that there is a significant association between IMC and ST sizes. Additionally, no significant difference was found among the control and study groups in the morphology of ST according to both classifications. Also, compared to conventional radiography, CBCT can provide more accurate data about the anatomical structure and linear dimensions of the ST. Although there are many studies conducted cadaver, 2D, and 3D imaging techniques about ST, there are few studies on the relationship between ST and IMC. The present research can be a reference for further studies on the common embryological origin of ST and maxillary canines.

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Conflicts of Interest Statement

The authors declare that they have no conflict of interest.

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Management of Lobulated and Non-Lobulated Capillary Haemangioma in a 22-Year-Old Male Patient- A Rare Case Report

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Case Report

History

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ABSTRACT

Pyogenic granuloma (PG), a benign, reactive, vascular exophytic growth occurring in oral cavity with a sessile or pedunculated base. Commonly occurs on gingiva, lip, tongue, buccal mucosa, palate and floor of the mouth. The usual causative agents are calculus, presence of foreign body, although certain drugs and hormonal imbalances precipitate its growth. Difficulty in speech, mastication and compromised aesthetics is encountered when increased in size. Histologically two variants are reported: Lobulated capillary haemangioma (LCH) and non- LCH. LCH shows organised arrangement of lobular aggregates of blood vessels whereas, non-LCH features granulation tissue type without lobular aggregates. The treatment consists of elimination of local irritants with conservative surgical excision. This case report deals with a patient who presented with long standing PG at multiple sites causing him difficulty in mastication leading to inadequate dietary intake which causing undernourishment. The management included elimination of local factors and excision by diode laser.

Keywords: Histology, lobulated capillary haemangioma, non-lobulated capillary haemangioma, laser excision, pyogenic granuloma..

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Introduction

The term pyogenic granuloma (PG) introduced in 1943 is a misnomer since the lesion has no pus nor is it a granuloma. Its histologic variant termed as Lobulated capillary hemangioma (LCH) was introduced in 1980 and since then both terms are used synonymously.[1] PG is described as a commonly occurring, reactive, benign vascular lesion of the oral cavity formed by proliferating capillaries. Clinically it may appear as a red lobulated or smooth exophytic growth occurring at isolated or multiple sites with a sessile or pedunculated base. Although it can occur at any age, the peak prevalence is said to be during second and third decade of life with a predilection for younger females compared to older males with a ratio of 1.2:1.[2]

Any injury/stimulus like calculus, presence of foreign body may precipitate its growth, caries and overcrowding of teeth may aggravate the condition. Hormonal imbalances and usage of certain drugs have also been implicated in its development.[2,3] The most affected intraoral site is gingiva followed by lips, tongue, buccal mucosa, hard palate, and floor of the mouth. The lesion may vary in size from few millimeters to centimeters and may cause difficulty in mastication, interfere with speech, and cause esthetic concerns. Any slightest provocation can cause considerable bleeding due to its high vascular nature. Other nomenclatures for PG include, granulation tissue type hemangioma, granuloma gravidarum/pregnancy tumor, Crocker and Hartzell's disease, vascular epulis, hemangiomatous granuloma, epulis teleangiectaticum granulomatosa and granuloma telangiectactium, granuloma pediculatum.[1-4] The treatment includes a combination of conservative approach with surgical excision.

Case Report

A 22-year-old male patient complained of multiple swelling of gums in the oral cavity that existed for 3 months. History revealed that 1 or 2 swellings occurred initially in isolated areas of gums for which he did not seek any treatment and ignored them thinking they might subside on their own. But with passage of time the swellings gradually increased in number and size at multiple sites. They were painful, bled excessively on touch, caused difficulty in chewing, swallowing and compromised his esthetics, causing him worry for which he seeked treatment. His guardians who accompanied him revealed about the patient's reluctancy towards food intake and mentioned about his consumption of only fluid beverages. They also showed concern over his continuing weight loss. The patient's medical, family and drug history was non-contributory to his present condition and his smoking history was negative.

Physically, the patient appeared thinly built with small body frame. His body mass index (BMI) recorded was 14.5 KG/M^2 revealing him to be an underweight person. Extraoral examination revealed incompetent lips. (Figure 1) On intraoral examination, multiple reddish shiny protuberant overgrowths on marginal, attached, and interdental gingiva were noted extending up to occlusal surfaces of posterior teeth of both

arches. Anteriorly the enlarged gingiva had a sessile base and covered almost 2/3rd of the labial surface of mandibular incisors. The consistency in this region was soft and friable. (Figure 2) Another bigger and firmer swelling extending from 24 to 27 was noted on hard palate with a pedunculated base. (Figure 3) Below these bases was found mild to moderately accumulated deposits of plaque and calculus. Mobility check revealed first degree with 14, 15 and 16.

To exclude the possibility of systemic involvement and considering surgical intervention, the patient was advised hematological investigations that included complete hemogram, HbsAg and HIV tests and radiographic investigations i.e., orthopantomograph (OPG), which revealed normal parameters. OPG depicted localized bone loss, root pieces with 36 grossly destructed crown with 26,37,46 and impacted 28. (Figure 4)

Procedure

As per the protocol a signed informed consent was obtained from patient and non-surgical periodontal therapy was initiated that included scaling and root planing under the cover of antibiotics and anti-inflammatory drugs. During the procedure it was noticed that not only the gingiva bled profusely but all the reddish swellings had turned black in color. (Figure 5) Upon completion of scaling, bleeding was controlled by local hemostatic measures. The patient was recalled after two weeks and remarkable improvement in tissue morphology was noted. (Figure 6) Excisional biopsy was carried out at two different sites with the help of diode laser (wavelength: 980nm, power output: 1 watt, wave mode: pulsed) along with extraction of the hopeless teeth i.e., 36 at the same time. After receiving the biopsy reports, a combination of gingivectomy and laser curettage was performed precisely in all the quadrants and the patient was discharged after application of periodontal dressing with prescription of antibiotics, anti-inflammatories, multivitamins, and oral antiseptics. The patient was motivated for plaque control measures. The importance of nutritionally balanced diet with inclusion of fresh fruits and vegetables were recommended. The patient was followed up for 3 months and 6 months during which there was no recurrence noted. (Figure 7) Mobility of the teeth 14,15,16 had reduced to zero degree owing to resolution of inflammation. The patient failed to report further for follow-up.

Histopathological examination of the biopsy from mandibular anterior region with sessile base revealed discontinuous stratified squamous parakeratinised epithelium overlying fibrovascular stroma with numerous endothelial lined vascular spaces of varying sizes in the form of lobular aggregates well separated with connective tissue septae. Along with multiple evidences of budding capillaries with endothelial proliferation chronic inflammatory infiltrate composed of lymphocytes, plasma cells, neutrophils, and macrophages were found. Presence of abundant areas of hemorrhage suggested LCH. (Figure 8) The specimen excised from palate revealed deposition of dense homogenous eosinophilic material that comprised of proliferating fibroblasts along with thin-walled capillaries having small lumen and infiltration of chronic inflammatory cells interspersed in extracellular matrix that suggested granulation tissue or non-LCH. (Figure 9)

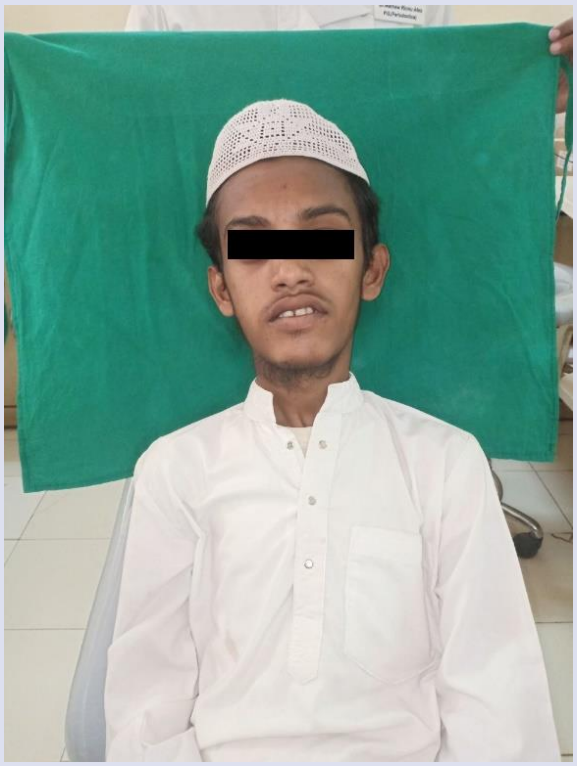

Figure 1: Extraoral picture showing incompetent lips.

