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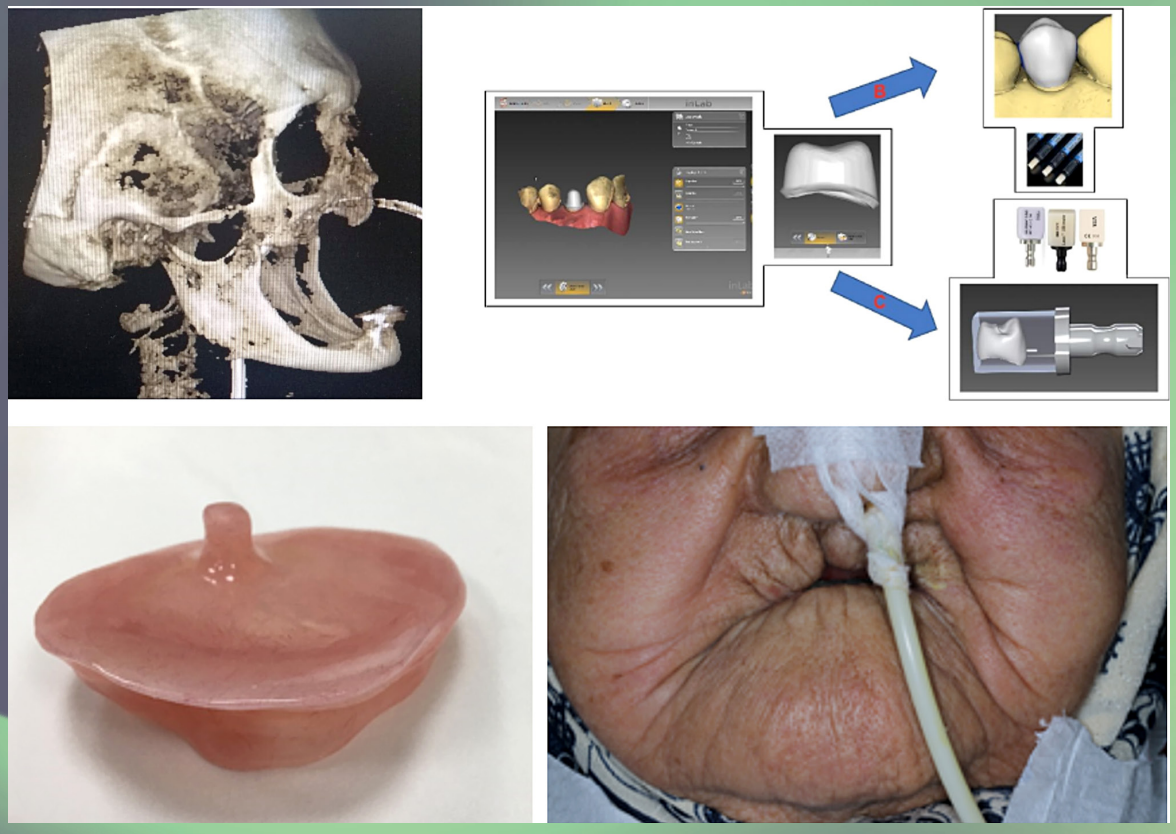

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Current Research *in* Dental Sciences

CONTENTS

ATATÜRK ÜNİVERSİTESİ YAYINLARI
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Current Research in Dental Sciences

Research Article *Araştırma Makalesi* DOI: 10.5152/CRDS.2023.223029

Effects of Botulinum Toxin Type A Injection in Patients with Bruxism and Masseter Muscle Hypertrophy

Bruksizm ve Masseter Kas Hipertrofisi Olan Hastalarda Botulinum Toksin Tip A Enjeksiyonunun Etkileri

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ABSTRACT

Objective: The aim of this study was to evaluate the efficacy of botulinum toxin type A injection on the severity and incidents of bruxism and joint noise and for pain in patients during the management of bruxism and masseter muscle hypertrophy.

Methods: Sixteen adults who had bruxism and bilateral masseter muscle hypertrophy were included in this study. One-session 30 U botulinum toxin type A injection was performed. Maximum interincisal mouth opening, visual analog scale evaluations, and severity and incident of bruxism were recorded at 3 times: baseline and 1 month and 8 months after the injection. Patient satisfaction was assessed only at 8 months after the injection.

Results: Significant decreases were observed in pain complaints, restriction in mouth opening, and severity of bruxism at 1 month and 8 months. Bite force decreased significantly at 1 month, but it returned to baseline levels at 8 months. Self-perceived pathologic sound decreased significantly at 8 months. No significant change was observed in painless maximum interincisal mouth opening and mastication efficiency at 1 month and 8 months. Patient satisfaction was good at 8 months.

Conclusion: Botulinum toxin type A injection lessened severity and incidents of bruxism and reduced joint noise and pain in patients with bruxism and masseter muscle hypertrophy, and botulinum toxin type A injection produced greater patient satisfaction.

Keywords: Botulinum toxin Type A, bruxism, masseter muscle hypertrophy

ÖZ

Amaç: Bu çalışmanın amacı; bruksizm ve masseter kas hipertrofisi tedavisi gören hastalarda Botulinum Toksin Tip A enjeksiyonunun bruksizm şiddeti ve sıklığı ile eklem ağrısı ve sesi üzerindeki etkinliğinin incelenmesidir.

Yöntemler: Bu çalışma bruksizm ve çift taraflı masseter kas hipertrofisi olan 16 erişkin hastayı içermektedir. Hastalara 30 U Botulinum Toksin Tip A enjeksiyonu yapılmıştır. Maksimum ağız açıklığı miktarı, görsel analog skala incelemeleri ile bruksizm şiddeti ve sıklığı 3 farklı zamanda kayıt edilmiştir: Tedavi başında, enjeksiyondan 1 ay sonra ve enjeksiyondan 8 ay sonra. Hasta memnuniyeti ise sadece enjeksiyondan 8 ay sonra değerlendirilmiştir.

Bulgular: Ağrı şikâyetleri, ağız açmadaki kısıtlılık ve bruksizmin şiddetinde tedavinin 1. ve 8. aylarında önemli azalmalar gözlemlenmiştir. Isırma kuvveti tedavinin 1. ayında önemli şekilde azalmış fakat tedavinin 8 ayında tedavi başlangıcındaki seviyelere geri dönmüştür. Bireysel olarak algılanan patolojik eklem sesi tedavinin 8. ayında önemli şekilde azalmıştır. Ağrısız maksimum ağız açıklığı ve çiğneme etkinliğinde tedavinin 1. ve 8. aylarında önemli değişimler gözlemlenmemiştir. Tedavinin 8. ayındaki hasta memnuniyet seviyesinin iyi olduğu görülmüştür.

Sonuç: Bruksizm ve masseter kas hipertrofisi olan hastalarda; Botulinum Toksin Tip A enjeksiyonu bruksizm şiddeti ve sıklığı ile eklem ağrısı ve sesini azalmıştır ve Botulinum Toksin Tip A enjeksiyonu yüksek oranda hasta memnuniyeti oluşturmuştur.

Anahtar Kelimeler: Botulinum toksin tip A, bruksizm, masseter kas hipertrofisi

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INTRODUCTION

Bruxism is a serious and uncomfortable condition, and it unfortunately is seen commonly in the Turkish population. Bruxism is defined as an unwanted oral habit consisting of involuntary clenching, bracing, grinding, or gnashing of teeth.[1]

Bruxism can show profound clinical signs and symptoms: masseter and temporalis muscle hypertrophy, myositis, morning jaw stiffness, and tooth sensitivity. Patients with bruxism are prone to experience jaw pain and limitation of jaw movement, which occur 3-4 times greater than in subjects with no bruxism.[1]

Unilateral or bilateral enlargement of masseter muscles is known as masseter muscle hypertrophy (MH). Muscle hypertrophy is characterized by a soft tissue enlargement near the angle of the mandible. The soft tissue enlargement may be associated with facial pain and can be obvious and cosmetically disfiguring.[2]

Muscle hypertrophy occurs more frequently in 20- to 40-year-old adults, with no gender distinction. The etiology of MH in children or adults may be multifactorial, and the exact etiology is uncertain.[3]

Several treatment modalities have been advocated for the management of MH: use of radiofrequency, botulinum toxin injections, a number of surgical methods such as partial resection of the masseter muscle and modeling osteotomy in the region of the masseteric tuberosity, conservative therapeutic approaches such as use of occlusal splints for the prevention of parafunctional habits, and systemic administration of muscle relaxants.[2]

Botulinum toxin is a powerful neurotoxin and produced by the gram-positive anaerobic organism *Clostridium botulinum*. It reversibly blocks presynaptic acetylcholine release at the neuromuscular junction.[3] Van Zandijcke and Marchau[4] first described botulinum toxin injection for patients with bruxism, and this injection method has gained popularity among clinicians.

Botulinum toxin type A (BTX-A) injection has been advocated for the management of orofacial muscle spasm or hypertrophies and bruxism[5-9] as well as for treatment of MH.[10] For patients with severe bruxism, some authors advocated the injection of botulinum toxin in both masseter and temporal muscles,[4,11,12] whereas others[13] suggested only masseter muscle injection to reduce bruxism.

However, the possible effectiveness of a reversible paralytic agent like BTX-A injection for treating bruxism and masseter muscle hypertrophy has been neglected in the literature. Thus, this study aimed to evaluate the efficacy of BTX-A injection on severity and incidents of bruxism and joint noise and pain in patients with bruxism and masseter muscle hypertrophy.

METHODS

The author designed a prospective clinical study composed of patients with bruxism and disfiguring MH who underwent 1-session bilateral BTX-A injection treatment.

This study was approved by the ethics committee (approval number: 2014/12). Patients were informed about the study design and potential side effects of BTX-A. All participants signed an informed consent agreement. The author confirms to have read the Helsinki Declaration and to have followed the guidelines for this investigation.

The following criteria were used to include patients in the study sample: (1) MH diagnosed through clinical self-evaluation (the soft tissue enlargement at near the angle of the mandible may be prominent enough to be considered cosmetically disfiguring) and magnetic resonance imaging (MRI) evaluations including patients with bilateral masseter hypertrophy, characterized by a soft enlargement that was associated with facial and masseter pain near the angle of the mandible; (2) incidents of bruxism; (3) age >16 years; (4) no underlying pathology diagnosed by MRI; (5) adequate existing clinical data at baseline (T0) and 1 month (T1) and 8 months (T8) after the injections.

Patients were excluded if they had pregnancy, drug allergy history, systemic disorders, inflammatory or malignant disease, previous temporomandibular joint treatment, and any individuals who had inadequate existing data at T0 and T1 and T8 after the injections.

The sample size was calculated with power analysis. A significance level of .05 and a test power of 80% was considered to detect a clinically meaningful difference of 4 mm in maximum interincisal mouth opening (MIO).[13] The power analysis showed that 11 patients were required for this study.

BTX-A Injection

The BTX-A (Botox, Allergan, İstanbul, Turkey) was supplied as a freeze-dried powder. The BTX-A was reconstituted gently with 1 mL of sterile saline solution, giving a concentration of 10 U/0.1 mL. The constituted drug was used immediately. Thirty units BTX-A was injected per side. The injection was carried out by using a 1 mL insulin syringe with a 26G, 0.5 inch needle. The toxin was injected equally into 2 regions (1 cm apart from each other) at the center of lower third of masseter muscle that were located each other after the disinfection as advocated by Lee et al.[14] Disinfection of the region was done by povidone–iodine solution. After the application, contamination with water was prohibited at the injection site for a few hours.

Clinical Parameters

Painless MIOs, visual analog scale (VAS) evaluations (mastication efficiency, pain complaints, self-perceived sounds and bite force, and restriction at mouth opening), and severity and incidents of bruxism and patient satisfaction were obtained.

A scale including 5 grading levels (0 = absent; 1 = slight; 2 = moderate; 3 = intense; and 4 = severe) was used to assess the severity of bruxism. Another scale including 5 grading levels (1 = no satisfaction; 2 = less; 3 = moderate; 4 = good; and 5 = excellent) was used to assess patient satisfaction. The patient marked 1 of the 5 levels accordingly on the line, and the marked level is assigned as the score of patient satisfaction or severity of the bruxism.

All assessments were recorded at baseline (T0) and 1 month (T1) and 8 months (T2) after the injection. The author performed all the evaluations.

Statistical Analysis

All statistical analyses were carried out using the Statistical Package for Social Sciences, version 17.0 software (SPSS Inc.; Chicago, IL, USA). Comparisons of time points (T0, T1, and T2) of parametric data (MIO and VAS evaluations) were done with repeated measures of analysis of variance (Tukey test). Comparisons of time points of severity of bruxism were done with Wilcoxon signed-rank test. Statistical significance was set at $P < .05$.

RESULTS

The sample was composed of 16 subjects (14 female and 2 male) with bruxism and bilateral MH. The mean age was 27.88 ± 9.32 years, and the mean follow-up period after the injection was 8.00 ± 2.13 months.

Table 1. Descriptive Data for Outcome Variables at Baseline and 1 Month and 8 Months After Treatment

Outcome Variables	Baseline (T0)	One Month (T1)	Eight Months (T2)
Pain complaints (VAS score)	5.34 ± 3.08	3.36 ± 3.21	1.84 ± 2.30
Mastication efficiency (VAS score)	8.30 ± 2.03	7.75 ± 1.61	8.63 ± 2.02
Bite force (VAS score)	9.53 ± 1.36	6.85 ± 2.61	9.11 ± 2.15
Self-perceived sound (VAS score)	7.53 ± 2.98	5.76 ± 3.88	1.39 ± 1.63
Painless MIO (mm)	34.31 ± 13.28	35.21 ±7.83	36.63 ± 6.72
Restriction at mouth opening (VAS score)	3.99 ± 3.57	0.87 ± 2.69	0.73 ± 2.48
Severity of bruxism (5 grading levels)	3.13 ± 1.26	1.29 ± 0.99	1.19 ± 1.17

MIO, maximum interincisal openings; VAS, visual analog scale.

The mean follow-up period after the treatment was calculated as 8.00 ± 2.13 months. Descriptive data for outcome variables at T0, T1, and T2 are shown in Table 1.

Statistical analysis showed that pain complaints, restriction of mouth opening, and severity of bruxism decreased significantly 1 month after the BTX-A injection, and these improvements remained relatively stable during the 8-month follow-up period. Bite force decreased at a statistically significant level 1 month after BTX-A injection, but it returned to baseline levels after 8-month follow-up period. Self-perceived sound showed insignificant decrease 1 month after the BTX-A injection, but this decrease reached a statistically significant level during the follow-up period. No statistically significant change was observed in painless MIO and mastication efficiency after the injection or during the follow-up period (Table 2).

About 81.3% of patients were reported to have high pleasure scores (high satisfaction) at T2. The mean of patient satisfaction was 4 (good) at T2 (Table 3).

Pain around the injection site in the first 1 month after the BTX-A injection was seen in 2 patients, though the side effects were found to be transitory.

DISCUSSION

The study sample comprised patients who had symptoms of bruxism and bilateral MH. Computed tomographic, MRI, ultrasonographic, and electromyographic measurements have been used in diagnosis of MH, in addition to clinical findings.[2,5,7] In the present study, MH was diagnosed with clinical and MRI evaluations, characterized by a soft enlargement that was associated with facial and masseter pain near the angle of the mandible.

Onabotulinumtoxin A (BTX-A or Botox) was used as a botulinum toxin injection agent in the present study. It has been well documented that BTX-A produced significant improvements in MH and cosmetic appearance of the subjects with reduction of muscle volume[9,10] and decreased electromyographic activity of the muscle.[7]

Table 2. Results of Repeated Measures Analysis of Variance Test Explaining the Significances in Variance Analyses

Outcome Variable	Comparisons (T1-T0)	(T2-T0)	(T2-T1)	Test
Pain complaints (VAS score)	$P < .05$	$P < .01$	$P > .05$	†
Mastication efficiency (VAS score)	$P > .05$	$P > .05$	$P > .05$	†
Bite force (VAS score)	$P < .01$	$P > .05$	$P < .05$	†
Self-perceived sound (VAS score)	$P > .05$	$P < .001$	$P < .01$	†
Painless MIO (mm)	$P > .05$	$P > .05$	$P > .05$	†
Restriction of mouth opening (VAS score)	$P < .01$	$P < .01$	$P > .05$	†
Severity of bruxism (5 grading levels)	$P < .01$	$P < .01$	$P > .05$	‡

MIO, maximum interincisal mouth opening; T0, baseline; T1, 1 month after BTX-A injection; T21, 8 months after BTX-A injection; VAS, visual analog scale.
† Repeated measures test (Tukey test). ‡ Wilcoxon signed-rank test.

Table 3. Patient Satisfaction Rates (%)

Satisfaction Degrees	%
No satisfaction	6.3
Low satisfaction	0.0
Moderate satisfaction	12.5
Good satisfaction	50.0
Excellent satisfaction	31.2
Total	100

To achieve maximum dose response and to minimize side effects of the injection, clinicians should use the most effective dose at the smallest volume. We used a 30 U BTX-A dose for one side. Many authors[4,14] suggest that an adequate dose of BTX-A should be >20 U for long-term effectiveness up to 9 months. Other researchers[2,15] injected 30 U Botox in the hypertrophic masseter muscle and found favorable patient satisfaction during 10 months of follow-up.

The results of the present study showed that pain complaints and restriction of mouth opening decreased significantly 1 month after BTX-A injection, and these improvements remained relatively stable during the 8-month follow-up period. Bite force decreased reaching a statistically significant level 1 month after the BTX-A injection, but it returned to baseline levels after the 8-month follow-up period. Self-perceived sound showed insignificant decrease 1 month after BTX-A injection, but this decrease reached a statistically significant level during the follow-up period. No statistically significant change was observed in painless MIO and mastication efficiency after the injection or during the follow-up period.