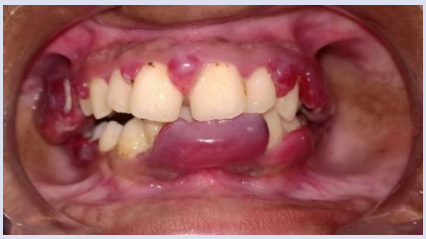

Figure 2: Diffused enlarged gingiva at multiple sites

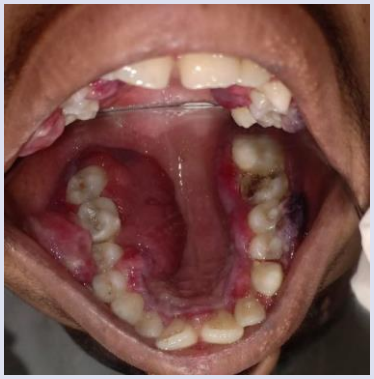

Figure 3: Palatal swelling on left side extending from first premolar to second molar

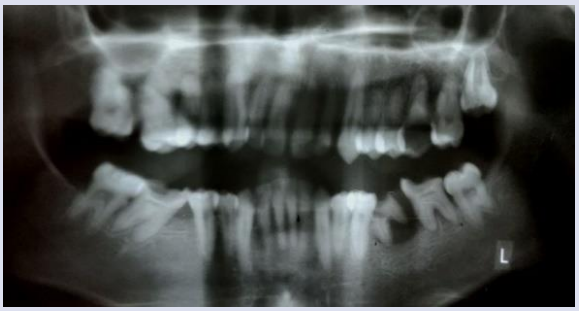

Figure 4: OPG showing root pieces and carious lesion with 26,36,37 and impacted 28.

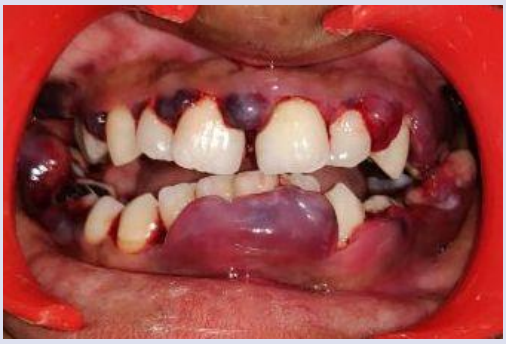

Figure 5: Blackish discoloration at provoked sites.

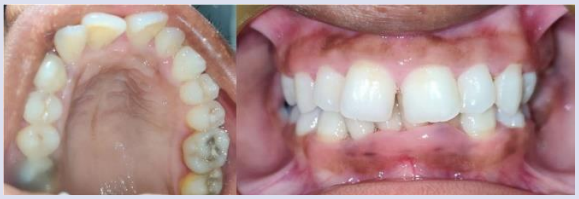

Figure 6: Clinical picture after two weeks of scaling

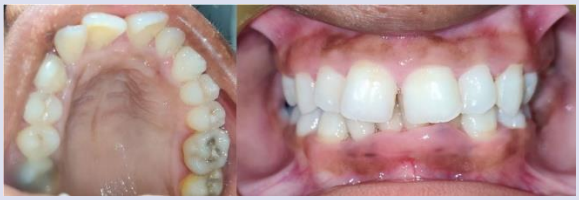

Figure 7: Labial and palatal view at the end of 6 months

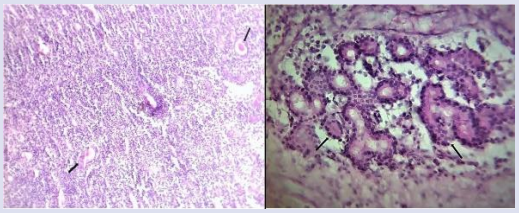

Figure 8: Photomicrograph showing budding capillaries of endothelial cells arranged in lobular aggregates separated by connective tissue septa. H&E stained (x10) and (x40)

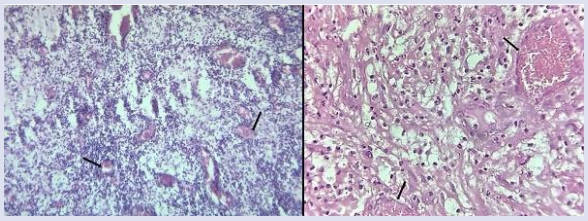

Figure 9: Photomicrograph showing areas of hemorrhage, filled with RBC's and thin-walled capillaries with small lumen along with chronic inflammatory infiltrates. H&E stained (x10) and (x40).

Discussion

PG is said to be a commonly occurring condition caused by trauma or local irritant factors. The lesion usually does not lead to serious outcomes if recognized early and treated promptly. Since it is a highly vascular lesion, the excess bleeding that occurs on provocation is explained by the role of angiogenesis through activation of cytokines and endothelial cell with greater expression of Intercellular adhesion molecule-1 (ICAM-1), Vascular cell adhesion molecule-1 (VCAM-1), CD34 molecules.[5] The varying size of the lesion is said to depend on factors such as duration, site, type of inflammatory infiltrates, vascularity etc. However, neglected, and long-standing cases may show increase in size and lead to difficulty in mastication, compromised esthetics. In the present case these conditions lead to inadequate diet intake thus paving the way for undernourishment and weight loss of the patient.

Two histological variants of PG i.e., LCH and non-LCH are found based on the presence or absence of lobular aggregates of endothelium lined vascular spaces. A different evolutionary pathway has been suggested for this difference.[2,6] Another distinguishing feature is said to be the foci of fibrous maturation being absent in LCH compared with non-LCH.[6] In the present case, two different sites were chosen for biopsy to assess if any variation existed histologically since the clinical picture varied from region to region and it existed.

The usual treatment consists of elimination of local irritants through phase I therapy followed by conservative surgical excision that include use of Nd: YaG lasers, cryosurgery using CO_2 snow, intralesional injection of triamcinolone, absolute ethanol, sodium tetradecyl sulfate and topical application of timolol.[2,3,7] In the present case phase I therapy resulted in resolution of inflammation to a greater extent. The blackish discoloration that occurred during this phase was found similar to a case of scorbutic siderosis reported.[8] In the present case report, surgical excision of the lesion was carried out by a soft tissue diode laser.

The differential diagnosis of PG includes Peripheral giant cell granuloma, peripheral odontogenic fibroma, hemangioma, Kaposi's sarcoma, angiosarcoma, hyperplastic gingival inflammation.[9] However confirmatory diagnosis is always certain with combination of clinical and histological correlation. Recurrence rate of PG is said to be as high as 22.2 percent especially in third and fourth decade, predominantly in

females.[10] However in the present case there was no recurrence till six months. There was improvement in the patient's oral and general health as his BMI recorded showed 20.06KG/M^2 at the end of 6 months.

Conclusions

The present case highlights both histological variants of PG in a single patient at gingival as well as extra gingival sites. Not only the local condition was managed but the patient's general health was also taken care of. The advantage of laser assisted gingivectomy and curettage result in minimal hemorrhage, pain, and discomfort to the patient. Hence, early diagnosis with meticulous treatment is the key for management of these benign lesions.

Acknowledgement

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Informed consent

An informed consent was obtained from the patient for publication of this case report.

Conflicts of Interest statement

No conflicts of interest.

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Digital Complete Dentures- An Overview

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Review

History

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ABSTRACT

Purpose of review: This review provides insight into the current techniques and systems used for fabricating digital dentures.

Recent Findings: In the current era of digitalization, innovations in the field of digital dentistry have led to significant advancements in complete denture fabrication. Digital technologies may revolutionize the future of dentistry in terms of simplicity and treatment time. Complete dentures fabricated with the help of a computer-aided design and manufacturing have become increasingly popular as they result in better fit, high patient and dentist satisfaction while reducing the number of appointments.

Summary: This review focuses on different techniques and digital workflow for digital complete denture fabrication.

Keywords: CAD CAM dentures, Digital complete dentures, Digital denture workflow, Printed dentures, Milled dentures.

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Introduction

Advancement in the field of medical sciences has led to an increase in life expectancy, thereby increasing the number of completely edentulous patients requiring rehabilitation with complete dentures. Conventional complete dentures always remain a choice for most patients, because of anatomical, physiological, and financial restraints, although other treatment options like implant-supported dentures are proven efficient.[1] The limitations of Polymethyl methacrylate (PMMA) dentures like porosity, dimensional shrinkage, and bacterial adherence to the denture base have led to the development of newer materials with improved physical properties.[2,3] Modern denture base materials and techniques like milled and printed complete dentures have overcome the limitations associated with conventional dentures. They also have potentially reduced chairside time, fabrication time, and incurring costs for the dentist and dental clinic.[4,5]

A digital denture is defined as "a complete denture created by or through automation using computer-aided designing (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE)" by the Glossary of Digital Dental Terms.[6] First, the geometrical shape of an object is obtained using CAD software, and later, CAM software directs the fabrication process. Maed *et al.* first applied the 3-dimensional (3D) laser lithograph technique by using the computer-aided system in complete denture designing and fabrication. A plastic shell of resin was fabricated with transfer bases made with photo-polymerized resin and denture teeth were made with teeth-colored acrylic. Later, another study incorporated scanned transfer bases and occlusion rims into a CAD software program.[2,7,8] Virtual dentures were designed, and the base and teeth were printed using rapid prototyping, and additive manufacturing technology in individualized printed flasks.[2]

Complete Denture fabrication with computer-aided technology uses light scanning technology to obtain clinical information from the patient, which is digitized, and on computer software digital designing of complete dentures is done and a designed virtual denture in occlusion is obtained. An automated manufacturing technique (CAM), which can be subtractive (such as computerized numerical control milling) or additive (such as 3D printing), is then applied.[9,10]

In the subtractive method, a pre-polymerized resin blank is used to mill the denture base. Later, milled denture teeth or prefabricated teeth are bonded on the denture base. Monolithic dentures also use the same milling technique where the denture base and teeth are milled together.[6] The subtractive technology benefits dentists, patients, and laboratory personnel, as it shortens the duration of the procedure. Its drawbacks include high material waste, thickness limitation on the prosthesis, and poor recording details due to the size of the cutter used for milling and the expensive nature of the equipment.[11-13]

Additive manufacturing also known as rapid prototyping (RP) or 3-dimensional (3D) printing involves

techniques that construct objects layer by layer. In additive manufacturing, the materials are generally based on liquid or powder to build a solid 3D model.[1,10] Additive manufacturing has high design flexibility and greater accuracy in recording details, and a negligible amount of material wastage.[9,14-16]

Digital denture (printed or milled) fabrication is done in two different methods – A complete digital protocol (scanning of hard and soft tissues intraorally) or a combination of conventional and digital fabrication techniques (recording impressions in the conventional technique, Jaw relation records, and designing digitally and denture fabrication). Earlier, a combination of conventional impressions and digital fabrication techniques was preferred which required procuring materials and trays, and equipment compatible with the particular digital system, and the denture was fabricated by specific manufacturers, However, recent advances have led to the development of open systems which allows the dentist to use their trays and materials for procedures which can be sent to the laboratory for scanning of the same, followed by designing and fabrication of the denture. These Open systems allow the in-house fabrication of dentures by the dentist if printers or milling machines are available in dental clinics.[17]

Applications of digital dentures include the fabrication of immediate dentures and implant-supported overdentures. The digital protocol can be applied for the fabrication of immediate dentures and implant-supported overdentures. For immediate denture fabrication, conventional steps for impression-making and jaw relation records are done, later these records are sent to the laboratory and can be scanned. The teeth can be extracted virtually on the virtual cast and prosthetic teeth placement can be planned. A try-in prosthesis can be printed for a try-in procedure. The final denture can be printed or milled, the natural teeth can be extracted and denture insertion can be done. Digital dentures have a few limitations like the need for relining. The use of intraoral scanners to record the denture-bearing areas requires relining and repeated adjustments of the tissue surface of the denture for accurate fit. It is not possible to digitally register interocclusal records without existing dentures.[18]

Advantages of Digital Complete Dentures

Digital complete dentures have numerous advantages over traditional complete dentures for dentists, patients, and dental technicians. In general, when compared to conventional complete dentures, both milled and printed dentures have the following advantages

1. Digital dentures can be fabricated within three to four appointments, thereby reducing the number of visits for patients. This is beneficial for elderly patients, as fewer visits to the dentist are required. The dentist and the technician can deliver the prosthesis in a more time-efficient manner.[2,19-22]
2. With fewer dental visits, the dentist spends less time in the chairside procedure.[2]
3. Digital systems have digital data stored in a repository, which does not require the making of new clinical records for the swift fabrication of replacement dentures. This is beneficial if dentures are lost or broken. The replacement dentures will have the exact contour of the old dentures, making patient adaptation easier.[2,23,24]

Advantages of milled dentures

1. Milled dentures exhibited superior fit and improved dimensional stability. This is due to the denture being milled from Pre-polymerized acrylic resin. The poly (methyl methacrylate) (PMMA) pucks are highly condensed resins as they are polymerized at high temperatures under pressure.[2,19]
2. Milled dentures showed enhanced physical and mechanical properties compared to conventional heat-polymerized PMMA.[2,25]
3. Milled bases and teeth show improved resistance to stain collection in comparison to traditional dentures.[2,26,27]
4. Monolithic dentures have the teeth as part of the denture as they are milled, compared to the techniques of denture processing used in conventional dentures; therefore, there is very little tooth movement.[2]
5. Denture teeth milled digitally as a part of a monolithic denture is not dislodged from the denture. The monolithic dentures' milled teeth enable the production of teeth of any size and form that precisely match the tooth morphology in the opposing natural dentitions.[2]

Advantages of printed dentures

1. Definitive dentures and trial dentures can be rapidly processed as printing of denture bases and denture teeth within in short time.[2,4]
2. 3D printing systems offer more environmentally friendly techniques by minimizing the use of denture resin.[2]
3. Printed dentures are cheaper compared to milling; it is affordable for both dentists and technicians and complex details can be obtained with high accuracy.[4]
4. Denture Duplication of existing dentures using 3D printing saves treatment time and material use and reduces the effect of the human factor.[4]

Disadvantages of digital complete dentures

Comparing digital complete dentures to traditional processed complete dentures, several disadvantages can be listed.

1. A Clinician has to have sufficient knowledge about using digital systems and making multiple complete dentures to achieve clinical skills.
2. Compared to traditional fabrication techniques, the cost of materials and lab fees is higher.[4]

Table 1. Advantages and Disadvantages of intra-oral scanning.

Advantages	Disadvantages
1. Mucostatic impressions can be recorded. 2. Decreased patient discomfort as impression materials need not be used to record impression. 3. Elimination of stresses associated with impression distortion.	1. Inability to accurately record flabby due to the software's deletion of sections that aren't stable over time. 2. Accuracy of the scan is affected by the length and distribution of the edentulous area, the skill of the operator, and the size of the scanner tip. 3. Difficulty in consistently capturing the border areas. 4. Inability to other impression techniques such as pressure, selective pressure, or minimal pressure. 5. Compressibility of the oral mucosa is difficult to assess. 6. Recording the mandibular edentulous arch is difficult due to the movements of the tongue.[24-26]

Use of intraoral scanners/ Extraoral scanners in digital denture fabrication

Most of the systems use conventional impression techniques or the master cast that was scanned later extraorally using laboratory scanners. The accuracy of the extraoral scan depends on the conventional impressions or casts scanned. The impressions and models are sent to specific laboratories and are scanned with the help of laboratory scanners. Studies have suggested the use of intraoral scanners for recording the denture-bearing area of edentulous patients.[18,28,29] Studies have suggested the use of the buccal-occlusal-palatial (BOP) and "zig-zag" techniques mainly used for the intraoral scanning of edentulous jaws.[30] Intra-oral scanners have a few advantages and disadvantages explained in Table 1.