Guarda-Nardini et al[12] carried out a study on 20 patients with bruxism. They evaluated the effects of masseter and temporal muscle BTX-A injections on mastication efficiency, pain complaints during chewing and rest, and MIO of the patients with sleep bruxism at baseline and 1 week, 1 month, and 6 months after the injections. When considering the BTX-A group in the study of Guarda-Nardini et al,[12] mean changes in mastication efficiency and MIO were similar with those observed in this study. Guarda-Nardini et al[12] reported that mastication efficiency was 7.70, 7.10, 6.40, and 7.40 VAS scores at baseline and after 1 week, 1 month, and 6 months after the injections, respectively. They also reported an approximately 2 mm increase in MIO at 6 months after the injections.

However, Guarda-Nardini et al[12] reported approximately 1.5 VAS score decrease in pain complaints in the BTX-A group, but we observed a 3.5 VAS score decrease in this parameter. These conflicting results can result from differences in the pain complaint evaluation method, the number of BTX-A-injected muscles (i.e., masseter and temporal muscles), and observation periods (i.e., shorter observation period) between the 2 studies.

Song et al[15] studied the pattern of mastication and force distribution after BTX-A injection into masseter muscles. They injected a total of 25 U BTX-A (50 U in total). The results of this study indicated significant change in force balance between 2 sides over time.

The findings of the present study also showed that severity of bruxism decreased significantly 1 month after BTX-A injection, and it remained relatively stable during the 8-month follow-up period. Supporting the results of this study,recent studies[7,14] have reported decreased subjective bruxism symptoms and bruxism events after 3 months of masseter BTX-A injection.

In the present study, 81.3 % of the patients reported high pleasure scores after the follow-up period. Redaelli[16] used BTX-A injection in the masseter muscle for the treatment of bruxism and found that 65.8% and 4.2% of the patients reported good and excellent improvements in the symptoms of bruxism, respectively.

Recent literature reviews[17] suggest that botulinum toxin injections are effective for preventing bruxism and that botulinum toxin is safe to use at a dosage of <100 U for otherwise healthy patients.

Actually, BTX is a powerful neurotoxin. The toxin injected into the muscle binds to the motor nerve (cholinergic terminal), gets absorbed into the cytoplasm of the terminal, and reversibly blocks the release of presynaptic acetylcholine at the neuromuscular junction. Thus, injection of botulinum toxin into the muscle causes masseter paralysis.[18] It acts selectively at the peripheral cholinergic nerve endings to produce muscle relaxation, diminished compression of the muscle vessels, and occasionally a reduction in the concentration of excitatory neuropeptides.[3,19] Patients tend to use paralyzed masseter muscles without full function and with reduced action. Possibly, reduced bruxing events in the masseter muscle depend on both decreased action potentials and muscle atrophy as time passes.

Study Limitations

Despite the fact that the results of this study showed favorable clinical outcomes after the BTX-A injection, the results must be interpreted with caution due to its limitations. First, this study had subjective evaluations (i.e., VAS score and 5-level grading evaluations). Second, the sample size of this study limits the generalizability of the findings.

CONCLUSION

Within the limitations of the present study, the findings of this study suggest that BTX-A injection lessened the severity and incidents of bruxism and reduced joint noise and pain in patients with bruxism and masseter muscle hypertrophy, and BTX-A injection produced greater patient satisfaction.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Faculty of Dentistry, Atatürk University, (Date: 2014, Number: 12).

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

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Current Research in Dental Sciences

Research Article *Araştırma Makalesi* DOI: 10.5152/CRDS.2023.22099

Comparison of Shaping Ability of a Newly Developed Pediatric Rotary File and the Conventional Rotary Instruments in Simulated Curved Canals: 2-Dimensional Computerized Study

Yeni Geliştirilmiş Pediatrik Döner Eğe ile Konvansiyonel Döner Aletlerin Simüle Eğri Kanallarda Karşılaştırılması: İki Boyutlu Bilgisayarlı Çalışma

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ABSTRACT

Objective: Deciduous teeth require special instruments for mechanical preparations due to the anatomical differences in the root canal morphology. This study aimed to assess the preparation features of a newly developed pediatric rotary file system in simulated curved canals versus conventional rotary systems.

Materials and Methods: Twenty-eight simulated canals in resin blocks were divided into groups for Endoart Pedo Smart Gold and Endoart Smart Gold instruments. Preparation was held on the crown-down technique. Pre-/post-operative digital images were superimposed, and aberrations were detected. The removed resin amount was measured at 10 points, and the mean values of outer and inner width differences were recorded. The centering ratio was also detected for each sample.

Results: The analyses from the apex revealed that the groups showed similar results in inner measurements except for the points of 0 mm ($P < .001$), 3 mm ($P < .001$), and 9 mm ($P = .036$). The statistical differences were also detected in the outer wall at the apical third, curved area, and middle third of the root length ($P < .05$). Endoart Pedo Smart Gold group showed statistically better-centering ability at the coronal entrance of the simulated root canals.

Conclusion: The root canal preparation with pediatric rotary systems revealed better results regarding centering ability and caused less dentin removal.

Keywords: Root canal treatment, root canal preparation, pediatric rotary files

ÖZ

Amaç: Süt dişleri, kök kanal morfolojisindeki anatomik farklılıklar nedeniyle mekanik hazırlıklar için özel aletler gerektirir. Bu çalışma, simüle edilmiş kavisli kanallarda yeni geliştirilen pediatrik döner eğe sisteminin geleneksel döner sistemlere göre preparasyonlarını değerlendirmeyi amaçlamıştır.

Gereç ve Yöntem: Endoart Pedo Smart Gold ve Endoart Smart Gold aletleri için reçine bloklarda yirmi sekiz simüle kanal gruplara ayrıldı. Crown-down tekniği ile preparasyonlar yapıldı. İşlem öncesi/sonrası dijital görüntüler üst üste bindirildi ve sapmalar tespit edildi. Çıkarılan reçine miktarı 10 noktada ölçülerek dış ve iç genişlik farklılıklarının ortalama değerleri kaydedildi. Her numune için merkezleme oranı da tespit edildi.

Bulgular: Analizler, grupların apeksten itibaren 0 mm ($P < ,001$), 3 mm ($P < ,001$) ve 9 mm ($P = ,036$) noktaları dışında iç ölçümlerde benzer sonuçlar gösterdiğini ortaya koydu. İstatistiksel farklılıklar,

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kök uzunluğunun apikal 1/3'ünde, kavisli alanda ve orta 1/3'ünde dış duvarda tespit edildi (P < ,05). Endoart Pedo Smart Gold grubu, simüle edilmiş kök kanallarının koronal girişinde istatistiksel olarak daha iyi merkezleme yeteneği gösterdi.

Sonuç: Pediatrik döner sistemlerle kök kanal preparasyonu, merkezleme kabiliyeti açısından daha iyi sonuçlar ortaya koydu ve daha az dentin çıkarılmasına neden oldu.

Anahtar kelimeler: kök kanal tedavisi, kök kanal preparasyonu, pediatrik döner eğeler

INTRODUCTION

The progressive characteristic of dental caries may cause pulpal damage when left without treatment. Once the pulp is involved, vital pulp therapies or root canal treatments may be needed to maintain the dental arch of primary dentition according to the pulp's clinical and histopathological status. Root canal therapies are the treatment of choice when the pulp is irreversibly affected by pathogenic factors.[1,2] The primary purpose of this application is to disinfect the canals and fill the sanitized area with a biocompatible material.[3] Mechanical preparation and irrigation are the 2 essential components of the disinfection procedure.[4] Since the infected dentinal tissue with remaining pulp is removed by mechanical preparation and thus the effectiveness of the chemo-mechanical agent is enhanced, this stage is one of the most critical phases of root canal treatments.[5]

Conventional K and H-type files have been used in mechanical preparation and recently many studies have shown that nickel–titanium (Ni–Ti) rotary files may also be used for this aim.[6-9] The rotary systems lessen the time-lasting procedure of mechanical preparation. Additionally, the root canals are more likely to be enlarged by preserving the original root anatomy; thus, the risk of canal transporting is minimized. The conventional rotary systems have drawbacks when used in primary teeth due to the taper and the length of the files, which may cause perforation in the lateral wall of the curved primary tooth root canal system. Considering the morphology of primary root canals, which is different from permanent ones by being shorter, thinner, and ribbon-shaped, the need for a particular system for primary teeth has become a current issue.[6,10] Accordingly, a few pediatric rotary file systems have been developed in different regions of the world, and recently, Endoart Pedo Smart Gold (EPSG) has presented to the dental markets in Turkey.

In the literature review, many studies have detected assessing the efficiencies of different rotary systems compared to conventional H and K files and various commercial pediatric rotary files[11-14]; however, no study was detected analyzing the preparation capacity of EPSG. In light of the beforementioned data, the purpose of the recent study was to compare EPSG with the conventional rotary file system of the same brand on the curved root canal system of resin blocks. Previously, comparisons of rotary files in different brands have been made in various studies. However, no study has been detected in the literature that compares pediatric files and conventional files produced with the same manufacturer and the same heat treatment (thermal processing) technology. The null hypothesis of the study is that no difference will be observed between the preparation performances of the two compared rotary file systems.

MATERIALS AND METHODS

A power analysis was performed for sample size calculation (G*Power Software) according to a previous study.[5] A total of 14 samples per group were calculated to be required to obtain an 85% power on an effect size of 0.28 and an alpha significance level of 5% (0.05). Thus, a total of 28 samples were planned to be used for the study.

Twenty-eight simulated polyester resin blocks (Endo Bloc, ENB012, Piramit Dental, Istanbul, Turkey) were used to observe the effect of instrumentation on the root canal system. The simulated root canals were compatible with ISO standard size 15 file, with a 40° curvature, in accordance with the Schneider method.[15] The canals were 13 mm long from the apex, which has a straight part of 5 mm and a curved part of 8 mm. Since mean values of deciduous root length were detected as 9-11 mm in a previous study,[16] a reshaping of 3 ± 0.2 mm to all blocks was done to stimulate deciduous teeth root canal length. The blocks were divided into 2 groups and prepared by 2 Ni-Ti rotary file systems: Endoart Smart Gold Files (ESG) (İnci Dental, İstanbul, Turkey) and EPSG (İnci Dental, İstanbul, Turkey). One experienced operator carried out the preparation stage. A second examiner, unaware of the experimental groups, held the measurements.

Crown-down instrumentation technique was done following the manufacturer's introductions. 16:1 reduction rotary handpiece X-Smart Contra-Angle (Dentsply-Maillefer) at a rotation speed of 300 rpm was used with X-Smart (Dentsply-Meillefer) torque-limited electric motor. The canals were prepared to a working final size of 25, 0.004 taper files for all groups. All the rotary files were used to enlarge 2 canals and excluded from the study. Before use, the root canal system was irrigated with distilled water.

Canal Preparation

The following procedure was applied to both ESG and EPSG groups. Following the recommendations by the manufacturer for curved canal structure, the working files were arranged as follows:

(i) Initially, a 10 K-file instrument was used to create a guiding path.
(ii) An Endoflare 0.12 taper size 25 instrument was used to 5 mm.
(iii) A 0.06 taper size 15 instrument was used to 9 mm.
(iv) In the end, a 0.04 taper size 25 instrument was used to 10 mm, the entire working length.

Assessment of Canal Preparation and Data Analysis

The assessment of prepared canal shapes was carried out in accordance with a previous study held by Aydin et al,[5] with a computer program Corel Graphics Suite 11 (Corel Inc., Ottawa, Canada). A charged coupled device camera (Canon S2 IS, Canon, Tokyo, Japan) was used to view pre-post instrumentation of root canal shapes in a standardized manner. Each canal's pre-post

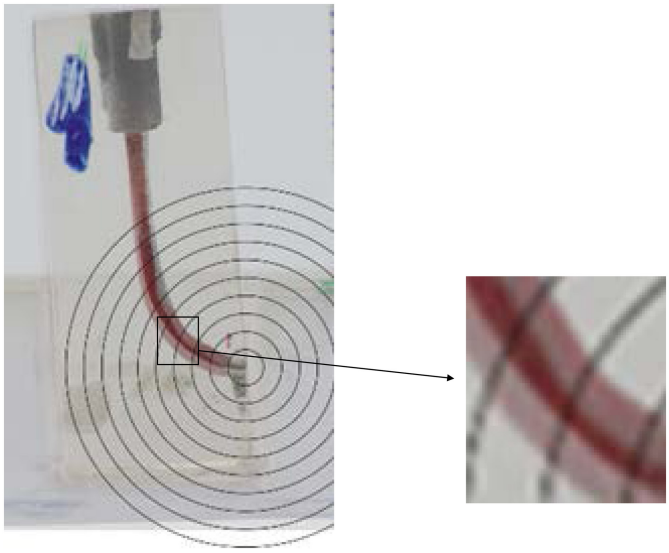

Figure 1. Composite images of the canal were produced from pre- and post-instrumentation images showing the 10 measuring points.

instrumentation images were superposed by Corel Capture 11 software (Corel Inc., Ottawa, Canada) computer program. Superimposition was aided by vertical and circular guidelines drawn on the resin blocks' images. The center of the circular lines was the apical endpoint of the root canal system. The measurements of the amount of internal and external resin removed from the root canal system were made on digital images by Corel Photo-Paint 11 program. The measurement precision was calibrated at 0.001 mm. by the program developers and the assessments were performed on an accuracy level of 0.001 mm. For this purpose, standard channels were viewed on the same camera, at the same magnification settings and fixed distance. The first measuring point was just the apical endpoint of the root canal system. A total of 20 measurements were made from the inner and outer sides of all root canal systems, in 1 mm intervals, apico-coronally.[17] All measurements were made perpendicular to the margin of the root canal walls (Figure 1).

Several canal aberrations such as perforation, ledge, danger zone, and apical zip associated with the elbow were assessed using superimposed images. Thompson and Dummer's descriptions were used to define canal aberrations.[18]

The formula calculated the centering ability of the instruments; resin removed from the inner wall/resin removed from the outer wall. The values closer to "1" indicate better centering ability.[5]

Statistical Analyses

Statistical Package for the Social Sciences 13.0 software (SPSS Inc.; Chicago, IL, USA) was used to perform all statistical analyses. According to the Shapiro–Wilk normality test results, the data did not show a normal distribution. Paired comparisons between 2 groups were performed by Mann–Whitney *U*-test. The level of statistical significance was accepted as $P < .05$.

RESULTS

Instrument Failure and Canal Aberrations

No instrument fractures occurred in the 2 compared groups.

Canal Aberrations

The ESG group showed more canal aberrations (3 zips and 2 ledges) than the ESGP group. Both observed systems did not show danger zones or perforations.

Width Measurements

The mean values of resin removed from the inner area are shown in Table 1, and the mean values removed from the canals' outer sides are shown in Table 2. According to mean values, EPSG and ESG removed a similar amount of resin from the inner side except for the points of the apical end ($P = .00$), 3 mm ($P = .00$), and 9 mm ($P = .036$) from the apex. The mean values of resin removed at the point of 0 mm were 0.031 mm for the ESG group and 0.016 for the group of EPSG. 0.092 mm resin was removed by ESG and 0.014 mm by EPSG at the point of 3 mm, on average. The mean values of resin removed at the point of 9 mm were 0.032 for ESG and 0.016 for EPSG.

The ESG removed significantly more material than EPSG at the apical third (0,2), curved area (3), and middle thirds (4,5,7) of the root length ($P < .05$) on the outer canal wall. The mean values of removed resin were 0.044 mm for ESG and 0.018 mm for the pediatric system at the apical endpoint (0 mm distance). The amount of removed resin by ESG was 0.047mm, and 0.017 mm was removed EPSG at a 2 mm distance from the apex ($P = .005$). At 3 mm, the Pedo system removed 0.014 mm of resin, and ESG removed a mean amount of 0.036 mm ($P = .018$). Meanly 0.041 mm resin was removed by ESG and 0.011 by EPSG at 4 mm ($P = .007$). The mean values for removed resin at 5 mm were 0.043 for ESG and 0.012 for EPSG ($P = .040$). Finally, the mean values determined at the point of 7 mm were 0.038 and 0.013 mm for ESG and EPSG groups, respectively ($P = .02$) (Table 2).

Centering Ability

The mean values of the centering ability can be seen in Table 3. The best centering ability was determined at the apical end of the simulated resin root (0 mm), and the values for centering ability

Table 1. Mean Values of Resin Removed from the Inner Area

		Reference Points from the Apex (mm)										
Groups		0	1	2	3	4	5	6	7	8	9	10
	Mean	0.031	0.029	0.027	0.092	0.031	0.026	0.030	0.027	0.032	0.032	0.037
	SD	0.013	0.020	0.009	0.031	0.031	0.015	0.019	0.018	0.023	0.022	0.053
	Median	0 .025	0.022	0.025	0.098	0.022	0.022	0.028	0.024	0.022	0.022	0.018
ESG	Percentiles 25	0.021	0.017	0.021	0.072	0.012	0.016	0.010	0.012	0.016	0.014	0.010
	Percentiles 75	0.044	0.029	0.031	0.115	0.028	0.039	0.049	0.049	0.06	0.051	0.042
	Mean	0.016	0.017	0.018	0.014	0.017	0.024	0.029	0.023	0.020	0.016	0.018
	SD	0.008	0.008	0.010	0.008	0.008	0.009	0.014	0.009	0.004	0.008	0.005
EPSG	Median	0.014	0.015	0.020	0.014	0.020	0.025	0.029	0.024	0.020	0.016	0.018
	Percentiles 25	0.010	0.010	0.009	0.005	0.010	0.018	0.019	0.018	0.017	0.009	0.013
	Percentiles 75	0.018	0.025	0.026	0.022	0.024	0.031	0.037	0.030	0.026	0.022	0.022
	P	.000*	.065	.056	.000*	.382	.645	.908	.800	.488	.036*	.646

EPSG, Endoart Pedo Smart Gold; ESG, Endoart Smart Gold; SD, standard deviation.
*$P < .05$.