Digital Denture Fabrication

Digital dentures may be fabricated using a complete digital protocol or a combination of conventional and digital fabrication methods. However, the completed digital workflow for complete dentures is still debatable since it is difficult to digitally register the interocclusal records and the functional impressions. A combination of conventional impressions and jaw relation records with digital designing, and processing techniques helps fabricate the final prosthesis.[31] Data acquisition, data processing (designing), and prosthesis manufacturing are the three fundamental phases in the fabrication of a digital denture.

Data acquisition –Data may be collected directly intraorally in the dental clinic using an intraoral scanner and later electronically sent to the lab. The conventional impressions/ master casts and jaw relation records are then sent to the laboratory where they are scanned using extra-oral scanners.

Data processing: Data processing is accomplished using computer-aided designing (CAD) tools and reverse engineering.

Prosthesis manufacturing: The prosthesis may be manufactured through the subtractive or additive method.[32]

Milling

During milling dentures, once the prosthesis design has been approved, a milling software program receives the CAD stereolithography file and instructs the milling machine to do a series of motions. The artificial teeth can be milled either as part of the prosthesis (monolithic), separately, as an entire arch, or prefabricated set and bonded to the milled denture base.[32] A Pre-polymerized block can be used to mill the denture base, and a dual cross-linked block can be used to mill denture teeth, and later bonded to the denture base. A bicolored disc can be used to mill a monolithic denture; on one side, the denture base is made of high-impact PMMA, and on the other, the teeth are formed of strongly cross-linked PMMA and can be milled simultaneously.[7] Milling machine type also plays a significant role in determining the quality of milled dentures. Classification of type of milling machines is based on the number of milling axes a machine has, which can be three to five axes. The ability of the milling machine is improved by adding more axes. The milling procedure will ultimately guarantee the denture's durability and minimize manufacturing flaws. However, waste materials and the wearing of the milling burs wear are the major drawbacks of milling.[9,33]

3D-Printing

3D printing involves the process of creating objects designed digitally by linking materials successively, layer by layer. Once the digital design is completed, it is printed using a large number of successive layers of liquid or filament material. The thickness of each layer and orientation significantly affect the characteristics of the final prosthesis. As the layers lack resolution, producing an esthetic prosthesis is often challenging. Additive manufacturing includes several types such as stereo lithography, fused deposition modeling, digital light projection, and jet printing.[9]

Stereolithography (SLA)

This method uses an electron beam or UV light for polymerization for the initiation of the chain reaction of monomer and resin. The materials in liquid form are used which comprise photopolymers such as pure polymer resins, composite resins, and polyamides. Liquid resin is used to create rigid layers which are hardened layer by layer until the

3D model is completed. The completed model is later rinsed and cured in an ultraviolet oven. The 3D printed models by SLA have high resolution and quality. The thickness of each layer is determined by the energy of the light source and the duration of exposure.[9,10,15]

Fused depositing modeling (FDM)

The important aspect of this technology is the polymer's thermoplastic nature, which permits the layers to bond together during the process of printing and later solidify at room temperature after printing. Commonly used materials are Acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), and polycarbonates. The material should have a low melting point and sufficient viscosity after melting to allow it to exit the nozzle smoothly. However, it must be strong enough to hold up the subsequent layers.[9,10,15]

Digital light projection (DLP)

This is a photo-curing method that uses the principles of the SLA method. Using liquid photosensitive resins the 3D model is printed layer by layer, with the following layers being added on top of the previous layers. The DLP 3D printer's projected light source from within the clear resin tank across the platform cures the entire building layer assembly. The complete part is put together by moving a build platform dependent on the layer thickness using a computerized projector screen after each layer has been hardened. Beyond a laser projector, a digital micro-mirror is used to reflect lightand create several layer combinations. While DLP uses UV light from the digital lens's projection source, SLA uses a UV laser beam as its light source. In SLA compared to DLP, the curing is more exact and the quality is higher since the UV light source is static and cures each layer of resin at the same time. The DLP 3D printer has a light source with variable intensity.[9,10,15,34]

Material jetting

A photopolymer injection system creates the entire three-dimensional item layer by layer through a number of nozzles. The material is cured by UV radiation and shares a chemical foundation with vat photopolymerization.[9,10,15,34] (Table 2)

Workflow for Milled Denture

Several workflows for fabricating milled dentures depending on the commercially available system and number of dental visits are available. Many protocols use combined conventional and digital clinical steps. The conventional steps are then later digitized or used for clinical try-in procedures. There are numerous options to combine the production of the base with one of the denture teeth milled as shown in Table 3. The workflow with various commercially available systems for milled dentures is presented in Table 4.

Table 2: Common Additive Manufacturing Methods, advantages, disadvantages, and materials used

AM Techniques	Advantages	Disadvantages	Materials used
Stereolithography	High accuracy Adequate mechanical strength Accurate recording of details	Expensive The need for final processing Toxicity of Residual monomer	Acrylate photopolymer Plastic
Fused depositing modeling	Low cost, High speed, Easy processing	Reduced mechanical strength, low surface quality Poor variety of thermoplastic materials	Acrylonitrile butadiene Polylactic acid (PLA) Styrene (ABS) Polycarbonate Composites
Digital light Projection	Quick Production Low cost Excellent surface finish High Precision	Limited material selection Skin sensitization	Resins Photopolymers Plastic
Material Jetting	Fast build process Thin layer with high resolution	Irritant to the body	Photopolymers

Table 3. Various options for the fabrication of milled dentures

Milled Denture base	Denture teeth bonded in the milled recess of the denture base or on milled abutments	Printed Denture base
with Prefabricated Denture Teeth Set	Hybrid combination of milling and printing	With Milled Denture Teeth Set
With Milled Denture Teeth set		With printed individual Denture Teeth
With Milled individual Denture Teeth		With prefabricated Denture Teeth
Monolithic denture base and denture teeth		With printed individual teeth set

Table 4. Overview of Commercially Available Milled Denture System for Complete Dentures

Clinical Steps	AvaDent® Digital Dentures	Ivoclar digital denture TM	Ceramill® full denture system	Baltic denture system
1st appointment	Intra-oral scanning the edentulous jaws using an intraoral scanner Final impression, Recording vertical and horizontal jaw relation	Primary impression Recording vertical and horizontal jaw relation occlusal plane determination Papillometer upperlip length+lip closure line	Final impression Recording vertical and horizontal jaw relation (Ceramill Transferkit)	Final impression using specific trays(upper and lower KEY, 3 sizes)
2nd appointment	Try in, checking aesthetics and functional aspects.	Final impressions with milled customized trays Recording vertical and horizontal jaw relation(gothic arch tracing)	Try in, checking aesthetics and functional aspects.	Determination of vertical and horizontal jaw relation(gothic arch tracing)
3rd appointment	Denture insertion Checking for fit of the tissue surface and correction of occlusal errors.	Try-in of milled monolithic trial dentures (Ivobase CAD+individual manufactured or milled denture eeth	Denture insertion Checking for fit of the tissue surface and correction of occlusal errors.	Denture insertion Checking for fit of the tissue surface and correction of occlusal errors.
4th appointment		Denture insertion Checking for fit of the tissue surface and correction of occlusal errors.		
Method of fabrication	Milled bases with bonded teeth or the teeth and denture bases milled as a single unit.	Milled base with recesses for denture teeth	Milled base with recesses for denture teeth	Milled prefabricated base with denture teeth

Table 5. Overview of commercially available printed denture system for complete dentures

Clinical Steps	Dentca Digital Dentures
1st appointment	Impression with specific trays Recording vertical and horizontal jaw relation (Gothic arch tracing) upper lip length measured with lip ruler and incisal edge position Try in on demand
2nd appointment	Denture insertion Checking for fit of the tissue surface and correction of occlusal errors.
Method of fabrication	Printed base with recesses for denture teeth

Table 6. Comparison between Printed and milled dentures.