Table 2. Mean Values of Resin Removed from the Outer Area

Groups		Reference points from the apex (mm)										
		0	1	2	3	4	5	6	7	8	9	10
	Mean	0.044	0.047	0.047	0.036	0.041	0.043	0.034	0.038	0.038	0.034	0.039
	SD	0.058	0.066	0.061	0.036	0.073	0.071	0.043	0.057	0.059	0.045	0.068
ESG	Median	0.024	0.03	0.028	0.025	0.019	0.022	0.021	0.024	0.021	0.021	0.017
	Percentiles 25	0.020	0.014	0.020	0.013	0.013	0.009	0.010	0.010	0.011	0.012	0.010
	Percentiles 75	0.039	0.046	0.041	0.040	0.030	0.039	0.037	0.036	0.030	0.034	0.039
	Mean	0.018	0.022	0.017	0.014	0.011	0.012	0.014	0.013	0.013	0.018	0.016
	SD	0.009	0.008	0.008	0.008	0.005	0.005	0.008	0.006	0.007	0.006	0.010
EPSG	Median	0.016	0.023	0.015	0.014	0.012	0.014	0.015	0.012	0.013	0.020	0.013
	Percentiles 25	0.012	0.013	0.013	0.007	0.007	0.007	0.007	0.006	0.005	0.012	0.008
	Percentiles 75	0.025	0.027	0.022	0.018	0.015	0.016	0.022	0.020	0.020	0.023	0.025
	P	.011*	.214	.005*	.018*	.007*	.040*	.168	.020*	.056	.519	.213

EPSG:Endoart Pedo Smart Gold; ESG, Endoart Smart Gold; SD, standard deviation.
*$P < .05$.

tended to decrease through the coronal entrance. The values were 0.76 and 0.71 for ESG and EPSG groups at the apical end, respectively. Furthermore, the Pedo system showed statistically better-centering ability at the coronal entrance (10 mm) of the simulated root canals ($P = .016$).

DISCUSSION

The current study examined the preparation features of a pediatric rotary file versus a conventional rotary file system. Accordingly, the root canal preparation with pediatric rotary systems revealed better results regarding centering ability and caused less dentin removal than the conventional rotary system. The null hypothesis was rejected.

Manual H and K-type files have been widely used to prepare permanent and deciduous teeth. Ni–Ti rotary systems have been developed to overcome the drawbacks of manual files, such as long preparation time and the standard form for each size that does not show taper.[6,19] Recently, pediatric rotary file systems have been developed to suit the particular anatomy of deciduous teeth. Although various studies were conducted to assess the preparation features of Kedo-S files versus manual files and conventional rotary systems.[11-13,20] No study was determined assessing the shaping ability of EPSG versus conventional rotary files in the literature review. Accordingly, the present study aimed to compare the preparation features of this newly developed pediatric rotary system versus the conventional rotary system of the same brand. Thus, helping the clinicians to make a decision-making choice in using the most effective rotary file system for the endodontic treatment of deciduous teeth.

The preparation features of instruments were examined in simulated resin root canals under strictly controlled laboratory conditions in the present study. This design allows standardization of the curvature by means of degree, location, and radius. The computerized superimposition technique was preferred to assess the pre-and post-operative outlines of the canal anatomy. This method facilitates the measurements of deviations at any point of root canals and ease of application.[21]

The outcomes of the present study showed that the groups revealed similar results in inner measurements except for the points of 0 mm, 3 mm, and 9 mm from the apex of the root canal system. Regarding the removed resin measurements in the outer line, statistical differences were detected at the apical end, curved area, and the middle third of the simulated root. The centering ability of the pediatric rotary system was higher than the compared group. This result means that the pediatric systems perform the canal preparation adhering to the original canal anatomy. Additionally, the resin amount removed by the pediatric system was lesser than the values obtained by the conventional rotary system of the same brand. These findings may enhance the preferability of the pediatric systems since the main aim of root canal preparation is preserving the original root anatomy, causing a minimal removal from the surrounded dentin while shaping the root canals to enhance the effect of irrigation solutions and leading to a tapered form for an adequate root filling.

In a previous study,[22] different pediatric rotary files' preparation capacity was compared to K-files in a total of 72 canals of 24 freshly extracted deciduous molars. Accordingly, rotary file systems have shown superior results than hand instrumentation, and a statistical difference was observed at the cervical level regarding centering ability. The values of Pedo-S were higher compared to Pro Af Baby Gold and manual files. However, no significant difference

Table 3. Centering Ability

Groups		Reference Points from the Apex (mm)										
		0	1	2	3	4	5	6	7	8	9	10
	Mean	0.764	0.668	0.641	0.380	0.623	0.600	0.530	0.627	0.580	0.589	0.372
	SD	0.204	0.239	0.247	0.268	0.235	0.250	0.240	0.241	0.199	0.224	0.264
ESG	Median	0.785	0.625	0.690	0.290	0.615	0.530	0.530	0.660	0.625	0.635	0.290
	Percentiles 25	0.657	0.477	0.427	0.200	0.357	0.395	0.320	0.492	0.405	0.415	0.195
	Percentiles 75	0.927	0.970	0.832	0.657	0.830	0.822	0.700	0.805	0.715	0.800	0.535
	Mean	0.710	0.640	0.509	0.430	0.504	0.465	0.475	0.485	0.540	0.545	0.587
	SD	0.156	0.258	0.227	0.172	0.264	0.191	0.232	0.276	0.269	0.212	0.248
EPSG	Median	0.725	0.650	0.500	0.445	0.445	0.460	0.415	0.400	0.520	0.560	0.530
	Percentiles 25	0.597	0.415	0.342	0.265	0.330	0.325	0.302	0.257	0.257	0.450	0.420
	Percentiles 75	0.840	0.890	0.707	0.522	0.745	0.580	0.705	0.820	0.762	0.670	0.795
	P	.301	.764	.161	.358	.190	.168	.581	.168	.662	.535	.016*

EPSG: Endoart Pedo Smart Gold; ESG: Endoart Smart Gold; SD, standard deviation.
*$P < .05$.

between all the groups regarding canal transportation and removed dentin thickness was detected. Although the comparison of hand files and manual files was held and conventional rotary systems were not included, this study is essential since it supports the idea of preferring pediatric rotary systems in deciduous teeth's root canal preparations compatible with the recent study we held.[22]

Mohamed et al[11] planned a study in which they observed the preparation ability of a pediatric rotary file (Kedo-S square) versus stainless steel K and H files. The study results showed that the amount of dentin removed by Kedo-S was statistically lesser than the values of other groups. In another similar study, Seema et al[13] evaluated the root canal shaping features of Kedo-S rotary files, Pro Taper system, and manual K files. Accordingly, Kedo-S removed significantly less dentin than the hand file in the apical and coronal third of the root. At the same time, unlike the recent study we held, no statistical difference was detected between Kedo-S and Pro Taper system values. Kalita et al[14] have also conducted a similar study in which the comparison of a pediatric rotary file system (Kedo-S), manual K files, and Pro Taper system was made. Accordingly, the centering ability was found to be superior in Kedo-S system compared to manual files, while no difference was detected between the values of Pro Taper and Kedo-S systems, contrary to the result of the present study we held. Since the centering ability reveals the original root canal preserving the performance of the mechanical instruments, this feature may also enhance the preference for pediatric rotary systems.

In vitro studies on root canal therapies may be held on both extracted teeth and simulated root models. Since the root resorption degree of deciduous teeth may differ in each extracted tooth, a standardized simulated resin root model was used in the present study. However, the simulated resin root canals may not reflect the biological environment of teeth as in the oral cavity.[17] This model may also eliminate the variables encountered in tooth root canals.[23] Although the preparations were under conditions in which an irrigation procedure was followed, the heat generated by the applications may soften the resin blocks.[24] These points can be listed as the limitations of the present study.

CONCLUSION

Within the limitations of the present in vitro study, it was concluded that the root canal preparation with pediatric rotary systems revealed better results regarding centering ability and caused less dentin removal. Since maintaining the original root anatomy while enlarging the canals to form an adequate width for irrigation, disinfection, and filling process, is the desired approach for mechanical preparation, the less removal of dentin with a better centering ability put the pediatric rotary system to a preferable stage compared to conventional file systems. These advantages may also lead clinicians to use pediatric rotary systems as a choice of treatment approach. However, in the future, in vivo studies should be conducted to assess the clinical features of this newly developed preparation system.

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ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Current Research in Dental Sciences

Research Article *Araştırma Makalesi*

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Bibliometric Analysis of the Prosthodontic Studies Used Finite Element Analysis in TR Index

TR Dizin'de Sonlu Elemanlar Stres Analizi Yöntemini Kullanan Protetik Diş Tedavisi Çalışmalarının Bibliyometrik Analizi

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ABSTRACT

Objective: Finite element stress analysis is a method in which stress formation on tissues and materials of any structure and shape can be analyzed. In this study, it is aimed to make a bibliometric analysis of studies in prosthetic dentistry using finite element stress analysis in TR Index.

Materials and Methods: Articles were obtained by searching the "finite element" keyword in the TR Index. Dentistry journals were filtered and studies were reduced to the field of dentistry. The publications were classified and recorded to include the journal name, publication year, author institutions, departments, article type, article language, and number of citations. Publications in the field of prosthetic dentistry were included in this study. Frequency analysis of the data, descriptive statistics and Mann–Whitney *U* test were performed ($\alpha = 0.05$).

Results: Twenty-seven studies, including 2 reviews and 25 research articles, were reached. It was seen that the most publications were in the *Journal of Dental Faculty of Atatürk University* and *Cumhuriyet Dental Journal*. Post core restorations, all-ceramic crowns, maxillofacial prostheses, and implant-supported prostheses were the subject of the studies, 13 of which were in Turkish and 14 in English.

Conclusion: Finite element stress analysis is a preferred method in prosthetic dentistry studies. The field of implantology stands out in this sense. National studies using this method have shown a significant increase in the last decade. The language had no significant effect on the number of citations of the publications.

Keywords: Bibliometrics, prosthodontics, finite element analysis, dentistry, database

ÖZ

Amaç: Sonlu elemanlar stres analizi (SESA) herhangi bir yapı ve şekle sahip dokular ve materyaller üzerindeki stres oluşumunun analiz edilebildiği bir yöntemdir. Bu çalışmada TR Dizin'de SESA kullanan Protetik Diş Tedavisi çalışmalarının bibliyometrik incelemesinin yapılması amaçlanmıştır.

Gereç ve Yöntem: TR Dizin'de 'sonlu elemanlar' ve 'finite element' anahtar kelimeleri aranarak yayınlar elde edilmiştir. Diş hekimliği dergileri filtrelenerek çalışmalar diş hekimliği alanına indirgenmiştir. Yayınlar dergi adı, yayın yılı, yazar kurumları, anabilim dalları, makale türü, makale dili, atıf sayısı bilgilerini içerecek şekilde sınıflandırılarak kaydedildi. Protetik Diş Tedavisi alanında yapılan yayınlar bu çalışmaya dahil edildi. Verilerin değerlendirilmesi için tanımlayıcı istatistik, frekans analizi ve Mann–Whitney U testi yapıldı ($\alpha = 0,05$).

Bulgular: İkisi derleme, yirmi beşi araştırma makalesi olmak üzere yirmi yedi çalışmaya ulaşıldı. En fazla yayının Atatürk Üniversitesi Diş Hekimliği Fakültesi Dergisi ve Cumhuriyet Dental Journal dergilerinde yer aldığı görüldü. On üçü Türkçe, on dördü İngilizce olarak hazırlanan çalışmalarda post core restorasyonlar, tam seramik kronlar, çene yüz protezleri ve implant üstü protezler konu edilmiştir.

Sonuç: SESA Protetik Diş Tedavisi çalışmalarında tercih edilen bir yöntemdir. İmplantoloji alanı bu anlamda öne çıkmaktadır. Bu yöntemi kullanan ulusal çalışmalar son on yılda önemli bir artış göstermiştir. Makale dilinin yayınların atıf sayısına anlamlı bir etkisi bulunamamıştır.

Anahtar Kelimeler: Bibliometri, protetik diş tedavisi, sonlu elemanlar analizi, diş Hekimliği, veri tabanı

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INTRODUCTION

The oral environment is a complex biomechanical system and has limited access. Therefore, studies in many fields such as prosthodontics, endodontics, and orthodontics are carried out under in vitro conditions.[1] Finite element stress analysis (FEA) is a method by which dental materials and stress formation in the orofacial region can be analyzed. This method can be used in the evaluation of restorations and complex treatments. Stress and deformations in structures of any geometric shape are examined with a numerical method. In this way, researchers can predict the stress distributions that may occur in dental prostheses, implants and abutments, bone structure, dental tissue, and periodontium.[2,3] The behavior of any structure or tissue under a certain stimulus could be evaluated using FEA and the biomechanical changes in the tissues could be analyzed. It allows the determination of stress distribution within bone during chewing and various dental implant designs.[4] In prosthetic dentistry, biomechanical behaviors, preparation types, and preparation properties of different dental ceramics can also be examined with this method.[5] It is feasible to predict the stresses that the substructure and veneer design will create in the restoration.[6] Changes that may occur in the muscles in response to chewing forces can be evaluated in implant-supported prostheses.[7] Finite element stress analysis, which is a non-invasive technique, can be used in linear and non-linear solid and liquid structures. Using this method, any biological state can be simulated before, during and after the procedure. In the method where static and dynamic analyses can be made, even complex operations can be performed in a short time and the research could be easily repeated.[1]

Bibliometric analysis has a significant role in assessing the scientific chain, with methods for measuring the scientific productivity of researchers and communities.[8] Publication-based data work is widely applied in assessment. Analysis of research results is the most common form of use. However, it also offers utility as a partial indicator of overall research results and the productivity and impact of research teams and centers. Some problems arise in the use of bibliometric measurements of research and development activities. A long period of time, 10 years or more, is required to fairly evaluate the results of studies. Also, in research and development activities, results are often correlated with results produced by other working groups and programs. It is often difficult to base all success on a single source.[9]

The TR Index was developed in accordance with international standards for researchers to access national and scientific data and functioned under the name of National Databases-UVT until the end of 2013. The TR Index which has content created by ULAKBİM, consists of journals in the main fields of science and social sciences and the sub-fields of dentistry, pharmacy, engineering, basic sciences, health sciences, veterinary, social sciences, and humanities.[10] The aim of this study is to evaluate the studies of prosthetic dentistry using FEA in the dental journals in TR Index.

MATERIALS AND METHODS

In the national database TR Index (https://trdizin.gov.tr/), all studies on this subject are listed with the keyword "finite element." Among all publication types in English and Turkish, between January 2000 and November 2022, only those in dentistry journals were filtered out. The publications were classified as including the journal name, publication year, author institutions, departments, article type, article language, and number of citations and saved in the Excel software package (Microsoft Office Professional Plus 2010, USA). As a result of the examination of the records obtained, publications in the field of prosthetic dentistry were included in this study (Figure 1). Frequency analysis, descriptive statistics, and Mann–Whitney *U* test of the data related to the studies were performed using IBM Statistical Package for the Social Sciences Statistics 23.0 program for Windows (IBM, NY, USA) ($\alpha = 0.05$).

RESULTS

Totally, 54 studies that used the FEA method were determined. They were analyzed according to their fields and 27 of them were excluded from the study. Excluded articles belong to oral and maxillofacial surgery (13), orthodontics (4), endodontics (1), pedodontics (1), and restorative dentistry (8). Twenty-seven studies related to the field of prosthodontics were reached. It was determined that 4 of these studies were carried out jointly with the departments of Pedodontics (1), Oral and Maxillofacial Surgery (2), Restorative Dentistry and Pedodontics (1), and Restorative Dentistry (1). All FEA studies in prosthodontics are shown in Table 1. Two of the 27 studies were prepared in review type. The remaining 25 studies are included as research articles.

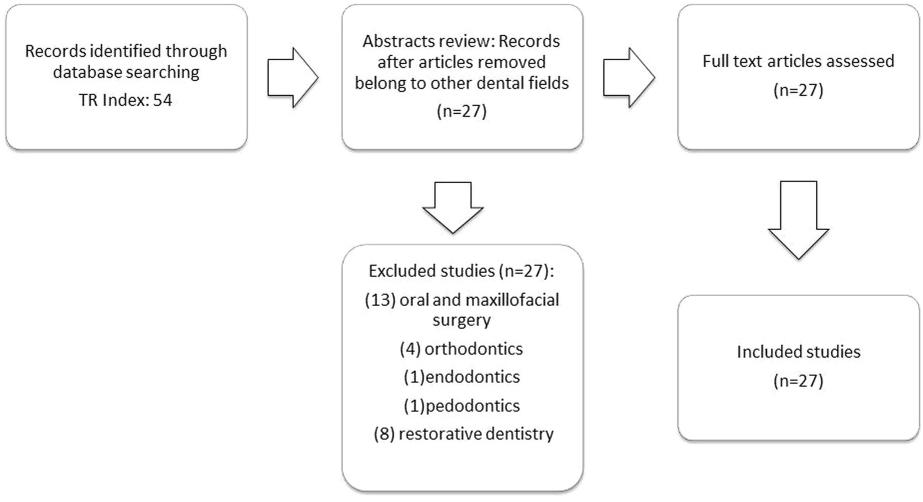

Figure 1. Flowchart of bibliometric analysis.

Table 1. Detailed Data Belong to the Studies with FEA in the Field of Prosthodontics in TR Index

Authors	Journal	Year	Research Type	Number of Citations	Institute
Akay C, Karakış D, Yaluğ S.	*Journal of Dental Faculty of Atatürk University*	2015	Original research	2	Gazi University
Aksan M. E., Atsü S., Bulut A. C	*Journal of Dental Faculty of Atatürk University*	2018	Review	1	Kırıkkale University
Asar NV, Burgaz Y.	*The Journal of Gazi University Faculty of Dentistry*	2009	Original research	1	Gazi University
Bölükbaşı N., Koçak A., Özdemir T	*Journal of Istanbul University Faculty of Dentistry*	2012	Original research	3	Yildiz Technical University İstanbul University
Çakan U, Saygili G	*Clinical Dentistry and Research*	2015	Original research	0	İstanbul Medipol University Hacettepe University
Çelik E, Özden AN	*Selçuk Dental Journal*	2019	Original research	1	Ordu University Near East University
Çulhaoğlu AK, Terzioğlu H	*Selçuk Dental Journal*	2020	Original research	1	Kırıkkale University Ankara University
Deste G, Durkan R	*Journal of Dental Faculty of Atatürk University*	2020	Original research	0	Bursa Uludağ University Afyonkarahisar Health Sciences University
Durkan R, Oyar P, Deste G	*Cumhuriyet Dental Journal*	2019	Original research	1	Afyonkarahisar Health Sciences University Hacettepe University
Egilmez F, Nalbant L*	*Cumhuriyet Dental Journal*	2012	Original research	5	Gazi University
Soğancı Ünsal G., Hasanoğlu Erbaşar G. N	*Journal of Dental Faculty of Atatürk University*	2020	Original research	0	Ankara Yıldırım Beyazıt University
Güler MS, Güler Ç, Şen S, Bayindir YZ	*Journal of Dental Faculty of Atatürk University*	2012	Original research	1	Atatürk University İnönü University
Guven S, Eratilla V, Beydemir K, Dundar S	*Cumhuriyet Dental Journal*	2015	Original research	3	Dicle University Fırat University Diyarbakır Oral Health and Care Center
Gündoğdu TM, Erkmen E, Öztürk Gündoğdu Ö	*ADO Journal of Clinical Sciences*	2022	Review	0	Gazi University
Karaoğlu Ç, Güngör MA, Dündar M, Artunç C	*Clinical Dentistry and Research*	2005	Original research	1	Ege University Dokuz Eylül University
Kaleli N, Ural Ç	*Journal of Dental Sciences*	2020	Original research	1	İstanbul Medeniyet University On Dokuz Mayıs University
Kaleli N, Ural Ç	*Journal of Dental Sciences*	2020	Original research	1	İstanbul Medeniyet University On Dokuz Mayıs University
Karaali A. E., Doğan M. S., Günay A	*Journal of Dental Faculty of Atatürk University*	2018	Original research	0	Harran University Dicle University
Karadayi Yüzükcü AE, YerlîYurt K	*Cumhuriyet Dental Journal*	2022	Original research	1	Gaziosmanpaşa University
LeblebiCiOğlu İ, EsiM E, Kiliç D, Kiliç K	*Selçuk Dental Journal*	2021	Original research	1	Erciyes University
Özkir SE, Çulhaoğlu AK, Şeker E, Ünal SM	*Clinical Dentistry and Research*	2017	Original research	0	Afyonkocatepe University Kırıkkale University Osmangazi University
Ramoglu S, Ozan O, Kurtulmuş Yılmaz S	*Cumhuriyet Dental Journal*	2014	Original research	3	Near East University
Sevimay M, Özyılmaz ÖY, Eraslan O	*Selçuk Dental Journal*	2015	Original research	0	Selçuk University Medipol University
S. Darendeliler Yaman And Ö. Karacaer	*Ankara University Faculty of Dentistry Journal*	2001	Original research	0	Gazi University
Sivrikaya EC, Güler MS, Bekçi ML	*Selçuk Dental journal*	2021	Original research	0	Ordu University Karadeniz Technical University
Tuzlali M, Öztürk C, Zortuk M	*Journal of Dental Sciences*	2018	Original research	2	İnönü University Mustafa Kemal University
Türk AG	*Cumhuriyet Dental Journal*	2017	Original research	1	Ege University

FEA, finite element stress analysis.
*Most cited article.

Between the years 2000 and 2022, it was seen that the most publications were made in 2020 (n = 6). While it was determined that 8 publications received no citations, it was determined that there were 12 publications with 1 citation, 3 with 2 citations, 3 with 3 citations, and 1 with 5 citations. The number of publications and citations by year are shown in Table 2.

When the number of publications and citations were examined according to the journal, it was seen that the most publications were in *Journal of Dental Faculty of Atatürk University* (n = 6) and *Cumhuriyet Dental Journal* (n = 6). It was determined that they were followed by *Selçuk Dental Journal* (n = 5), *Türkiye Klinikleri Journal of Dental Sciences* (n = 3), and *Clinical Dentistry and Research* (n = 3), respectively. Table 3 shows the number of publications and citations by journal. It was determined that *Cumhuriyet Dental Journal* was the journal with the most cited publications due to the reference to all publications in the field of prosthodontics related to FEA.

Thirteen of the studies were prepared in Turkish and 14 in English. When the number of citations was evaluated according to the language, it was seen that 69.2% of the Turkish studies and 71.4% of the English studies were cited. As a result of the Mann–Whitney *U* test, it was determined that the language did not

Table 2. Number of Publications and Citations by Year

Year		2001	2005	2009	2012	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Number of publications		1	1	1	3	2	3	1	1	3	2	5	3	1	27
Number of citations	0	1	0	0	0	0	2	0	1	1	0	2	0	1	8
	1	0	1	1	1	0	0	1	0	1	2	3	2	0	12
	2	0	0	0	0	1	0	0	0	1	0	0	1	0	3
	3	0	0	0	1	1	1	0	0	0	0	0	0	0	3
	5	0	0	0	1	0	0	0	0	0	0	0	0	0	1

Table 3. Number of Citations by Journals

Journals	Number of Citations					Total
	0	1	2	3	5	
Journal of Dental Faculty of Ankara University	1	0	0	0	0	1
The Journal of Gazi University Faculty of Dentistry	0	1	0	0	0	1
Türkiye Klinikleri Journal of Dental Sciences	0	2	1	0	0	3
Cumhuriyet Dental Journal	0	3	0	2	1	6
Journal of Istanbul University Faculty of Dentistry	0	0	0	1	0	1
Selçuk Dental Journal	1	3	1	0	0	5
Clinical Dentistry and Research	2	1	0	0	0	3
ADO Journal of Clinical Sciences	1	0	0	0	0	1
Journal of Dental Faculty of Atatürk University	3	2	1	0	0	6
Total	9	12	3	3	1	27

Table 4. Effect of Article Language on the Citation Counts (Z=−0.129; P > .05)

ArticleLanguage	n	Mean Rank	Sum of Ranks	U	*Z*	*P*
Turkish	13	14.19	184.50	88.500	−0.129	.897
English	14	13.82	193.50			

make a significant difference in the number of citations (P = .897) (Table 4).

All 27 studies were examined according to their subjects, 5 were on post-core restorations, 3 on full ceramic crowns, 1 on maxillofacial prostheses, and the remaining 18 on implant-supported fixed and removable prostheses. According to the institutions of the researchers participating in the studies, it was seen that the highest participation was from Gazi University (Figure 2).

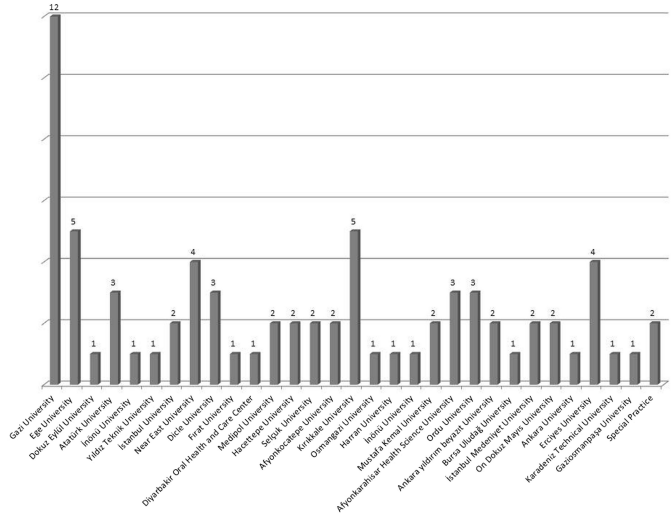

Figure 2. Researchers by institutions.

DISCUSSION

In this study, the publications made with FEA in the field of prosthodontics in the TR Index were examined. Prosthodontics with the impact of tooth or tissue damage and partial or complete loss of teeth on oral function. The discipline covers a large part of a dental school curriculum. As the main focus in prosthetic dentistry has changed from removable dentures to fixed dentures, implant-supported restorations have become highly popular. Another factor affecting prosthetic practice is patients' awareness of new technologies in aesthetic dentistry.[11] It is thought that the reason why 4 of the publications examined in this study were carried out jointly with other departments and the rest were carried out only in the field of prosthodontics, is due to the fact that the prosthodontics contains many areas within itself.

Finite element stress analysis has been used in determining stress analysis and researching dental implantology,[12] fixed and removable prosthetic restorations,[13] maxillofacial prostheses,[14] post-core structures,[15] and biomechanical properties of the dental materials[16] in prosthodontics. When the TR Index was examined, the publications on the aforementioned subjects were determined. The fact that dental implantology is the most used area suggests that FEA is very useful and facilitating despite the complexity of study planning in this field.[17] There are more possibilities for the other subjects of research to carry out compared to implantology, both clinically and in vitro.

National bibliometric studies provide benefits both for the analysis of current studies and for the creation of demographic data. Evaluation of the scientific effectiveness of a researcher or institution can be done through access to one of the national databases.[8] In this study, as a result of the publications examined in TR Index, it was seen that the most FEA-related publications in the field of prosthetic dentistry were made in 2020. The fact that studies using FEA have a significant increase in the second decade compared to the first decade in a 20-year period is beneficial both in terms of national academic effectiveness and in terms of the contribution of the obtained data to clinical applications. It is thought that the process of staying at home due to the coronavirus disease 2019 pandemic had a positive effect on academic production. The most publications were in *Journal of Dental Faculty of Atatürk University* (n = 6) which continues to be published under the name of *Current Research in Dental Sciences* and *Cumhuriyet Dental Journal* (n = 6). It is thought that these journals are more preferred by researchers in terms of academic success, article review, and publication processes.[18] While publication numbers measure production, citation counts go one step further and consider scientific impact based on how many times subsequent articles refer to the previous article.[9] When the number of citations was evaluated, the years with the highest number of cited publications (n = 3) were determined as 2020 and 2021. It was seen that *Cumhuriyet Dental Journal* was the journal which had the most cited publications. Although it was thought that publishing the article in English would increase accessibility, no difference was found between the number of citations of Turkish and English articles.

Two of the analyzed studies were published as reviews and the remaining 25 studies were published as research articles. It can be said that the acceptance of research articles for publication is effective in this regard and prevents the efforts of researchers to make reviews or case reports.[19]

Online resources are quite effective for collecting large publication data. However, it is necessary to be careful in the selection of the source. Google Scholar seems to be an easy tool for evaluation, as it offers a superior method of finding articles and is very easily accessible. However, it is structured with author information regardless of the institutional relationship. Therefore, Google Scholar does not aim to create accurate metadata.[9] In the current study, research was carried out in the TR Index national database and the information of the articles was evaluated.

The subject is 'bibliometric studies' that are carried out with at least 100 publications or studies published in at least 10 years and summarizes large amounts of bibliometric data to present the academic activity structure and emerging trends of a

research topic or field.[20] Although the number of data is more limited for the present study, academic data over a period of 20 years has been used. This study was carried out on the national database. Therefore, studies with international indexes will be useful for more comprehensive results regarding the use of FEA in prosthetic dentistry.

CONCLUSION

It was concluded that FEA was the preferred method for prosthodontic studies, the field of implantology stood out in this sense, and the national studies using this method increased significantly in the last 10 years. Most of the participants in the studies using this method are affiliated with Gazi University. The journals with the highest number of publications made with FEA are the *Journal of Dental Faculty of Atatürk University* which continues the publication process under the name of *Current Research in Dental Sciences* and *Cumhuriyet Dental Journal*. The language of the article did not affect the number of citations of the publications.

Peer-review: Externally peer-reviewed.

Declaration of Interests: The author has no conflicts of interest to declare.

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Hakem Değerlendirmesi: Dış bağımsız.

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ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Current Research in Dental Sciences

Research Article *Araştırma Makalesi*

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Could Ofloxacin Be an Alternative to Amoxicillin–Metronidazole as an Adjunct to Non-surgical Periodontal Therapy?

Ofloksasin, Cerrahi Olmayan Periodontal Tedaviyle Beraber Kullanılan Amoksisilin Metronidazolün Alternatifi Olabilir mi?

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ABSTRACT

Objective: The best antibiotic approach for generalized periodontitis remains under debate. Therefore, in this study, the systemic administration of ofloxacin was compared against amoxi cillin–metronidazole in terms of clinical periodontal parameters.

Materials and Methods: A prospective, experimental, double-blind, active-controlled, randomized, parallel-grouped, and single-centered clinical trial was carried out at a university hospital in Istanbul, Turkey, between April 2017 and August 2019. Seventy-four patients with generalized periodontitis were randomized into 2 study groups (ofloxacin and amoxicillin–metronidazole groups). Clinical periodontal parameters were recorded at baseline and at 1-, 3-, and 6-month follow-ups following phase 1 periodontal therapy. Changes in clinical periodontal parameters from baseline to 6 months were evaluated and compared between groups.

Results: Thirty-eight patients were lost to follow-up and excluded from the analysis. Thirty-six patients completed the study (ofloxacin group, n = 18; amoxicillin–metronidazole group, n = 18). The clinical periodontal parameters were significantly reduced in both groups at all time points compared to baseline ($P < .05$). No significant differences in plaque or gingival indices were observed between the groups at any time point ($P > .05$). Bleeding on probing at 1 month as well as probing depth and clinical attachment loss at 6 months were significantly lower in the amoxicillin–met ronidazole group compared to the ofloxacin group ($P < .05$). No adverse effects were reported.

Conclusion: Systemic ofloxacin administration as an adjunct to non-surgical periodontal therapy showed significant clinical improvement during the first 3 months but was not as effective as amoxicillin–metronidazole at 6 months.

Keywords: Amoxicillin, metronidazole, ofloxacin, periodontitis, root planning

ÖZ

Amaç: Generalize periodontitis için en iyi antibiyotik yaklaşımının hangisi olduğu tartışma konusudur. Bu nedenle, bu çalışmada, klinik periodontal parametreler açısından, ofloksasinin sistemik uygulaması amoksisilin-metronidazolünkiyle karşılaştırıldı.

Metodlar: Prospektif, deneysel, çift körlü, aktif kontrollü, randomize, paralel gruplu ve tek merkezli klinik çalışma, Nisan 2017 ile Ağustos 2019 tarihleri arasında İstanbul, Türkiye'deki bir üniversite hastanesinde gerçekleştirildi. Generalize periodontitisli 74 hasta, iki çalışma grubuna (ofloksasin ve amoksisilin-metronidazol grupları) randomize edildi. Klinik periodontal parametreler başlangıçta ve faz 1 periodontal tedaviyi takiben birinvi, üçüncü ve altıncı ay takiplerinde kaydedildi. Klinik periodontal parametrelerdeki değişiklikler, başlangıçtan altıncı aya kadar değerlendirildi ve gruplar arasında karşılaştırıldı.

Bulgular: Otuz sekiz hasta takip edilemedi ve analizden çıkarıldı. Otuz altı hasta çalışmayı tamamladı (ofloksasin grubu, n = 18; amoksisilin-metronidazol grubu, n = 18). Klinik periodontal parametreler, başlangıca kıyasla tüm zaman noktalarında her iki grupta da önemli ölçüde azaldı ($p < 0.05$).

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Herhangi bir zaman noktasında, gruplar arasında, plak veya gingival indeksinde anlamlı fark gözlenmedi ($p > 0.05$). Ofloksasin grubuyla karşılaştırıldığında amoksisilin-metronidazol grubunda birinci ayda sondalamada kanama, altıncı ayda sondalama derinliği ve klinik ataşman kaybı anlamlı olarak daha düşüktü ($p < 0.05$). Herhangi bir yan etki bildirilmemiştir.

Sonuç: Cerrahi olmayan periodontal tedaviye ek olarak kullanılan sistemik ofloksasin uygulaması, ilk üç ayda önemli klinik iyileşme gösterirken, altıncı ayda amoksisilin-metronidazol kadar etkili değildi.

Anahtar kelimeler: Amoksisilin, kök yüzeyi düzleştirme, metronidazol, ofloksasin, periodontitis

INTRODUCTION

Periodontitis is an inflammatory disease associated with microbial dental plaque and characterized by loss of tooth-supporting tissues. Treatments include mechanical non-surgical interventions, such as intensive oral hygiene instructions and the mechanical removal of supra- and sub-gingival plaque accumulations (scaling and root planing (SRP)) and surgical interventions on inflamed periodontal tissues. However, non-surgical periodontal therapy alone does not always produce the anticipated tissue-healing results in severe cases of periodontitis.[1] Therefore, adjuvant treatments such as systemic antibiotics are used to improve clinical periodontal parameters (CPPs).