Printed Dentures	Milled dentures
The cost of equipment is less	High cost of equipment
Non-polymerized resin can cause skin reactions	Highly cross polymers used in the fabrication
Polymerization shrinkage	No polymerization shrinkage
Printed teeth lack a variety of shapes and shades	Milled teeth Have more choices
Do not exhibit surface details (root Prominence)	Enhanced esthetics

Workflow for Printed Denture

There are numerous options to combine the fabrication of the base with the one of the denture teeth milled as shown in Table 3. The workflow with various commercially available systems for printed dentures is presented in Table 5.

Physical Properties

1. Flexural strength- studies have compared the flexural strength of conventional heat-polymerized PMMA to both printed and milled denture base materials. Milled denture base materials showed higher flexural strengths in comparison to printed and conventional PMMA. Milled dentures use PMMA pucks that are processed under significantly higher temperatures and pressure resulting in dense material with lesser voids. This procedure enables the fabrication of milled dentures with thinner dimensions while maintaining acceptable strength.[35-38]
2. Fracture Toughness- studies compared the fracture toughness among conventional, milled, and printed dentures. Printed dentures showed less fracture toughness in comparison with the two other groups.[38,39]
3. Color Stability – several studies examined the color stability in milled, conventional, and printed denture materials and found that the printed resin group showed considerably larger color changes. It is attributed to increased water sorption seemed to be higher in printed denture materials. Surface deterioration, and factors relating to the mixing, polymerization, and post-processing of the printed material, could all be contributing factors to the decreased color stability.[39-41]
4. 4.Denture tooth bond strength- literature reports that the bond strength of printed denture base with printed teeth is lower than observed with conventional

processes of denture base and teeth. The printed group showed both adhesive and cohesive failures.[42,43]

5. Denture base adaptation- Milled dentures of exhibited superior denture base adaptation when compared with conventional processed dentures.[27,44] Milled dentures also showed improved retention. Printed dentures showed poor denture base adaptation when compared with milled dentures.[27,39]
6. Surface Characteristics- After polishing, milled dentures showed superior surface
7. characteristics than 3D printed and conventional dentures.[2,39,45] (Table 6).

Conclusions

Digital technology permits dentists to provide dentures that are highly esthetic, strong, and have better patient outcomes. The dentures can be fabricated in three to four clinical visits, which is beneficial to the clinician, technician, and patient. A better understanding of the indications, workflow, and limitations of the various digital systems used to fabricate complete dentures can promote simplified protocols for dentures, patient satisfaction clinical efficiency, and favorable long-term outcomes. With the aid of a fully functional laboratory, digital dentures can be largely or nearly totally incorporated into clinical practice to effectively increase clinical efficiency, communication, and outcomes.

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Effectiveness of Various Modes of Education of Tooth Brushing Technique in Plaque Control Among Visually Impaired Children: A Systematic Review

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Review

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ABSTRACT

Aim: To compare different forms of newer tooth brushing techniques and oral health educational approaches to assess how well these children's oral health knowledge, oral hygiene practices, plaque and gingival status, and dental caries status have improved as a result of the implementation of various OHE techniques for visually impaired school children.

Methodology: Comprehensive data search was conducted in EBSCO Host, PubMed, Scopus, Google Scholar, and Web of Science until 31st January 2023 for studies in the English language. Three reviewers critically assessed the studies for eligibility criteria, and data extraction was performed. Quality assessment of the included studies was performed using a quality assessment Revised Cochrane Risk of Bias tool for randomized control trials (RoB 2.0)

Results: The search strategy yielded 32 manuscripts after screening through titles and abstracts, full text, and removing duplicates. In the end, 6 articles were included in a systematic review according to pre-set eligibility criteria. The present review emphasized newer oral health educational approaches for visually impaired children and improvement in their oral hygiene practices and plaque status.

Conclusion: The visually impaired children should be provided with the knowledge and abilities they'll need to take care of their oral health and hygiene on their own.

Keywords: Visually Impaired Persons, Health Education, Child, Toothbrushing, Systematic Review.

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Introduction

The most crucial sense for discovering the world around us is vision, and vision impairment, particularly in childhood, can have serious consequences for a person's ongoing physical, neurological, cognitive, and emotional growth over their entire lifetime.[1] Around 1.5 million children are blind worldwide, and this number seems to be rising. One child goes blind per minute, or 500,000 children annually, and almost half of them pass away within a year or two.[2] As there is no population-based nationwide survey available, the prevalence of blindness in India is estimated to be 0.8 per thousand children in the age range of 0 to 15 years. At least 210,000 children are blind or have severe visual impairments.[3,4] Children who go blind have a significant negative impact on the family's economic, psychological, and emotional development. Compared to a sighted child, a blind child is more likely to experience developmental milestone delays, frequent hospitalisations, and early death. Such severe visual impairment also negatively impacts orientation and educational activities from an early age, which results in a lack of work privilege.[5]

Children who are visually impaired struggle daily to carry out their regular tasks. One of them is to maintain good oral hygiene. They rely on someone else to complete their everyday tasks. The carers for the visually impaired tend to take care of their general health, but oral health is neglected.[6,7] Subjects with visual impairments are more likely to experience more dental problems and more issues with oral care access. The majority of them are ignorant of basic oral health prevention measures. For children who are visually impaired, preventive and oral health education methods are more cost-effective and less time-consuming than conventional dental care.[8]

It's important to improve communication between dentists and people with visual impairments, and one way to do this is through oral health education. For visually impaired children, oral health education along with self-maintenance skills provide the most substantial improvements in oral hygiene.[7] Visually impaired children need to be taught dental hygiene in a unique way that takes more time and patience. Most oral health education (OHE) programmes rely on auditory and tactile sensations since children with visual impairments rely heavily on speech, sound, and touch to orient themselves to circumstances. There are several unique and special approaches for providing OHE to help visually impaired children with their dental health.[9]

There are a variety of specialised and unique methods for providing OHE to enhance the oral health status of children with visual impairments, such as teaching with conventional audio aids, specially designed Braille booklets, teaching each child their tooth-brushing technique on dental models using songs, and the audio-tactile performance (ATP) technique.

'Audio tactile performance technique (ATP)' is a specially designed oral health education method for visually impaired children to educate them on oral hygiene maintenance. The technique was given this name because children were first taught verbally about the value of brushing their teeth before being made to feel the teeth on a large-scale model and then brushing the model using the Fones method with help. It includes three components: audio, tactile, and effectiveness.[10] A study introduced the importance of the 3D braille media technique for the improvement of oral hygiene in visually impaired children. It is a learning process in which braille alphabet booklets are used to improve oral health status and oral hygiene maintenance.[11] Also, Tiwari B.S. *et al.* concluded that the reduction in oral plaque scores following the sequential implementation of the oral health education model in various formats, such as Braille, audio, or their combination, etc., demonstrates the success of the programme's motivational component.[12] AS Varghese *et al.* conducted a study in 50 visually impaired children in which they concluded that oral hygiene improvement was seen in children who received audio instructions and music-assisted toothbrushing programs. The oral health condition of visually impaired children has significantly improved as a result of using these specially designed oral health education programs.[13]

It is a constant struggle to get visually impaired children to use OHE resources and translate information from contemporary OHE approaches into oral hygiene practices. The aim of this systematic review is to compare different forms of newer tooth brushing techniques and oral health educational approaches to assess how well these children's oral health knowledge, oral hygiene practices, plaque and gingival status, and dental caries status have improved as a result of the implementation of various OHE techniques for visually impaired school children.

Material and Methods

Protocol and Registration

This review has been registered in PROSPERO, an international prospective register of systematic reviews supported by the National Institutes of Health Research and created by the University of York's CRD (Centre for Reviews and Dissemination). A thorough methodology was devised, and it is carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) declaration. The registration number for this review is CRD**42022375677** and can be accessed at:

https://www.crd.york.ac.uk/prospero/export_details_pdf.php

Study Design

This study design involves a meticulous and transparent process of identifying, selecting, and critically appraising relevant studies from diverse sources, such as academic databases, grey literature, and unpublished research. The systematic review design is widely recognised for its objectivity, transparency, and ability to provide a robust summary of the available evidence on a given topic.

Eligibility criteria

Based on the PRISMA guidelines, the following focused question was developed:

PICO can be referred to as:

1. **Population:** Visually impaired children
2. **Intervention:** Toothbrushing
3. **Comparator:** Various modes of toothbrushing techniques or oral health education
4. **Outcome:** Oral health status

The following PICO question was raised:

Which mode of education of tooth brushing technique is effective in the reduction of plaque and gingivitis in visually impaired children?