Amoxicillin (AMX), one of the most commonly used antibiotics globally,[2] is a beta-lactam antibiotic, and metronidazole (MET), one of the most frequently prescribed antimicrobials in periodontal recipes,[3] is a nitroimidazole-derivative medical agent. In addition to non-surgical periodontal therapy, the adjunctive use of AMX+MET has been shown to produce significant benefits in the improvement of CPPs compared with control groups.[4] However, the development of antibiotic resistance in periodontopathogens[5] and various side effects such as allergic reactions and gastrointestinal problems have been reported.[2] Therefore, the effectiveness of new medical agents to support periodontal therapy should be assessed.

Ofloxacin (OFX) is a fluoroquinolone antibiotic used against periodontal disease-associated pathogens.[6-11] It is used for treating oral infections including periodontal infections, pericoronitis, and osteitis; moreover, it shows minimal toxic effects on periodontal ligament fibroblasts and gingival epithelial cells,[12,13] and the reported adverse drug reactions are mild.[14,15] It has been suggested that the pharmacokinetics of OFX, which include the maintenance of high serum and tissue concentrations because of the prolonged half-life, allow once-daily dosing on an empty or full stomach, which may improve cost-effectiveness and facilitate patient compliance with drug therapy.[16]

As far as we know, no randomized controlled clinical trials have evaluated the effects of OFX as an adjunct to SRP in the treatment of generalized periodontitis at stages III-IV/grade C. Therefore, this work aimed to compare the clinical outcomes of OFX versus AMX+MET as an adjunctive therapy to full-mouth SRP in patients with generalized periodontitis. We hypothesized that SRP treatment in combination with systemic OFX therapy would result in equivalent clinical periodontal outcomes to the combination treatment in patients with generalized periodontitis.

MATERIALS AND METHODS

Trial Design

This was a prospective, experimental, double-blinded, active-controlled, randomized, parallel-grouped, and single-centered clinical trial with a 6-month follow-up period. The study procedure was reviewed by the İstanbul Medipol University Ethics Committee (Date/Number: 22.12.2016/10840098-604.0 1.01-E.27503) and adhered to the 1964 Declaration of Helsinki and its latest amendments. The ClinicalTrials.gov registration number for the study is NCT04353362. All patients were briefed on the study procedure and gave written informed consent for participation.

Participants

This study was conducted on a voluntary basis with patients who visited the university hospital in İstanbul, Turkey, between April 2017 and August 2019. Each participant completed a questionnaire asking about their general background and medical and dental history. An obesity assessment was based on body mass index, which was calculated according to the criteria recommended by the World Health Organization.[17]

Inclusion criteria were as follows: systemically healthy; 18-40 years of age (35 years or younger at the time of diagnosis); clinically diagnosed with generalized aggressive periodontitis[18] (e.g., rapid attachment loss, rapid bone destruction, systemically healthy except for periodontal inflammation, plaque deposition disproportionate to the severity of bone destruction, and generalized interproximal attachment loss affecting at least 3 permanent teeth other than first molars and incisors); the presence of at least 20 teeth (at least 1 molar tooth in each quadrant); and no antibiotic therapy within the previous 6 months. All cases were then re-evaluated according to the new classification of periodontal diseases and conditions[19] based on secondary evidence. Cases were found to be in the "generalized stages III-IV/grade C periodontitis" group.

Exclusion criteria were as follows: systemic disease such as diabetes mellitus or taking medication such as cortisone that has a possible influence on the periodontium; current smokers who smoked more than 20 cigarettes per day;[20] lactation; current or suspected pregnancy; systemic antibiotics taken within the previous 6 months; medication that could interact with OFX, AMX, or MET; history of previous periodontal surgery; and history of SRP within the last year.

Interventions

During the first appointment, full-mouth CPPs were recorded by a blinded investigator (B.A.) at 6 sites per tooth using a periodontal probe (Williams Probe; Hu-Friedy, Chicago, Ill, USA) including plaque and gingival indices (PI, GI),[21] probing depth (PD), bleeding on probing (BOP), and clinical attachment loss (CAL). Following the measurements, supra-gingival debridement using an ultrasonic instrument and polishing using a rubber cup with a polishing paste were performed. All patients were instructed to brush their teeth twice daily with a toothbrush (Oral B Vitality, Braun, Hesse, Germany) followed by an interdental brush (Oral-B

Pro-Expert Clinic Line Interdental Kit, USA). A follow-up appointment was made 1 week later, and all patients who adhered to the twice-daily cleansing regimen were selected for study inclusion and randomized in 1 of the 2 study groups in order of arrival. The OFX group (experimental group) received 400 mg of OFX once a day for 5 days, and the AMX+MET group (gold standard group) received 500 mg AMX and 500 mg MET 3 times a day for 7 days. The use of chlorhexidine digluconate mouthwash was prohibited during the study. All participants were called the day before their visits to remind them to attend their appointment, and the first dose of medication was taken on the morning of the treatment day under the supervision of an investigator. At the next appointment, an experienced periodontist (N.A.) completed the full-mouth SRP procedure using local anesthesia, Gracey curettes (Hu Friedy, Chicago, Ill, USA), and ultrasonic instruments. Patients were screened at 1, 3, and 6 months after completion of the SRP. During these appointments, all CPPs were recorded. In addition, supra-gingival professional dental cleaning and polishing procedures were re-performed, but sub-gingival areas were not re-instrumented with curettes. The endpoint for the first SRP appointment was the smoothness of the scaled roots, and the endpoint for each control appointment was the complete absence of calculus in the dentition.

Outcomes

The primary outcome measure selected for this study was PD reduction between baseline and follow-up visits. The changes in PI, GI, BOP, and CAL were assessed as secondary outcome measures of efficacy.

Sample Size

A power calculation (G-Power software, Dusseldorf, Germany) based on the data suggested that a sample size of 30 participants per group would have 85% power at an effect size of 1.0 and an α level = 0.05.[22] Considering a loss of approximately 15%,[23] it was foreseen that at least 35 subjects should be included in each group.

Randomization

After obtaining informed consent from the patients and recording their CPPs, participants were randomized into 1 of 2 treatment groups by drawing lots, with the constraint that there should be an equal number of participants in each group. The allocation was implemented by a person who was blinded to patient data. The identity of the patients participating in the study was kept confidential.

Blinding

Although the patients knew which drug they were using as their names were on the medication packaging, they were not aware of which group (experimental or gold standard) they belonged to. Furthermore, the investigators performing the treatment (N.A.) and collecting the data (B.A.) were blinded to the allocation.

Statistical Methods

The Statistical Package for Social Sciences version 24.0 software (IBM Corp.; Armonk, NY, USA) was used for the analyses. Pearson's chi-squared and Mann–Whitney *U* tests were used to compare categorical variables and determine differences between groups at given times, respectively. Differences within the groups over time were evaluated using Friedman's and Wilcoxon signed-rank tests. A post hoc analysis was carried out to test for specific differences between groups. Statistical significance was defined as $P < .05$.

RESULTS

Figure 1 depicts the flow chart of the study. A total of 95 patients with generalized periodontitis were included in the study; 21 patients, who were unable to maintain oral hygiene, were excluded at the first appointment. Thus, a total of 74 patients were randomized into 2 groups, OFX (n = 39) and AMX+MET (n = 35), with 36 patients completing the study. In the OFX group, 14, 6, and 1 participants were withdrawn from the study at 1, 3, and 6 months, respectively. In the AMX+MET group, 15 participants were withdrawn at the 1-month follow-up, and 1 participant each was withdrawn from the group at the 3- and 6-month follow-ups. The baseline characteristics and CPPs for the 36 patients that completed the study are presented in Table 1. There were no differences between the groups in terms of gender, smoking status, age, body mass index, and baseline CPPs ($P > .05$) (Table 1). The number of smokers was the same in both groups and 1 female participant from each group was in the obesity class I category without any other systemic symptoms. Each patient in the OFX group received 400 mg OFX (1 × 1 for 5 days), and each patient in the AMX+MET group received 500 mg of AMX and 500 mg of MET (3 × 1 for 7 days). There were no patients to receive antibiotics repeatedly during the whole study. No drug-related adverse events were reported by any of the patients, including those who dropped out. Both groups exhibited significant decreases in all CPPs at the end of all the follow-up times compared to baseline (PI, GI, PD, BOP, CAL, $P < .05$, Table 2). No significant differences were observed for the PI and GI parameters between the groups at any time points ($P > .05$) (Table 2). The BOP (after 1 month) and the PD and CAL (after 6 months) were significantly lower in the AMX+MET group than in the OFX group ($P < .05$) (Table 2).

DISCUSSION

As far as we know, this is the first study to assess the clinical effectiveness of systemic OFX compared to AMX+MET as an adjunct to non-surgical periodontal therapy for the treatment of generalized periodontitis stages III-IV/grade C. Based on the current findings, systemic OFX was not superior to the combination therapy in the treatment of generalized periodontitis. The results indicate that our hypothesis should be partially accepted, as CPPs were significantly decreased in both groups at the end of months 1, 3, and 6 compared to baseline; however, PD was significantly lower in the AMX+MET group than in the OFX group by month 6.

Similar to our results, some studies have indicated that OFX treatment results in considerable CPPs recovery.[6,7,14,15,24] Most of the reported clinical studies investigating the effects of local and systemic OFX administration on periodontal therapy have found that it has positive effects on periodontal healing.[14,15,24-26] Kleinfelder et al[6] concluded that systemic OFX therapy as an adjunct to surgical periodontal therapy resulted in a significant reduction of PD and a significant increase in clinical attachment compared to a control group that did not receive antibiotic treatment. One study investigated the clinical effects of OFX+MET topical gel as an adjunct to periodontal therapy and reported that the GI, PD, and BOP results from the OFX+MET topical gel group were similar to those in a MET gel group but better than those taking a placebo gel.[27] In an observational study on the effectiveness of systemic OFX+MET treatment in periodontal patients, the bleeding index, PD, and height of the alveolar bone in an OFX+MET group were better than those in a MET group alone.[24] In a published case series, 2 Papillon–Lefèvre syndrome children with severe periodontal destruction were treated with systemic OFX

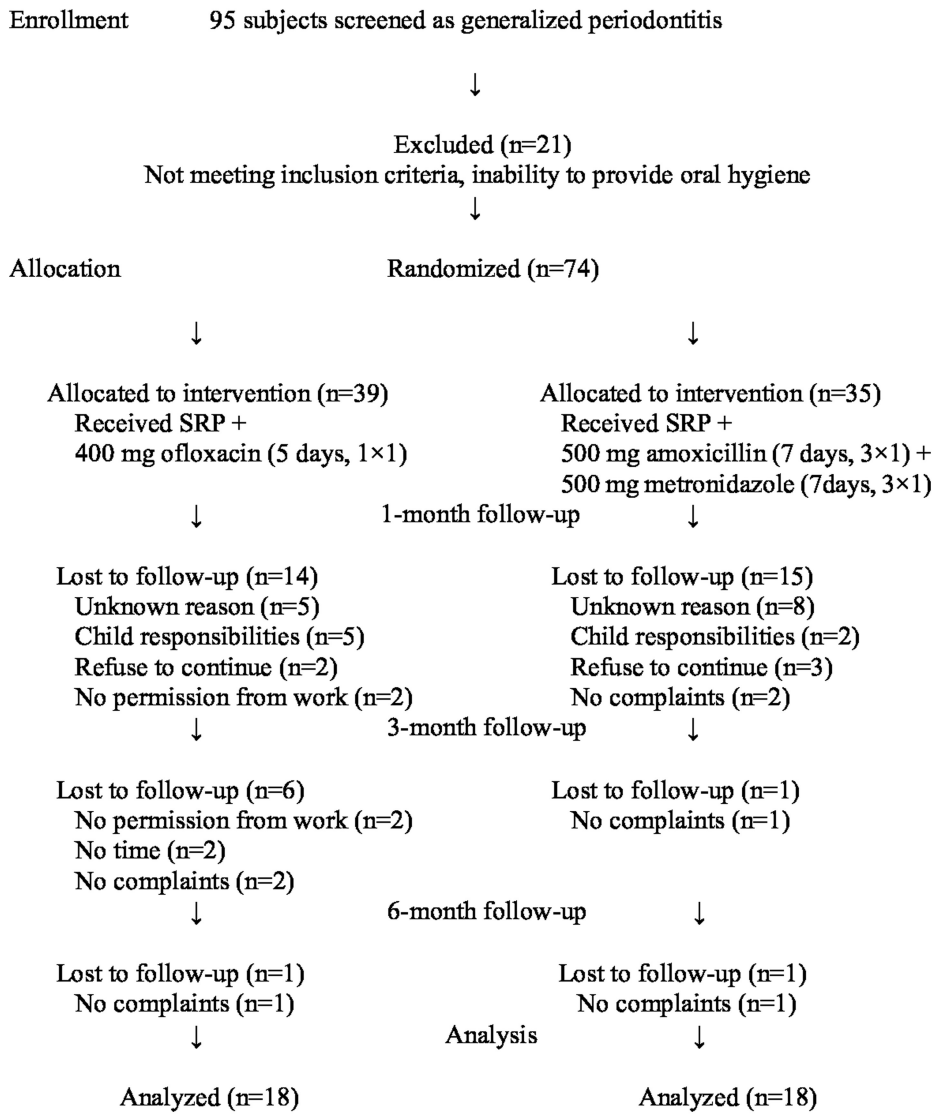

Figure 1. CONSORT flow diagram outlining the current study.

administration as an adjunct to non-surgical periodontal therapy, and gingival inflammation and PD were eliminated.[7] Another study that evaluated a systemic OFX regime as an adjunct to surgical periodontal therapy declared that PD and CAL were significantly decreased in patients who received systemic OFX.[6] However, it is not appropriate to make direct comparisons between our findings and previous studies owing to differences in the methodology and research strategies. Some studies used OFX alone, while others included OFX in combination with different antibiotics, and the inclusion criteria and subsequent periodontal treatment planning were also different. In addition, there is no consensus in the literature as to the best antibiotic regimen for the treatment of generalized periodontitis.[28] Therefore, it is challenging to compare the outcomes of studies owing to differences in the evaluated CPPs, the characteristics of the study populations, and the research methodologies used.

Table 1. Gender, Smoking Status, Age, Body Mass Index, and Baseline Clinical Periodontal Parameters of Participants Who Completed the Study

	OFX Group (n = 18)	AMX+MET Group (n = 18)	*P*
Female/male (n)*	10/8	9/9	.74
Smokers (n, %)*	8, 44.44	8, 44.44	1
Age (year)†,‡	32.72 ± 6.13 (20-40)	34.17±4.43 (26-40)	.66
Body mass index†,‡	24.27±3.49 (19.72-30.80)	26.22 ± 4.13 (19.88-31.64)	.17
Plaque index†,‡	1.58 ± 0.44 (0.87-2.54)	1.44 ± 0.50 (0.25-2.25)	.46
Gingival index†,‡	1.07 ± 0.34 (0.4-1.77)	1.06 ± 0.21 (0.78-1.51)	.82
Probing depth (mm)†,‡	4.44 ± 0.77 (3.51-5.68)	4.67 ± 0.76 (3.3-5.81)	.32
Bleeding on probing (%)†,‡	83.71 ± 11.19 (61.54-100)	79.49 ± 13.98 (43.21-100)	.28
Clinical attachment loss (mm)†,‡	4.79 ± 1.02 (3.53-6.76)	4.84 ± 0.84 (3.3-5.96)	.86

*Pearson chi-square test; †Mean ± SD (minimum–maximum); ‡Mann–Whitney *U* test.
AMX, amoxicillin; MET, metronidazole; OFX, ofloxacin.
P > .05: the difference between the 2 groups is not statistically significant.

According to the findings of our study, the PD parameter was significantly lower in the AMX+MET group compared to the OFX group at the end of month 6, indicating that OFX was not superior to AMX+MET. In a study[29] examining the concentrations of 500 mg AMX and clavulanic acid in gingival crevicular fluid (GCF) after the first and tenth oral dose, the mean AMX concentration was measured as 14.05 mg/mL approximately 1 hour after administration on day 0 and 13.93 mg/mL approximately 1 hour after

Table 2. Mean ± Standard Deviation (Minimum–Maximum) Values for Clinical Periodontal Parameters of the 2 Groups for Each Follow-Up Period

	OFX Group (n = 18)	AMX+MET Group (n = 18)	*P* (Between the Groups)
Plaque Index			
Baseline	1.58 ± 0.44 (0.87-2.54)	1.44 ± 0.50 (0.25-2.25)	.46
1 month	0.47 ± 0.19 (0.21-0.87)*	0.38 ± 0.21 (0.14-0.79)*	.64
3 months	0.45 ± 0.25 (0.20-1.21)†	0.33 ± 0.21 (0.14-0.91)†	.78
6 months	0.41 ± 0.24 (0.09-0.87)‡	0.19 ± 0.13 (0.03-0.58)‡	.17
Gingival index			
Baseline	1.07 ± 0.34 (0.40-1.77)	1.06 ± 0.21 (0.78-1.51)	.82
1 month	0.27 ± 0.16 (0.10-0.67)*	0.24 ± 0.17 (0.06-0.61)*	.66
3 months	0.24 ± 0.13 (0.06-0.51)†	0.16 ± 0.14 (0.04-0.54)†	.53
6 months	0.22 ± 0.15 (0.03-0.65)‡	0.10 ± 0.10 (0.03-0.44)‡	.52
Probing depth (mm)			
Baseline	4.44 ± 0.77 (3.51-5.68)	4.67 ± 0.76 (3.3-5.81)	.32
1 month	3.32 ± 0.62 (2.68-4.53)*	3.46 ± 0.67 (2.66-4.82)*	.38
3 months	3.18 ± 0.62 (2.15-4.30)†	3.23 ± 0.55 (2.53-4.04)†	.12
6 months	3.14 ± 0.65 (2.12-4.48)‡	2.91 ± 0.40 (2.38-4.02)‡	.02
Bleeding on probing (%)			
Baseline	83.71 ± 11.19 (61.54-100)	79.49 ± 13.98 (43.21-100)	.28
1 month	49.62 ± 13.44 (27.98-71.43)*	26.01 ± 15.77 (3.57-52.56)*	.00
3 months	46.14 ± 13.80 (28.47-70.83)†	19.84 ± 11.80 (2.38-42.95)†	.82
6 months	42.59 ± 19.82 (13.70-77.78)‡	–	.49
Clinical attachment loss (mm)			
Baseline	4.79 ± 1.02 (3.53-6.76)	4.84 ± 0.84 (3.3-5.96)	.86
1 month	3.82 ± 0.98 (2.70-5.87)*	3.79 ± 0.76 (2.86-4.88)*	.18
3 months	3.73 ± 1.03 (2.67-6.10)†	3.62 ± 0.58 (2.68-5)†	.87
6 months	3.77 ± 1.10 (2.57-6.42)‡	3.49 ± 0.54 (2.51-4.27)‡	.03

Friedman test, Wilcoxon signed-ranks test.
*Significant difference between baseline and 1-month follow-up within the group ($P < .05$).
†Significant difference between baseline and 3-month follow-up within the group ($P < .05$).
‡Significant difference between baseline and 6-month follow-up within the group ($P < .05$).
P-value < .05, the difference between the 2 groups is statistically significant.

administration on day 3. In a clinical study[30] examining the mean MET concentration in GCF after a single 250 mg oral dose, the concentration peaked at the second and seventh hours following application (~4 µg/mL) and was still at a detectable concentration after 18 hours (~1 µg/mL). In a clinical study[26] examining OFX concentrations in GCF after a single 200 mg oral dose, the concentration was reported to have peaked at 7 µg/mL approximately 2 hours after administration and gradually decreased to 2 µg/mL after 10 hours. We did not test the concentrations of antibiotics in GCF; however, the reason for this difference between the groups in the sixth month may be related to their concentration capability in GCF.

It has been reported that the adjunctive use of AMX+MET in non-surgical periodontal treatment results in statistically significant improvements in CPPs and reduces the need for periodontal surgery compared with non-surgical treatment alone.[4] We did not include a group without antibiotics in our study. In clinical trials designed to test the effectiveness of new antimicrobial regimens as an adjunct to SRP, establishing a group without medication would be unethical. Therefore, the AMX+MET group served as both the gold standard group and the control group in the present study. Patients were prescribed 500 mg of AMX and 500 mg of MET 3 times a day for 7 days to ensure that an adequate concentration of antibiotics was reached in the GCF and the blood.

The starting point and duration of systemic antibiotic regimens for periodontal therapy vary between studies. However, by focusing on randomized clinical trials and systematic reviews, a consensus report on systemic antibiotic administration concluded that antibiotic tolerance in biofilms increases within the first 24 hours after non-surgical periodontal therapy.[31] Therefore, in our study, antibiotic treatment was initiated on the morning of the day that the SRP was due to be carried out, and the full-mouth SRP treatment was completed on the same day as the first dose of antibiotics.

The principal limitation of this trial is that, although it is related to the use of antimicrobials, no microbiological analysis was performed. According to van Winkelhoff,[32] assuming all patients with periodontitis are infected with the same microorganisms sub-gingivally is controversial. However, a study comparing the sub-gingival microbial flora of periodontitis patients and healthy controls found little difference between the groups.[33] In in vitro[11,34-36] and in vivo[6,7,37] studies, resistance and susceptibility to tested antibiotics have been found to vary among periodontal pathogens. Therefore, antibiotic treatment as an adjunct for controlling periodontal disease should be selected based on the results of a microbial analysis of subgingival plaque samples. However, given the difficulties in identifying complex subgingival microflora, the time needed to conduct laboratory procedures, and the high cost of the analysis limit the routine use of microbiological laboratory tests in dental clinics.

The second weakness of this study was the very high dropout rate during the follow-up period. The number of patients who completed the study was below the target sample size (36 participants finished the study as opposed to the planned 60). One possible explanation for this high dropout rate may be the absence of personal contact participants had with the researchers. The administrative staff was responsible for calling patients and arranging appointments. Patients who consistently missed their appointments were called by a researcher to try to understand the reasons for their non-attendance. Noncompliance with medical treatment involving check-up appointments is a chronic issue and can result in unexpected patient losses. This may have been exacerbated by the researchers' lack of telephone contact with patients. In addition, we did not insist that patients stay in the study, but, rather, informed them that it was inappropriate to use antibiotics without medical supervision.

A third weakness of this study concerns intra-examiner reliability and reproducibility, which was not evaluated. Therefore, the possibility of underestimation or overestimation in the measurement interpretation of the clinical parameters should be considered.

Despite these limitations, the clinical trial reported here has several strengths, including the study design, a selection of an appropriate group of periodontitis patients for treatment with antibiotics, and the use of an entry phase to enroll patients with oral hygiene motivation. In conclusion, systemic OFX administration, together with non-surgical treatment, is not as effective as AMX+MET combination treatment for periodontitis based on clinical improvements at 6 months follow-up. Further studies should be undertaken to identify suitable systemic antibiotic regimens as alternatives to the AMX+MET combination as an adjunct to non-surgical periodontal treatment.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul Medipol University (Date: December 22, 2016, Decision Number: 10840098-604.01.01-E.27503).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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Comparison of Microleakage and Fracture Strength of Veneering Techniques for Polyetheretherketone Cores

Polietereterketon Alt Yapılar İçin Kullanılan Veneer Tekniklerinin Mikrosızıntı ve Kırılma Dayanımlarının Karşılaştırılması

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ABSTRACT

Objective: This study aimed to compare both microleakage and fracture strengths of polyetheretherketone crowns manufactured via conventional composite layering and different computer-aided design and computer-aided manufacturing veneering techniques on polyetheretherketone cores.

Materials and Methods: In total, 40 cores with 0.7-mm thickness were milled from polyetheretherketone discs and separated into 4 groups: layering with composite resin, computer-aided design and computer-aided manufacturing-fabricated lithium disilicate veneer, computer-aided design and computer-aided manufacturing-fabricated hybrid ceramic veneer, and computer-aided design and computer-aided manufacturing-fabricated feldspathic veneer. Then, all cores were air abraded and an adhesive has applied to these surfaces. After the cores were connected to veneers, thermomechanical aging was applied in a chewing simulator. Evaluation of microleakage and fracture strength was performed via micro-computed tomography analysis and universal test machine, respectively. One-way analysis of variance was used to detect any statistically significant differences between test groups. Also, failure modes and the correlation between microleakage and fracture strength data were analyzed statistically.

Results: Statistical analyses between the groups showed significant differences for both microleakage and fracture strength values. The lowest microleakage was in the computer-aided design and computer-aided manufacturing-fabricated hybrid ceramic veneer group (0.02 ± 0.01 mm^3). The highest microleakage was in the layering with composite resin group (0.56 ± 0.21 mm^3). The lowest fracture strength values were in the computer-aided design and computer-aided manuf acturing-fabricated feldspathic veneer group (620.58 ± 114.02 N). The highest fracture strength was in the computer-aided design and computer-aided manufacturing-fabricated lithium disilicate veneer group (1245.82 ± 197.75 N). Also, there was no correlation between the microleakage and fracture strength groups.

Conclusion: The use of computer-aided design and computer-aided manufacturing-fabricated lithium disilicate and hybrid ceramic veneers can be an alternative to layering when its other advantages are considered.

Keywords: Polyetheretherketone, digital veneering, microleakage, fracture strength, adhesive dentistry, dental technology

ÖZ

Amaç: Bu çalışma, PEEK altyapı üzerinde geleneksel kompozit katmanlama ve farklı CAD/CAM veneerleme teknikleri ile üretilen polietereterketon (PEEK) kronların hem mikrosızıntı hem de kırılma dayanımlarını karşılaştırmayı amaçlamıştır.

Gereç ve Yöntemler: PEEK disklerinden toplamda 0,7 mm kalınlığında hazırlanan 40 altyapı örnek dört gruba ayrılmıştır: LCR; Kompozit reçine, LDV, CAD/CAM fabrikasyon lityum disilikat kaplama,

HCV ile katmanlama; CAD/CAM tarafından üretilmiş hibrit seramik kaplama ve FFV; CAD/CAM fabrikasyon feldspatik kaplama. Daha sonra tüm örnekler hava ile tozlama sayesinde pürüzlendirilmiş ve bu yüzeylere adeziv uygulanmıştır. Kor örnekler veneer üst yapılara bağlandıktan sonra çiğneme simülatöründe termomekanik yaşlandırma uygulanmıştır. Mikrosızıntı ve kırılma dayanımının değerlendirilmesi sırasıyla mikro-CT analizi ve üniversal test cihazı ile yapılmıştır. Test grupları arasında istatistiksel olarak anlamlı farklılıkları tespit etmek için tek yönlü ANOVA kullanılmıştır. Ayrıca, kırılma paternleri ve mikrosızıntı ile kırılma dayanım verileri arasındaki korelasyon istatistiksel olarak analiz edilmiştir.

Bulgular: Gruplar arasındaki istatistiksel analizler, hem mikrosızıntı hem de kırılma dayanım değerleri için önemli farklılıklar göstermiştir. En düşük mikrosızıntı HCV grubunda (0,02 ± 0.01 mm^3). En yüksek mikrosızıntı LCR grubunda (0,56 ± 0,21 mm^3) tespit edilmiştir. En düşük kırılma dayanım değerleri FFV grubunda (620.58 ± 114.02 N) olmuştur. En yüksek kırılma mukavemeti LDV grubunda (1245,82 ± 197,75 N) tespit edilmiş olup mikrosızıntı ve kırılma dayanımları arasında bir korelasyon tespit edilmemiştir.

Sonuç: CAD/CAM fabrikasyon lityum disilikat ve hibrit seramik veneerlerin kullanımı, PEEK altyapı üzerinde diğer avantajları da düşünüldüğünde katmanlama tekniğine alternatif olarak kullanılabilir.

Anahtar Kelimeler: Polietereterketon, dijital veneerleme, mikro sızıntı, kırılma dayanımı, adeziv diş hekimliği, dental teknoloji

INTRODUCTION

Developments in dental technology and the introduction of new materials, especially milled to fabricate dental prostheses, had led to greater utilization of computer-aided design and computer-aided manufacturing (CAD/CAM).[1] Polyetheretherketone (PEEK), one of these new materials, is a semi-crystalline, linear, and aromatic thermoplastic polymer.[1,2] The low melting temperature of PEEK makes it possible to process in various ways. Polyetheretherketone can be processed by pressing or milling with CAD/CAM systems. For CAD/CAM milling, industrially manufactured PEEK blanks under standardized parameters are used.[3,4]

Polyetheretherketone is a beneficial material for dental applications due to the material's superior mechanical properties and biocompatibility, as well as its chemical stability. It shows resistance to hydrolysis, high temperatures, and chemical wear.[5-8] Polyetheretherketone has a very low density of 1.265 g/cm^3, 3-4 GPa elastic modulus, and 343°C melting temperature.[9,10] Its dimensional stability, excellent mechanical, and physical and chemical properties make it applicable in dentistry.[1,11] The low weight of PEEK makes it possible to fabricate lightweight prostheses, providing patients comfort and pleasure. The use of PEEK in prosthetic and restorative dentistry includes frameworks for metal-free removable or fixed dental prostheses, implant-supported or retained dental prostheses, endocrowns, post and core restorations, resin-bonded fixed dental prostheses, and occlusal splints.[1]

Despite its advantages, PEEK has esthetic disadvantages that limit its monolithic usage.[4-6,12] Polyetheretherketone frameworks require veneering because of their grayish-brown or pearl-white opaque color.[1,4,5] Using composite veneering for better shape and translucency requires solving problems in achieving the bond strength between PEEK and composite resin.[5,13,14] Polyetheretherketone surfaces are hydrophobic and inherently inert, which can cause chipping, delamination, or fracture of the composite layer.[13] Several treatment methods, such as sandblasting,[15] silica coating,[16] piranha etching,[5] acetone,[7] sulfuric acid,[16] phosphoric acid,[17] plasma treatment,[13] laser treatment,[18] and adhesive[14] applications were used to provide better bond strength between PEEK and composite resin.

Several veneering methods can be workable alternatives to veneering PEEK frameworks. Generally, conventional layering with light polymerized composite resin is preferred for PEEK veneering, but premanufactured veneers and CAD/CAM fabricated veneers must also be considered as new approaches.[1] However, there are some important criteria in deciding which of these techniques provide similar and almost adequate aesthetics to use. One of these criteria is to evaluate which techniques present enough fracture strength to allow optimal use in the mouth. The other is the amount of leakage between PEEK cores and CAD/CAM veneers bonded with cement. This study aimed to evaluate the microleakage and fracture strength of PEEK crowns veneered with conventional composite resin and alternatively proposed CAD/CAM fabricated veneers cemented to PEEK cores following thermomechanical aging. The null hypothesis of the present study was that the different veneering applications do not affect the microleakage and fracture strength of PEEK crowns.

MATERIALS AND METHODS

The schematic workflow of the study design is given in Figure 1.

Fabrication of the Crowns

A maxillary first premolar made of hard, thermosetting plastic material (Phantom; Frasaco GmbH, Tettnang, Germany) was used for crown preparation. Preparation was performed with a 1-mm-wide chamfer finish line and 1.5-2 mm occlusal reduction. Sharp edges and undercuts of preparation were eliminated.

CEREC Omnicam (Sirona Dental Systems GmbH, Bensheim, Germany) was used for digital impressions. The fabrication of the crowns core and veneer designs was performed simultaneously with InLab 16 (Dentsply Sirona), which eliminates the need for additional scanning of the core for veneer design. A uniform core was designed with 0.7 mm thickness following the manufacturer's recommendations. The thickness of the die spacer was selected as 120 µm. The veneer was designed with a total restoration thickness of 2 mm.

In total, 40 cores were milled from PEEK disc (breCAM.BioHPP; Bredent GmbH & Co., Senden, Germany). Specimens were randomly separated into 4 groups (n = 10) given below according to the veneering procedure and material used:

1. LCR: Layering with composite resin (crea.lign; Bredent GmbH & Co.) was performed by an experienced technician with a single transparent silicone mold for standardization of specimens' veneer thickness to minimize personal mistakes. This mold has been used to obtain similar size and shaped crowns.

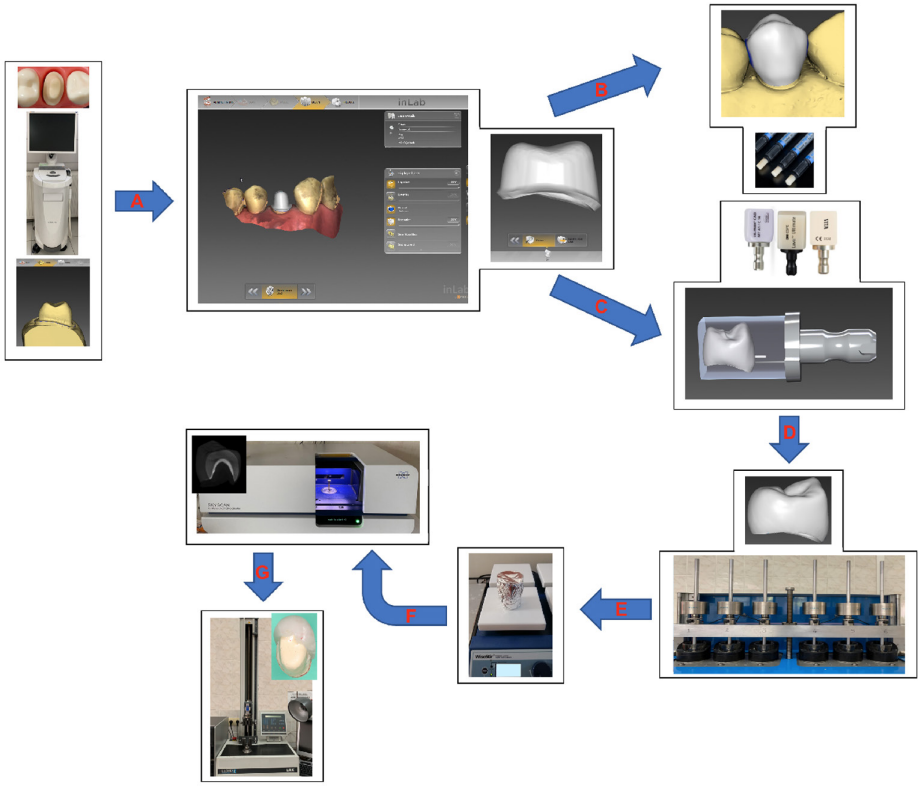

Figure 1. Schematic abstract of the study design.

2. LDV: CAD/CAM fabricated lithium disilicate veneer (IPS e.max® CAD for CEREC® and inLAB®; Ivoclar-Vivadent AG) cemented to PEEK core.
3. HCV: CAD/CAM fabricated hybrid ceramic veneer (LAVA™ Ultimate CAD/CAM Restorative; 3M ESPE) cemented to PEEK core.
4. FFV: CAD/CAM fabricated feldspathic veneer (Feldspatic Ceramic Blocks C; VITA Zahnfabric) cemented to PEEK core.