Search Strategy

A thorough data search was conducted in EBSCO Host, PubMed, Scopus, Google Scholar, and Web of Science. The dates of publication filter for the search using PubMed were set to be up until January 2023. The article type filter was configured to include only experimental studies. Although research reported in other languages was also chosen and subsequently subjected to Google translation to acquire the data in English, Studies were only rejected in terms of language if it was impossible to translate the data into English. No filters for full-text articles were set. The search terms were decided after searching through the literature and the MeSH database.

Search Terms

The following combination of keywords, MeSH terms, were used in the electronic search for terms related to intervention: "Audio tactile performance" OR "ATP" AND "Braille" OR "3DBraille" AND "Dental model" OR "Dental models" OR "Model, Dental" AND "Music-based toothbrushing" AND "Toothbrushing" OR "Oral hygiene" OR "Visually impaired person" OR "Blind person" OR "Impaired Person, visually" OR "Person, visually impaired" OR "Visually impaired children". Additionally, the randomised controlled trial (RCT) search filter was applied. Searches were restricted to human research.

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Studies done on visually impaired children to assess various modes of education of tooth brushing technique in plaque control.
2. Studies with institutionalised or non-institutionalised settings.
3. Studies involving population belonging to the 4–18 age groups.

4. Studies done on both the gender i.e., males and females.
5. Studies with a randomised control trial.
6. Study assessing oral diseases, which includes plaque formation and gingivitis as a part.
7. Study published from inception till January 2023.
8. Studies written in the English language and studies written in any other language that are possible to get translated into English.

Exclusion criteria:

1. Reviews
2. Case reports
3. Case series
4. Conference proceedings
5. Letters to the editor
6. Short communications

Screening and Data Extraction

Three reviewers independently examined the titles and abstracts obtained through the search strategy and included them if they met the inclusion criteria. Later on, the whole texts of all the included studies were obtained. They first retrieved the complete text of the article and analysed it before deciding whether or not the articles matched the criteria needed for inclusion. A fourth and fifth reviewers were consulted if there was any uncertainty over the inclusion of any research article. Relevant data were gathered by the reviewers, the results were collated, and all the data were meticulously validated.

Data Collection Process

With the assistance of a professional, a standardised data extraction form was created in Microsoft Excel. The Excel spreadsheet initially had 3–4 entries, and an expert reviewed it. Disagreements between the authors were resolved by discussion. This sheet for data extraction was referred to as a pilot sheet. After the retrieved data was verified under specified categories, the next extraction procedure was started.

Outcome Variables

Data extraction from the selected studies used preset primary and secondary outcome variables. Oral health status was one of the secondary outcomes examined in addition to the major outcomes of PI, GI, and OHI. It was considered that outcome factors changed from the baseline to the 6-month follow-up.

Assessment of Risk of Bias

A quality assessment of the included studies was performed using a Revised Cochrane Risk of Bias tool for randomised control trials (RoB 2.0).[14] The risk of bias in the included studies was evaluated independently by reviewers. Any disagreement was looked into until a conclusion was reached. Studies were divided into three risk categories: high, unclear, and low. When one or more important domains are absent, there is a high risk of bias; when one or more important domains are not defined, there is an uncertain risk of bias; and when all quality standards are considered to be fulfilled, there is a low risk of bias. A graph was used to summarise the bias risk.

Strategy for Data Synthesis

A qualitative synthesis was performed for data analysis among the selected studies. The mean and standard deviation (when specified in the manuscript) of oral hygiene among the visually impaired children population were recorded from the selected studies. Reviewers independently assessed the studies for the Revised Cochrane Risk of Bias tool for randomized control trials (RoB 2.0) quality assessment. Any discrepancies between them were resolved via discussion. No meta-analysis could be conducted because of the high degree of heterogeneity in the chosen trials and the scarcity of well-designed RCTs in the literature.

Results

A total of 356 records were identified through database searches in PubMed and Scopus. Google Scholar yielded 12 articles based on titles, giving a total of 368 articles overall. These 368 articles were subjected to a screening process based on titles, duplicates, abstracts, and full-text reading and were included and excluded according to the predefined eligibility criteria. [Figure 1]

First step: The articles were screened based on titles to include the relevant manuscripts. From 368 manuscripts, 150 manuscripts were included as the titles represented the population and outcome of the review. Thus, 218 manuscripts were excluded at this step.

Second step: The remaining 150 manuscripts were screened for duplicates. From these, 45 manuscripts were found to be duplicates, which came up repeatedly in different search strategies. Thus, these 45 manuscripts were excluded, leaving the remaining 105 manuscripts.

Third step: In this step, 105 manuscripts were screened based on their abstracts. If the abstract gave relevant information, then the manuscripts were included. In case the information in the abstract is not clear and the reviewer is in doubt, the article was retained to move it into the full-text screening step. Only those manuscripts were excluded that did not match the eligibility criteria of population and the outcome of the review. Thus, 73 manuscripts were excluded based on abstracts.

Fourth step: The remaining 32 manuscripts were read for full text, and a final decision was made on whether to include or exclude them from the review. If, after reading the full text, the manuscripts were unable to provide the relevant information, then it was excluded at this final step. Thus, a total of six manuscripts were included.