After controlling the adaptation of core and CAD/CAM veneers, each core was air abraded using 110 µm Al_2O_3 particles with 2 bar pressure and 10 mm distance for 15 seconds. Then, an adhesive (visio.link PMMA & Composite Primer; Bredent GmbH & Co.) was applied to core surfaces. The adhesive was polymerized using a polymerization unit (bre.Lux Power Unit; Bredent GmbH & Co.) that provides an energy wavelength of 370-400 nm for 90 seconds. Then, all LCR specimens were veneered with the composite resin using a single transparent silicone mold that was prepared from digitally fabricated crowns to provide standardization of the final form of the crowns. After placing the resin material on the PEEK cores with the mold, the crowns were polymerized with this transparent silicone mold. Finally, the veneers were polymerized using the same unit for 180 seconds. For the other test groups, the veneers' intaglio was treated with 9% hydrofluoric acid (Ultradent Products, Inc., South Jordan, Utah, USA) for 60 seconds and the crowns were rinsed thoroughly with deionized water for 10 seconds, then dried at room temperature. After this procedure silane agent (Clearfil Ceramic Primer Plus; Kuraray Noritake Dental Inc., Okayama, Japan) was applied to these surfaces according to the manufacturer's instructions. The cores were connected to veneers by dual-polymerized resin cement (Panavia V5 Adhesive Resin Cement System; Kuraray Noritake Dental Inc.) by applying finger pressure by the same researcher. Excess cement was removed. Resin cement was light-polymerized from all aspects for 20 seconds (bre.Lux; Bredent GmbH & Co.).

Aging Procedure

Crowns were embedded in acrylic resin (Ortocryl; Dentaurum) dies, and thermomechanical aging was applied in a chewing simulator (MOD; Esetron). Crowns were occluded against 2 mm diameter, sphere-shaped stainless-steel tips touching two lateral ridges of the restorations for standardized simulation. A total of 240 000 cycles were applied with an occlusal load of 50 N at a frequency of 1.3 Hz to simulate approximately 1 year in vivo. Additionally, thermal cycling was applied during loading from 5°C to 50°C every 60 seconds.

Evaluation of Microleakage

Following aging, the crowns were sealed with 2 layers of nail varnish except for a 1 mm thick area around the restoration margin and allowed to dry for 10 minutes. The coated crowns were stored in 50% w/v ammoniacal silver nitrate solution (50% $AgNO_3$; Sinopharm) in the dark for 24 hours and then rinsed with running water for 2 minutes. The crowns were immersed in a photo-developing solution (RPXOMAT; Kodak) and exposed to daylight for 8 hours. Then, ultrasonic cleaning was applied for 1 minute with a toothbrush to eliminate silver deposits on the surface.

Each specimen was scanned using a micro-computed tomography (Skyscan; Kontich) with an X-ray source of 100 kV/100 mA. Each specimen was rotated 360° with a rotation step of 0.2. A 1 mm copper filter was used to interrupt soft X-rays and to avoid shooting artifacts. Each specimen was scanned for nearly 40 seconds. One-thousand-eight hundred projections were taken for each sample. The pixel size of the image resolution was 18 µm. The projections were reconstructed with NRecon software (SkyScan) to eliminate radiologic defects and create axial images of the

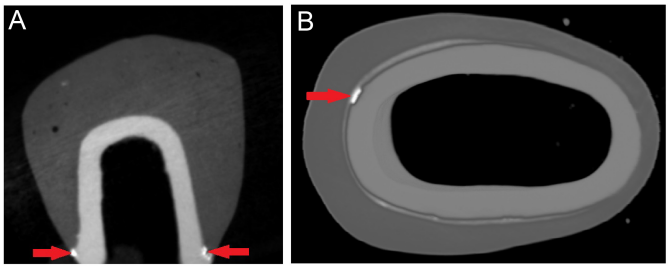

Figure 2. Demonstrative images of micro-CT depicting cervical microleakage measuring according to a depth of $AgNO_3$ presence between the core and veneer interfaces. (A) Sagittal view of sample. (B) Axial view of the sample. CT, computed tomography.

specimens. These images were uploaded to Dataviewer software (SkyScan), and then the sample was viewed with axial, coronal, and sagittal axes. Samples were flattened, and angular corrections were made so that the restoration margins corresponded to equal sections. To calculate the amount of $AgNO_3$ that has penetrated the margins, the upper and lower boundaries of the restorations were determined with this program, and other sections were excluded from the analysis. A volume of interest containing each slice, the full object was chosen.

Grayscale thresholds were established to distinguish $AgNO_3$ from penetrating the leak between PEEK core and veneers. Then, the silver leak volume was automatically calculated in 3D and volumetrically (Figure 2).

Fracture Strength

A single static load failure test was applied using a universal test machine (Instron; Instron Corp., Fareham, UK). A 2-point contact between the tip and the occlusal surface of the crown was provided like the aging procedure. The load was applied with a 2.5 mm diameter stainless steel tip at a 1 mm/min crosshead speed until fracture. The tip was applied vertically at the center of the occlusal surface. The fracture pattern of each crown was evaluated (Figure 3).

Statistical Analyses

Statistical analysis was performed by PAWS Statistics for Windows, Version 18.0.0 (SBAS Hong Kong Headquarters, Quarry Bay, Hong Kong). One-way analysis of variance (ANOVA) was used to analyze both fracture strength and microleakage data. The homogeneity of the data was analyzed with the Shapiro–Wilk test. Fracture strength data showed normal distribution in all groups ($P > .05$). Microleakage data showed no homogeneous distribution with the FFV group ($P < .05$). For microleakage data, Tamhane's post hoc test was used to determine the differences between the groups since variances were not homogeneous ($P < .05$). For fracture strength data, Tukey's post hoc test was used to determine the differences between the groups since variances were homogeneous ($P < .05$).

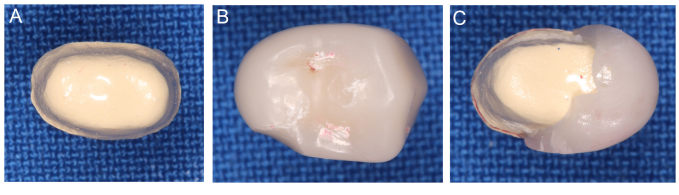

Figure 3. The different fracture patterns of samples. (A) Adhesive. (B) Cohesive, (C) Mixed failures.

Spearman's rho correlation coefficient evaluated the correlation between microleakage and fracture strength data in each group.

RESULTS

One-way ANOVA test between the groups showed significant differences for microleakage data (F = 60.807). The maximum and minimum microleakage values, mean, and standard deviation with statistical differences are shown in Table 1 ($P < .05$). The lowest microleakage was observed for the HCV group (0.02 ± 0.01 mm^3). The highest microleakage was obtained in LCR (control) group (0.56 ± 0.21 mm^3).

One-way ANOVA test between the groups showed significant differences in fracture strength values (F = 28.085). The maximum and minimum fracture strength values, mean, and standard deviation with statistical differences are shown in Table 2 ($P < .05$). The lowest fracture strength value was observed in the FFV group (620.58 ± 114.02 N). The highest fracture strength was obtained in the LDV group (1245.82 ± 197.75 N). The fracture patterns of the crowns in each group were given in Table 3.

When the correlation between each group's microleakage and fracture strength data was evaluated by Spearman's rho correlation coefficient, there was no correlation ($P > .05$). However, the CAD/CAM groups with lower microleakage showed higher fracture strength (LDV and HCV) except FFV.

DISCUSSION

The present study evaluated both the microleakage and fracture strength of PEEK crowns veneered using different veneering materials and procedures. The results showed that veneering material and procedure are effective on microleakage and fracture

Table 1 . Mean, Maximum and Minimum Microleakage Values (mm^3), Standard Deviation with Statistical Differences Between the Groups ($P < .05$)

Group	Mean ± Standard Deviations	Minimum-Maximum
LCR	$0.56^c \pm 0.21$	0.32-0.91
LDV	$0.03^a \pm 0.02$	0.01-0.07
HCV	$0.02^a \pm 0.01$	0.01-0.03
FFV	$0.08^b \pm 0.03$	0.01-0.12

FFV, computer-aided design and computer-aided manufacturing-fabricated feldspathic veneer; HCV, computer-aided design and computer-aided manufacturing-fabricated hybrid ceramic veneer; LCR, layering with composite resin; LDV, computer-aided design and computer-aided manufacturing-fabricated lithium disilicate veneer.
$P < 0.05$

Table 2 . Mean, Maximum and Minimum Fracture Strength Values (N), Standard Deviation with Statistical Differences Between the Groups ($P < .05$)

Group	Mean ± Standard Deviation	Minimum-Maximum
LCR	$931.95^b \pm 128.09$	704.16-1168.45
LDV	$1245.82^a \pm 197.75$	977.07-1658.68
HCV	$1134.60^a \pm 196.93$	796.49-1392.63
FFV	$620.58^c \pm 114.02$	458.37-788.03

FFV, computer-aided design and computer-aided manufacturing-fabricated feldspathic veneer; HCV, computer-aided design and computer-aided manufacturing-fabricated hybrid ceramic veneer; LCR, layering with composite resin; LDV, computer-aided design and computer-aided manufacturing-fabricated lithium disilicate veneer.
$P < 0.05$

Table 3. Fracture Pattern of the Crowns in Each Group

Group	Adhesive Failure	Cohesive Failure	Mix Failure
LCR	10		
LDV	6	4	
HCV	7	3	
FFV	5		5
Total	28	7	5

FFV, computer-aided design and computer-aided manufacturing-fabricated feldspathic veneer; HCV, computer-aided design and computer-aided manufacturing-fabricated hybrid ceramic veneer; LCR, layering with composite resin; LDV, computer-aided design and computer-aided manufacturing-fabricated lithium disilicate veneer.

strength of PEEK crowns. Therefore, the null hypothesis of the present study was rejected.

The chemical composition and low surface energy of PEEK may give rise to bonding problems with resin composites despite being increasingly used in dental practice. Therefore, PEEK surfaces should be treated for adequate bond strength to resin composites for restorative applications. According to Çulhaoğlu et al,[7] shear bond strengths higher than 10 MPa would be accepted as sufficient. For that purpose, from airborne particle abrasion to laser irradiation, some viable surface treatment modalities may improve PEEK material bonding. Sandblasting is a commonly used surface treatment method that cleans the surface, increases the bonding area,[19] and increases the surface wettability.[6] Sandblasting is reported to increase the bond strength between composite resin and PEEK and is recommended for the surface conditioning of PEEK.[20-22] Thus, the bonding surfaces of PEEK frameworks were sandblasted in the present study. Also, the usage of adhesive systems is essential for bonding between PEEK and veneer materials.[5,14,15,18] Additionally, the chemical composition of the adhesive system influences the adhesive strength between the PEEK and veneering materials.[12,14] Most studies showed that methylmethacrylate-based adhesives provide an adequate bond to PEEK.[12,19,23,24] Therefore, visio.link PMMA & Composite Primer was used at the PEEK veneer interface, considering the manufacturer's suggestion and instructions. According to the manufacturer's instructions, the inner surfaces of the CAD/CAM veneers were etched to provide mechanical bonding and increase the bonding area. Due to thermal aging volumetric changes, mechanical stresses and cracks can occur at the core and veneer interface and veneer edges, affecting the fracture strength values.[3,5] All crowns were subjected to thermomechanical aging to simulate intraoral conditions.

Microleakage is the migration of saliva, molecules, bacteria, and/or ions between the hard dental tissues and a restorative material or between 2 materials. Microleakage occurs when the adhesion at an interface is missed due to insufficient bond, thermal and mechanical stresses, or lack of accuracy during laboratory fabrication.[25] Previous studies have evaluated marginal gap and marginal adaptation associated with PEEK crowns; however, there has been no adequate study about microleakage between the PEEK core and its veneers.[26,27] The present study evaluated the microleakage between the core and different veneering materials. The results indicate that the type of the veneering material and the veneering procedure applied were effective factors in microleakage at the core veneer interface. The highest microleakage was observed for the LCR group (0.56 ± 0.21 mm^3), while the lowest microleakage was observed in the HCV group (0.02 ± 0.01 mm^3). As a result, less microleakage detection in all CAD-CAM veneering demonstrated that bonding the veneer material with resin cement reduces leakage compared to the conventional layering process. This result can be attributed to because of the larger polymerization shrinkage towards the light source when the resin veneer material with a larger volume is polymerized on the PEEK core, and thus the breakdown of adhesion between the surfaces in the LCR group. On the other hand, the high compatibility of digitally manufactured veneers and the filling of strong resin cement between the PEEK cores and the veneers reduced microleakage in veneering groups.

Sintering shrinkage seen in pressed PEEK substructures is avoided in CAD/CAM PEEK substructures, leading to compatible margins. Additionally, higher fit and trueness are reported for CAD/CAM fabricated PEEK.[28] Misfit of margins can adversely affect not only microleakage properties but also fracture strength. Also, CAD/CAM milling was reported to produce higher fracture strength than pressing.[3-5] The CAD/CAM milling PEEK substructure was used in this study because of its advantages compared to pressed PEEK.

Maximum masticatory load at the molar region is reported to reach up to 900 N.[29,30] Fracture load values reported for composite layered PEEK in previous studies are acceptable for posterior use. For example, Jin et al[31] reported a fracture load of 1518 N for 3-unit composite layered modified PEEK restorations following aging (5000 thermal cycles of 5°C-55°C, mastication simulation of 4.9 N load for 10 minutes). Also, Shetty et al[10] reported that higher fracture resistance was obtained with composite-layered PEEK crowns than composite-layered zirconia crowns. The mean fracture strength of composite layered PEEK was 2134.64 MPa before thermocycling and 1765.01 MPa after thermocycling (5000 cycles of 5°C-55°C). Taufall et al[4] evaluated fracture loads of different veneered PEEK fixed partial dentures. They used CAD/CAM fabricated composite resin veneer, 2 different composite resins as conventional composite veneers, and premanufactured veneers under thermocycling conditions from 5°C to 55°C for 10 000 cycles. They reported that the highest fracture load was obtained with CAD/CAM fabricated veneers (2021 N). The superior mechanical properties of milled composites are explained by providing a more homogenous structure and higher material quality. Moreover, the stability of CAD/CAM fabricated veneers is explained by eliminating faults in the manufacturing process. The only manual step during application is the bonding of the veneer to the PEEK framework for this technique.[4,29] In the present study, the mean fracture strength value was 931.95 MPa for the LCR group, while mechanical aging was applied in addition to thermal aging. Considering the artificial aging parameters of the present study are more difficult, it is seen that the results obtained for layering are similarly scaled to these studies. Similarly, Ghodsi et al[32] reported a mean fracture resistance of 843.56 N for composite veneers on PEEK abutments in a study that compared zirconia and PEEK abutments with thermomechanical aging (3000 cycles, 5°C-55°C and 500 000 cycles, 50 N force).

As seen, CAD/CAM fabricated and layered composite veneers were evaluated in previous studies. In addition, some studies evaluated the sole fracture resistance of ceramic or hybrid veneering materials.[33,34] However, there is inadequate information about other CAD/CAM fabricated veneers for PEEK, especially lithium disilicate or feldspathic ceramics. Although the strength of the material is an important parameter, when considered clinically, the compatibility between the core and the veneer in terms of the fracture strength of the restoration may also affect the result. In this study, the highest fracture strength was observed for the LDV group (1245.82 ± 197.75 N), while the lowest values were observed for the FFV group (620.58 ± 114.02 N). LDV and HCV groups showed statistically higher fracture strength values compared to the LCR group. The CAD/CAM groups with lower microleakage showed a higher fracture strength except for FFV. Nevertheless, the FFV group also presented the least adhesive failure compared with the other groups. Additionally, the LCR group presented fully adhesive failure. Accordingly, LDV and HCV groups could present more fracture strength through both their adhesive success and structural strength which depend on mineral contents like lithium disilicate. On the other hand, the FFV group and the LCR

group are less strong because of their fragile structure and less adhesion to PEEK cores respectively.

When fracture patterns were evaluated, the LCR group showed the highest adhesive failures associated with the highest microleakage values. CAD/CAM veneering groups, especially lithium disilicate and hybrid ceramic veneers, presented the lowest microleakage values. According to these results, it can be discussed whether the less adhesive failure between PEEK and the veneering materials indicates the lower microleakage at the veneer core interface. Nevertheless, even if thermomechanical aging used in this study is a good way to simulate clinical conditions, clinical studies are still needed.

CONCLUSION

Within the limitations of the present study, the use of CAD/CAM fabricated veneers can be an alternative to layering when its advantages are considered. Although this study could not imitate all clinical variations, it is thought that the use of CAD/CAM fabricated lithium disilicate and hybrid ceramic veneers can be an alternative to layering when its advantages are considered.

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Clinical Effect of Quadrant-wise Non-surgical Periodontal Treatment on Patients with Stage III Grade B and C Periodontitis

Kadran bazlı Cerrahi Olmayan Periodontal Tedavinin Evre III Derece B ve Derece C Periodontitis Hastalarındaki Klinik Etkisi

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ABSTRACT

Objective: The aim of this study was to evaluate clinical effects of quadrant-wise non-surgical periodontal treatment in patients with stage-III grade-B and grade-C periodontitis.