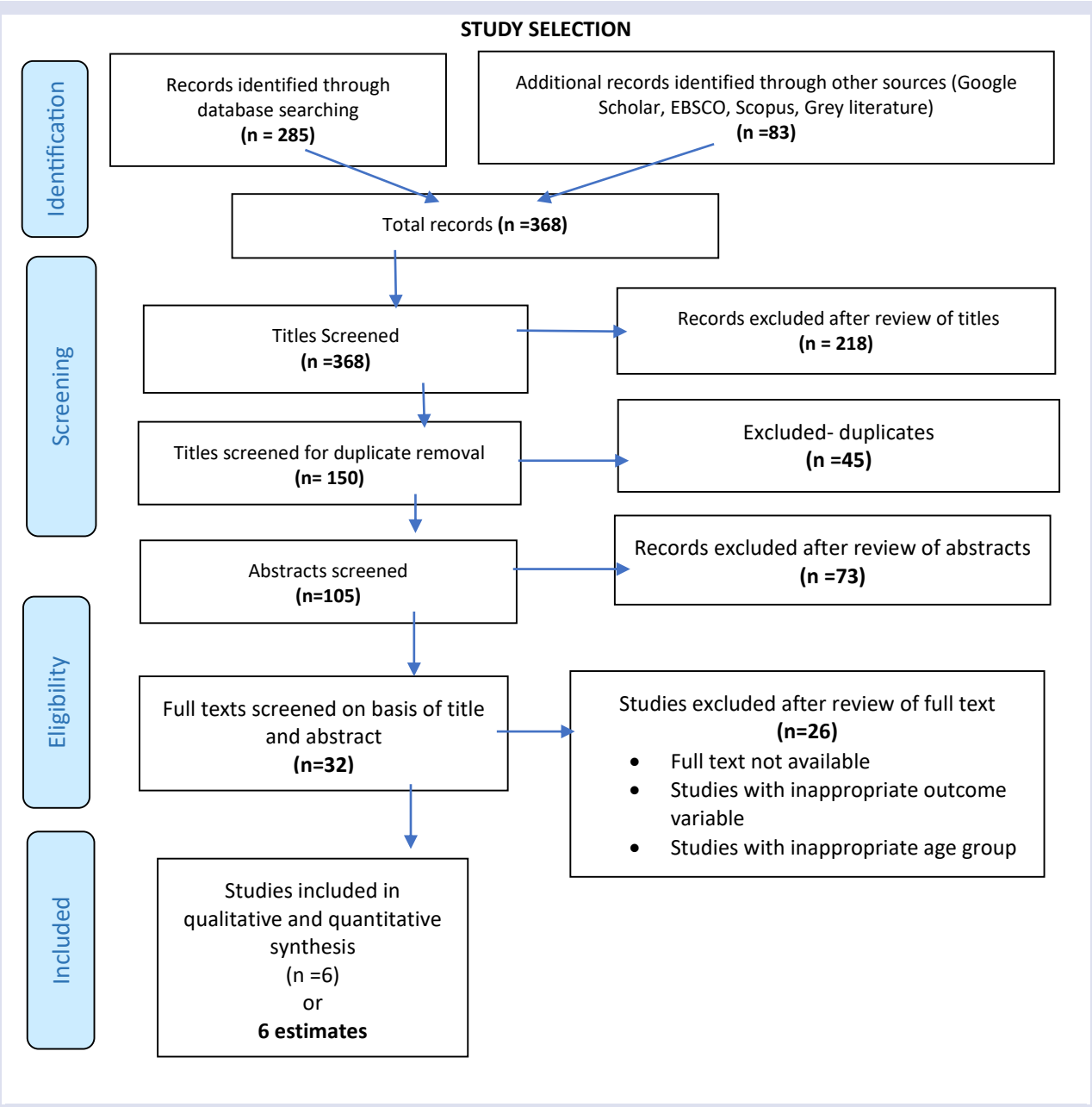

Figure 1. [PRISMA FLOW CHART

Study Characteristics

This review contains six articles, the general features of which are shown in Table 1. All of the studies[15–20] used a randomised control trial as their study design. The majority of the research is from different regions of India, with one study from each of Pakistan and Thailand. [16, 17] Out of the 6 RCTs, three studies[16-18] involved pre- and post-intervention in two groups, while three studies involved pre- and post-intervention in three groups.[15,19,20] All the studies selected[15–20] included schools without a track record of oral health care interventions. The participants had complete visual impairments throughout the duration of the interventions. The ages of the participants ranged from 6 to 16 years old. Everyone who participated was able to read Braille and had no other systemic illnesses. Additionally, the parents or guardians and the participating pupils each provided their informed consent and assent. A total of 374 participants were included in the studies' analysis, with 288 in the New toothbrushing techniques\OHE group and 69 in the Braille group, [15, 19, 20] 99 in the ATP group[15,18–20], 30 in Audio and Braille[18], 37 in Braille and ATP group[15,19], 53 in Guided tooth brushing programme and Modified Bass method with verbal and tactile toothbrushing instructions[16,17], and 86 in Traditional oral health talk group.[16,17,20]

The interventions utilised in the included research varied significantly in terms of methodology. As a result, the interventions that the research reported were divided into the following categories: (1) Contemporary OHE methods Braille text, audio tactile performance, oral hygiene instructions delivered verbally, oral brushing demonstrations using dental models or music, a

combination of the above methods, and (2) traditional techniques: oral hygiene instructions delivered verbally, audio recordings, and verbal tooth brushing demonstrations; the intervention study period lasted from one month to six months. Only dental experts offered newer toothbrushing strategies in various forms in all studies.[15–20] Overall, dropouts were noted at the end of the follow-up period.

Depending on the duration of the research, the OHE was administered in various ways in all of the studies in the beginning with the following reinforcement periods: one at baseline, 1 month, and 6 months[16]; one at baseline, 7th day, and one month[15]; two at baseline, every 3rd week, 3 months, and 6 months[18,20]; one mentioned reinforcement but did not mention time intervals[19]; and one at baseline only.[17]

The studies had different post-intervention measures of outcome. Two studies assessed the Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index and gingival index of Loe and Sillness.[16,18] Loe and Silness plaque index by two studies[15,19], oral hygiene index by one study, [17] Debris index, calculus index, and gingival index plaque index by one study.[20]

Assessment of Risk of Bias

Each study's risk of bias is assessed, and it is divided into three categories: high, medium, and low. For each domain in each of the included studies, a summary of the assessments of the risk of bias is shown in [Figure 2]. The quality assessment of the given six studies was executed according to the Revised Cochrane Risk of Bias tool for randomised control trials (RoB 2.0), where four studies showed a high risk of bias[15,16,19,20] and two studies showed a low risk of bias.[17,18] [Table 2]. Randomization was reported by all the included studies.[15–20] Allocation concealment was reported in only two studies.[15,18] For each study[15–20], participant and examiner blindness were not clearly defined. For 4 studies[15,16,19,20], selective reporting and other biases were low-risk, but they were high-risk for 2 studies.[17,18]

Figure 2. Risk of bias graph: For individual studies and across all studies

Table 1. Characteristics of included studies

Study Id	Place of study	Study design	Age group	Method of intervention	Sample size	Reinforcement period	Follow up period	Method of outcome assessment	Authors conclusion
Deshpande S. et al[15]	Pune, India	Randomized control trial	12-16 years	G1: Braille G2: ATP G3: Combination of both	60	at baseline, 7th day, and 1 month for all the groups	Follow up after 1 month	Loe and Silness plaque index	Braille and the ATP technique for teaching about oral health were both excellent tools when used separately, but they performed better together.
Smutkeeree A. et al[16]	Thailand	Randomized control trial	10-12 years	G1: Horizontal scrub method G2: Modified bass method with verbal and tactile tooth brushing instruction twice daily	57	at baseline, 1 month, and 6 months.	Follow up at 1 month and 6 months	1. Turesky-Gilmore-Glickman modification of Quigley-Hein plaque index 2. Gingival index of Loe and Silness	Plaque and gingival index significantly decreased as a result of the effectiveness of horizontal scrub and modified bass toothbrushing techniques.
Qureshi A. et al[17]	Karachi, Pakistan	Randomized control trial	10-15 years	Test: Guided toothbrushing program Control: verbal oral hygiene message	50	No reinforcement	Follow up after 30 days	OHI index	As compared to verbal oral hygiene instructions, the author determined that guided manual toothbrushing improves the oral hygiene status of visually impaired children.
Das D. et al[18]	Bhubaneshwar, India	Randomized control trial	10-15 years	Test: ATP Control: Braille(oral health education booklets) and audio-aids	60	at baseline and every 3rd week for 90 days	Follow up at 30 days and after 90 days	1. Turesky-Gilmore-Glickman modification of Quigley Hein Plaque index 2.Loe and Silness gingival index	According to the study's results, a new approach to teaching visually impaired children about their oral health through (ATP) was just as effective at keeping their gingival healthy and plaque removal efficacy as the conventional method of using audio and braille text.
Indurkar M. et al[19]	Pune, India	Randomized clinical trial	9-15 years	G1 : Braille, G2: ATP, G3: Combination of both	51	Reinforcement has been given. But intervals are not mentioned	Follow up after 3 months	1. Loe and Silness plaque index 2. Loe and Silness	The authors concluded that a combination of techniques can aid in a better

								gingival index	comprehension of oral hygiene practices, improving not only the oral health of visually impaired children but also their general well-being. For visually impaired children, a combination of the three techniques—verbal, Braille text, and ATP—can be effective in producing the best results. The best results were obtained using the Fones technique and toothpaste containing fluoride.
Shrivastava R. et al[20]	Madhya Pradesh, India	Randomized clinical trial	6-16 years	G1: Verbal, G2: Braille, G3: ATP	96	baseline and at every 3 weeks for 6 months	Evaluation at baseline, 3 month, and 6 months follow-up	1. Debris index 2. Calculus index 3. Gingival index	

Table 2. Quality assessment of the included studies was performed using a quality assessment tool for prevalence studies and each study was categorized into high, medium, and low-quality studies.

SR.NO	Author's name	Randomization process	Deviation from the intended variation	Missing outcome data	Measurement of the outcome	Selection of reported result	Overall bias
1.	Deshpande S. et al [15]	Yes	No	Yes	Unclear	Yes	High risk
2.	Smutkeeree A.[16]	Yes	No	Yes	No	Yes	High risk
3.	Qureshi A. et al[17]	No	Yes	Yes	Yes	Yes	Low risk
4.	Das D. et al [18]	Yes	Yes	Yes	Yes	No	Low risk
5.	Indurkar M. et al[19]	No	No	No	No	Yes	High risk
6.	Shrivastava R et al[20]	No	No	Yes	No	No	High risk

Quality assessment of given 6 studies was executed according to the Revised Cochrane Risk of Bias tool for randomized control trials (RoB 2.0) where 4 studies showed a high risk of bias and 2 studies showed a low risk of bias.

Discussion

One of the challenges in dentistry is the prevention of dental caries and periodontal disease for individuals with special needs. Any effort to change oral hygiene must focus heavily on education because this is the main way to influence behavior. If patients are aware of the reasons for suggested changes in oral hygiene behaviour as well as the consequences of sustaining poor oral hygiene conditions, the possibility of behavioural change is significantly boosted.[21] An individual's social and physical appearance is greatly influenced by oral health. Hence, it is necessary to practice proper oral hygiene activities. This becomes a difficult task and can sometimes be challenging for visually impaired individuals. These individuals, due to their limitations, do not follow ideal toothbrushing techniques.[22] Access to dental care and information about oral health may be affected by visual impairment. For children who are visually impaired, a good oral health education programme needs to be implemented.[23] Newer oral health education techniques included in this review were a guided toothbrushing programme, methods of brushing with tactile sensation, Braille, 3D braille, and a multi-sensory approach with a combination of two techniques (ATP, Braille). As the perceptions of smell, touch, taste, and audio

are very sharp in visually impaired children, educating them about oral health using these techniques is simple.

There are a variety of specifically tailored newer oral health education programmes that were created for children with visual impairment, delivered by dental health experts, ranging from 1 month to 6 months.[24,10-11,15-20] This review includes interventions aimed at educating children with visual impairments who had never attempted to learn via an oral health care programme about proper tooth brushing procedures and other components of oral health.[15-20] None of the articles included in this review received specific grants from any funding agency in the public, commercial, or not-for-profit sectors. The credibility of study findings is also increased with ethical approval, which is essential when making decisions based on the research findings. This review's four articles describe getting institutional ethical permission, consent, and assent before starting their research.[15-18] Two studies included in this review have not mentioned institutional ethical approval, but they have mentioned consent or assent from visually impaired children or their parents or guardians. Prior to enrolling a participant and persisting after enrolment, informed consent and assent are voluntary commitments to participate in research. The majority of the research was done in India, maybe because the prevalence of childhood blindness is as high as 1.5 per 1000 children in developing countries as compared to developed countries, where the prevalence is 0.3 per 1000.[5]

In this systematic review, all the studies included were randomised control/clinical trials, and the effectiveness of the brushing technique that was taught was assessed through, i) the Oral Hygiene Index (OHI), the Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index, the gingival and plaque index of Loe and Sillness, the Debris index, and the Calculus index. ii) oral hygiene practices.

The training and calibration of examiners, as well as ensuring maximal intra- and inter-examiner reliability, are essential factors in producing accurate results. Three studies[17,18,20] included in this review showed maximum intra- and inter-examiner reliability, while the remaining three studies[15,16,19] did not evaluate the kappa statistics. The accuracy with which a method measures what it is supposed to measure is known as its validity. The techniques and tools used to gather the data must be reliable to produce relevant findings, which guarantees that the analysis of the data and the conclusions reached are reliable as well. All six studies have tested the validity of the instruments used for evaluating the outcomes. [15-20] All the studies included in the systematic review have successfully accomplished their objectives.[15-20]

Effective information distribution is the key to addressing challenges with visual impairment. Individuals who are visually impaired can be taught about oral hygiene and oral health through a variety of methods. The study by Deolia S *et al.* showed that the "audio-tactile performance technique" method of oral health education was successful in teaching visually impaired children to practice oral hygiene correctly. Children who are visually impaired benefit most from oral health education and oral hygiene maintenance skills when their oral hygiene is improved.[25] A study conducted in 2019 by Agarwal Swati and Natani Ankit showed that comparing all the oral health education methods, none of them is better than the other, and a well-planned and well-executed combination of all the educational approaches is the only way to create a notable improvement in the delivery of oral hygiene instructions and, as a result, the oral health status of children with visual impairments. The study highlighted the significance of creating a very effective integrated system of training methods for visually impaired children that is simple to conceive and easy to carry out by a dentist. Periodic reinforcement of knowledge helps persuade visually impaired children to adopt a more positive outlook on maintaining their oral health.[26]

The studies conducted by D.Sushmita *et al.*, Diptajit *et al.*, and I.S. Maya *et al.* have compared braille, ATP, and a combination of both. All the studies concluded that a combination of both braille and ATP is more effective in improving oral hygiene in visually impaired children. Mean plaque and gingival scores have been reduced in combination techniques. Visually impaired children can improve their oral hygiene to the greatest extent by receiving oral health education in conjunction with self-maintaining skills. Combining various techniques can aid in improving an individual's understanding, memory, and reinforcement of oral hygiene practices, which can both benefit an individual's oral health and subsequently their related overall health.[15,18,19]

This systematic review's primary objective was to assess recent OHE approaches to determine which strategy is most effective for teaching children with visual impairments to maintain their oral hygiene. All of the more recent toothbrushing techniques had comparable effects on the children's short-term improvement in oral hygiene behaviour, which was reflected in their oral health status. This shows that the oral hygiene education (OHE) offered by the experts, which included auditory sense and tactile perception, helped children increase their ability to concentrate, motor skills, social skills, and collaboration, which helped them learn and adapt to the practices of oral hygiene favourably. The study conducted by Kumar RVS *et al.* concluded that oral health education programmes are nevertheless likely to have an important influence on the oral health of disabled children.[27] Periodic reinforcement is an important factor in delivering toothbrushing techniques to maintain good oral health status among these children. A study by Shrivastava R concluded that the state of these particular children's oral hygiene is improved by learning newer toothbrushing techniques and the knowledge and abilities to maintain them. Combining all three techniques—verbal, Braille text, and tactile performance—gives the best results because they can all help these children get the results they need. The Fone's approach and the use of fluoride toothpaste produced the best results since they were simple for children to remember and comprehend.

The use of mild reminders and an emphasis on positive reinforcement is beneficial.[20]

Enhancing oral hygiene for individuals with visual impairments in the future can involve leveraging advanced technology and incorporating innovative design principles.

- AI-powered oral hygiene assistant: Create a virtual assistant or mobile app powered by artificial intelligence that provides personalized oral hygiene instructions. This assistant could use voice commands and provide feedback on brushing techniques, flossing, and other oral care routines.
- Tactile Navigation System in the Bathroom: Implement a tactile navigation system on bathroom surfaces to guide individuals with visual impairments to easily locate oral care products, sinks, and other essential elements in the bathroom.
- Smart Braille Labels: Incorporate smart Braille labels on oral care products, providing information about expiration dates, ingredients, and usage instructions. These labels can be read using smartphones or dedicated devices equipped with Braille readers.
- Voice-activated oral care products: design oral care products that respond to voice commands, making it easier for individuals with visual impairments to control devices like toothbrushes, water flossers, or UV sanitizers.

By combining these futuristic technologies and design principles, it's possible to create a more inclusive and effective oral hygiene experience for individuals with visual impairments.

Limitations and Suggestions

The newer OHE methods are child-friendly and make learning pleasurable for these children. However, the generalisability of the present review is limited, taking into consideration that the

- The majority of the studies were conducted in India and some parts of Asia.
- The studies conducted were not longitudinal in nature, and recent OHE methods were evaluated for a short period, showing oral hygiene improvement during that point in time; hence, the results cannot be generalised.
- Also, the sample size in each study and the duration of training were smaller, and more studies with a larger sample size should be carried out.
- More studies should be carried out in other parts of the world for the given population so that the results can be generalised worldwide.
- Longitudinal studies with larger sample sizes should be carried out.

Conclusions

- The findings consistently underscore the challenges faced by visually impaired children in maintainig proper oral hygiene practices.
- These challenges include limited access to visual cues, difficulties in mastering effective brushing techniques, and a higher prevalence of dental issues compared to their sighted peers.
- Implementing comprehensive oral health education programmes specifically tailored to the needs of visually impaired children can play a pivotal role.
- These programmes should focus on tactile and auditory techniques, providing hands-on training, and leveraging alternative sensory modalities to compensate for the absence of visual cues.
- Addressing these challenges requires a multidimensional approach that involves parents, educators, healthcare professionals, and policymakers.
- Though it is essential, education alone won't solve the problem. The aim is to provide visually impaired children with the knowledge and abilities they'll need to take care of their oral health and hygiene on their own.

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