Methods: Forty-five non-smoker individuals who were systemically healthy, including 15 periodontally healthy, 15 stage-III grade-B periodontitis participant, and 15 stage-III grade-C periodontitis participant, were involved in this study. At baseline, plaque index, gingival index, probing depth, clinical attachment level, and bleeding on probing were evaluated for all participants, and in periodontitis groups, probing depth measurements were categorized as intermediate (4-6 mm) and deep (>6 mm), and the percentages of all categorized probing depths were calculated. Quadrant-wise non-surgical periodontal treatment was performed in both periodontitis groups, and clinical measurements were performed again 1 and 3 months after quadrant-wise non-surgical periodontal treatment.

Results: At baseline, periodontitis was higher in stage-III grade-C group than stage-III grade-B group ($P < .05$), whereas plaque index, gingival index, bleeding on probing, and clinical attachment level were similar between 2 groups ($P > .05$). All clinical parameters improved from baseline to 1 and 3 months in all periodontitis groups ($P > .05$). The reduction of percentage of the regions with probing depth of 4-6 mm from baseline to 3 months was higher in stage-III grade-B group than stage-III grade-C group ($P < .05$). As compared to the stage-III grade-B group at 1 and 3 months, the percentage of sites with probing depth ≥ 5 mm and BOP+(%) was higher in the stage-III grade-C group ($P < .05$).

Conclusion: According to residual probing depth and deep periodontal pockets, the clinical response of quadrant-wise non-surgical periodontal treatment was superior in stage-III grade-B periodontitis group than stage-III grade-C periodontitis group, and there was a need for periodontal surgical treatment after quadrant-wise non-surgical periodontal treatment in the stage-III grade-C periodontitis group

Keywords: Dental scaling, periodontitis, root planing

ÖZ

Amaç: Bu çalışmanın amacı, evre III derece B (EIII-DB-P) ve derece C periodontitisi (EIII-DC-P) olan hastalarda kadran bazlı cerrahi olmayan periodontal tedavinin (KCPT) klinik etkinliğini değerlendirmektir.

Yöntem: Bu çalışmaya periodontal sağlıklı 15 katılımcı, EIII-DB-P 15 ve EIII-DC-P 15 hasta olmak üzere sistemik olarak sağlıklı sigara içmeyen 45 birey dahil edildi. Başlangıçta, tüm katılımcılardan plak indeksi (Pİ), gingşival indeks (Gİ), sondalama derinliği (SD), klinik ataşman seviyesi (KAS), sondalamada kanama (SK) ölçüldü ve periodontitis gruplarında, SD ölçümleri orta 4-6 mm ve derin >6 mm şekilde kategorize edilerek kategorize edilmiş tüm PD'lerin yüzdeleri hesaplandı. Her iki periodontitis grubuna KCPT uygulandı ve KCPT'den 1 ve 3 ay sonra klinik ölçümler tekrar yapıldı.

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Bulgular: Başlangıçta SD, EIII-DC-P grubunda EIII-DB-P grubuna göre daha yüksek (*P* < ,05) iken Pİ, Gİ, SK ve KAS iki grup arasında benzer bulundu (*P* > ,05). Tüm klinik parametreler, her iki periodontitis grubunda başlangıca göre 1. ve 3. aylarda azaldı (*P* > ,05). SD = 4-6 mm olan bölgelerin yüzdesinin başlangıca göre 3 aya göre azalması EIII-DB-P grubunda EIII-DC-P grubuna göre daha yüksekti (*P* < ,05). 1. ve 3. ayda EIII-DB-P grubu ile karşılaştırıldığında, SD ≥ 5 mm ve SK+(%) olan bölgelerin yüzdesi EIII-DC-P grubunda daha yüksek bulundu (*P* < ,05).

Sonuç: Rezidüel ve derin periodontal ceplere bakıldığında, KCPT ile EIII-DB-P'de EIII-DC-P grubuna göre daha iyi klinik iyileşme meydana geldiği ve EIII-DC-P grubunda KCPT sonrası periodontal cerrahi tedaviye ihtiyaç duyulduğu görüldü.

Anahtar Kelimeler: Diş yüzey temizliği, kök yüzey düzleştirmesi, periodontitis

INTRODUCTION

Periodontitis is a chronic multifactorial destructive inflammatory condition that affects the tooth-supporting tissues. It is characterized by the development of periodontal pockets, loss of attachment, and resorption of the alveolar bone and may also cause tooth loss.[1] Therefore, it negatively affects masticatory function, aesthetics, and quality of life. Due to its high prevalence, periodontitis is a major health problem in the world. In 2018, periodontal diseases were reclassified.[2] Periodontitis is divided into 4 stages according to the severity, complexity, prevalence, and distribution of the condition and grades A, B, and C according to the rate of progression.[3] Early diagnoses of periodontitis is crucial for efficient treatment, controlling the disease's severity and progression, and improving person's quality of life by preserving their healthy teeth.

The main objectives of periodontal therapy are to prevent tooth loss and to manage spread and development of periodontitis. Non-surgical periodontal therapy (NPT) is accepted as gold standard and the initial stage in the treatment approach for patients with periodontitis.[4-6] Mechanical debridement was used to eliminate the periodontal pathogens and their byproducts. Scaling and root planing (SRP) are the fundamental NPT procedures that help to reduce gingival inflammation. Scaling and root planing is considered as the cornerstone of cause-related treatment. Nevertheless, SRP is technically challenging, and total calculus removal is daunting to perform.[4] According to previous studies, after SRP pocket depth (PD) decrease, resolution of inflammation, and clinical attachment (CA) gain were obtained in patients with periodontitis.[7,8] Moreover, NPT is particularly less effective in mobile teeth and/or in deep periodontal pocket and at posterior teeth with furcation involvements. Thus, residual PDs following NPT can be detected.[9] It has been reported that there is a decrease in PD ≥4 mm after NPT, and the severity of periodontitis decreased significantly 1 month after NPT.[10] Clinical studies and clinical practice frequently use surrogate outcomes like CA level (CAL), PD, or bleeding on probing (BOP) to predict disease progression and risk of tooth loss.[11] In the re-evaluation of NPT, site-specific factors such as BOP positive site, PD ≥5 mm, and CA loss are among the prognostic factors used in the evaluation of periodontal diseases.[9,11-14]

As far as we know, there were limited studies which investigated the clinical effects of NPT in participants with stage-III grade-B (SIII-GB-P) and C (SIII-GC-P) periodontitis.[15] The null hypothesis of the present study was that severe forms of SIII-GB-P and SIII-GC-P would respond clinically similarly to quadrant-wise NPT (QNPT). The purpose of this study was to investigate the effects of QNPT on clinical parameters in patients with SIII-GB-P and SIII-GC-P at 1 and 3 months.

MATERIAL AND METHODS

Study Design and Sample Size Calculation

This study was designed as a prospective controlled clinical trial. The study protocol was approved by the Marmara University Faculty of Dentistry, Clinical Study Ethics Committee (25.11.2021 and protocol number; 2021/27). According to the 2013 revision of the 1975 Declaration of Helsinki, all participants gave their written consent after being informed about the objectives and methods of the study before any recordings were made.

The PD was the study's primary outcome. The sample size was determined with a software application (G* Power Version 3.1.9.2, 2014, University of Kiel, Germany) using a previous study.[16] The minimum sample size for each group was calculated as 13 with a power of 80% at α error of 0.05 according to the PD difference of 0.59 mm between baseline to three months in the severe periodontitis group, assuming that the standard deviation is 0.68.

Study Population and Clinical Assessment

In the Periodontology Department, Dental Faculty, Marmara University, İstanbul, Türkiye, 45 systemically healthy and non-smoking volunteers between the ages of 30 and 55 (17 women and 28 men; mean age 39.89 ± 6.99 years) were registered for the current study between December 2021 and May 2022.

Dental and medical anamneses and panoramic radiographs were taken from all individuals, and the presence of systemic disorders, smoking, pregnancy or lactation, any periodontal therapy, and use of antibiotics or anti-inflammatory medicines during the previous 6 months were the exclusion criteria.

All patients who had 20 or more teeth were examined with periodontal clinical measurements including plaque index (PI),[17] BOP, gingival index (GI),[18] PD, and CAL, and radiographic assessment, except for third molars. PD was categorized as intermediate (4-6 mm) and deep (>6 mm), and percentages of all categorized PDs were calculated inperiodontitis groups.[19] The ratios of sites with PD ≥ 5 mm and BOP positive were evaluated before and after NPT in periodontitis groups.[12]

The periodontal diseases of the participants were determined according to the standards in the consensus report published in 2017. According to this, participants were separated into 3 groups.[3] Patients in the healthy group (n = 15) had BOP <10%, PD ≤3 mm, no attachment loss, and no radiological evidence of alveolar bone loss.[11] Inclusion criteria were patients with SIII periodontitis who had interdental CAL ≥5 mm, PD ≥6 mm, radiographic bone loss that extended at least to the middle third of the root but no periodontitis symptoms. They lost no more than 4 teeth because of periodontitis. In addition, because there was no clear

evidence of progression, the grade was determined based on the age and radiographic bone loss. The worst-affected tooth in the dentition was chosen, and radiographic bone loss was estimated as a percentage of root length and divided by the patient's age in calibrated and not imposed periapical radiographs. The patients (n = 15) were classified as having grade B if the percentage of bone loss/age was .25-1.0. The participants were assigned to the grade C group (n = 15) if percentage of bone loss/age was >1.0.[3]

A calibrated blinded examiner (SK) measured the clinical parameters from 6 sites of each tooth using a periodontal probe (University of North Carolina 15 periodontal probe, Hu-Friedy, Chicago, Ill, USA) at baseline and 1 and 3 months after QNPT. Intra-examiner calibration was performed on 7 patients with SIII periodontitis who were excluded from the study. PD and CAL were recorded 2 times 24 hours apart. For PD and CAL, the intra-examiner kappa scores were .93 and .91, respectively.

Non-Surgical Periodontal Therapy

After completion of initial clinical evaluations, patients with periodontitis received motivation and oral hygiene instructions (OHI) including modified Bass brushing technique and interproximal cleaning with dental floss or interdental brushes. A periodontist (HSY) carried out QNPT using manual (Gracey curettes, Hu-Friedy, Chicago, Ill, USA; 5-6, 11-12, 12-13) and ultrasonic (Woodpecker UDS-A, Cavitron, Guilin Woodpecker Medical Ins. Co., China) instruments. Four sessions of quadrant-wise subgingival SRP were performed under local anesthesia over the course of 4 weeks. Antibiotics and antibacterial drugs were not used during therapy. Throughout the study period, OHI and motivation were reiterated at every visit. Clinical evaluations were repeated in patients with periodontitis at 1 and 3 months after QNPT.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) 23.0 software (IBM Corp.; Armonk, NY, USA) was applied to analyze the data. The distribution of the parameters was evaluated using Shapiro–Wilk's normality test. Nonparametric tests were applied because of the variables' non-normal distribution. While qualitative data were presented as percentages, quantitative data were given as median, minimum, and maximum ranges. The Kruskal–Wallis test was applied to assess multiple intergroup comparisons; if significance was found, the Bonferroni-adjusted Mann–Whitney *U* test was performed to analyze pairwise comparisons. Multiple intragroup comparisons were applied with Friedman's test, and pairwise comparison with the Bonferroni-adjusted Wilcoxon signed-rank test was performed. $P < .05$ was considered statistically significant.

RESULTS

The demographic data for individuals are presented in Table 1. Gender distribution, age, and the number of teeth were similar among groups ($P > .05$). Clinical parameters are shown in Table 2. The baseline PI, BOP (%), GI, PD, and CAL of the SIII-GB-P and SIII-GC-P groups were higher than that in the healthy group ($P < .0001$). The periodontal measurements in both periodontitis groups were similar at baseline and 1 and 3 months after QNPT ($P > .05$), except for PD ($P < .05$). At the baseline and 1 and 3 months after QNPT, PD was higher in the SIII-GC-P group than in the SIII-GB-P group ($P < .05$). In periodontitis groups, all clinical measurements dramatically reduced from baseline to 1 and 3 months following QNPT ($P < .0001$). Nevertheless, comparing the SIII-GB-P and SIII-GC-P groups, from baseline to 3 months, there was no noticeable difference in the reductions of PI, GI, BOP (%), PD, and CAL ($P > .05$).

DISCUSSION

Chronic inflammatory conditions known as periodontal diseases affect the alveolar bone, gingiva, and other periodontal tissues around the teeth[1] and may arise as a consequence of the host's reaction to the pathogenic microorganisms and their products in the biofilm.[20] The clinical signs and symptoms of periodontal diseases include changes in the gingiva's color, consistency, and volume; gingival bleeding; formation of periodontal pockets; tooth mobility; loss of attachment and alveolar bone; and tooth loss.

In the new periodontal disease classification, periodontitis is divided into 4 stages as I, II, III, and IV according to its severity, including CAL, alveolar bone, or tooth loss.[3] In order to demonstrate the effectiveness of the QNPT, this study was performed in SIII patients with severe periodontitis and with at least 20 teeth. Although stage IV (SIV) periodontitis involves masticatory dysfunction in contrast to SIII periodontitis, multi-disciplinary treatments such as periodontology, orthodontics, and prosthetic therapy are required.[2] However, in SIV periodontitis, there are some factors that increase the complexity of periodontitis, such as tooth mobility, more tooth loss due to periodontal disease, and bite collapse, which affect the response to NPT,[3] and for these reasons, the present study was not performed in patients with SIV periodontitis. In addition, in the new classification of periodontal disease, periodontitis is subdivided into 3 grades as A, B, and C according to the progression rate of the disease.[3] The present study was conducted in patients with SIII-GB-P and SIII-GC-P with the same severity and different periodontal disease progression rate as moderate and rapid, respectively.

Non-surgical periodontal therapy is the first step in the treatment of periodontal diseases and performed to control the infection and contains OHI, mechanically removing supra and subgingival dental plaque and calculus with curettes and ultrasonic instruments, and application of antimicrobial agents if necessary.[4] There are different treatment methods in the application of NPT such as conventional QNPT,[21] full-mouth disinfection method using local antimicrobial drugs in 24 hours,[22] and full-mouth NPT without using antimicrobial drugs in 24 hours.[23] The conventional QNPT approach allows repeating OHI in each session and detailed

Table 1. Demographic Characteristics of Study Groups

	Groups			
	Healthy (n = 15)	SIII-GB Periodontitis (n = 15)	SIII-GC Periodontitis (n = 15)	P*
Age (years)				
Median (minimum–maximum)	43.0 (32.0-48.0)	44.0 (30.0-52.0)	39.5 (30.0-55.0)	.680
Gender n (%)				
Female	7 (46.7)	5 (37.5)	5 (33.7)	.746
Male	8 (53.3)	10 (62.5)	10 (66.7)	
Number of teeth				
Median (minimum–maximum)	28.0 (22.0-28.0)	27.0 (22-28)	26.0 (22-28)	.088

SIII-GB, Stage III Grade B; SIII-GC, Stage III Grade C.*Kruskal–Wallis or chi-square test; $P < .05$.

Table 2. Comparisons of Clinical Parameters Among the Study Groups at Baseline and 1 and 3 Months

		Groups						
		Healthy (a)	SIII-GB Periodontitis (b)	SIII-GC Periodontitis (c)				
		(n=15)	(n=15)	(n=15)				
	Time Points	Median (minimum–maximum)	Median (minimum–maximum)	Median (minimum–maximum)	(a-b-c)P^*	(a-b)$P^\dagger$	(a-c)$P^\dagger$	(b-c)$P^\dagger$
PI	Baseline	0.10 (0.00-0.27)	2.26 (2.02-2.93)	2.10 (1.54-3.00)	.000	.000	.000	.160
	1 month		0.15 (0.00-0.50)‡	0.02 (0.00-0.83)‡				.373
	3 months		0.05 (0.00-0.41)‡	0.17 (0.00-0.68)‡				.031
	$P^\sharp$	–	< .0001	< .0001				
	Δ0-3	–	2.22 (1.94-2.85)	2.01 (1.37-2.93)				.072
GI	Baseline	0.04 (0.00-0.27)	1.72 (1.34-2.40)	1.87 (1.27-2.08)	.000	.000	.000	.417
	1 month		0.11 (0.03-0.54)‡	0.18 (0.03-0.48)‡				.373
	3 months		0.07 (0.00-0.33)‡	0.08 (0.00-0.40)‡				.475
	$P^\sharp$	–	<.0001	<.0001				
	Δ0-3	–	1.65 (1.21-2.39)	1.78 (1.27-2.04)				.607
BOP (%)	Baseline	7.71 (1.92-9.26)	71.46 (47.02-100.00)	89.10 (100.00-26.67)	.000	.000	.000	.267
	1 month		12.16 (3.47-31.41)‡	21.43 (2.67-48.72)‡				.101
	3 months		10.00 (2.27-26.19)‡	14.49 (1.00-40.12)‡				.123
	$P^\sharp$	–	<.0001	<.0001				
	Δ0-3	–	61.52 (38.69-87.68)	67.95 (21.34-90.38)				0.635
PD (mm)	Baseline	1.92 (1.51-2.32)	3.71 (3.37-4.94)	4.74 (2.81-6.88)	.000	.000	.000	.010
	1 month		2.80 (1.98-3.35)‡	3.34 (1.94-4.42)‡				.025
	3 months		2.49 (1.47-3.06)‡,§	2.87 (1.24-3.76)‡,§				.042
	$P^\sharp$		<.0001	<.0001				
	Δ0-3		1.46 (0.66-2.44)	1.40 (0.44-3.05)				.692
CAL (mm)	Baseline	1.92 (1.52-2.32)	4.15 (3.60-5.85)	4.59 (1.69-6.66)	.000	.000	.000	.075
	1 month		3.19 (2.20-5.25)‡	3.57 (2.04-5.86)‡				.020
	3 months		2.96 (1.89-4.92)‡	3.40 (0.02-5.42)‡,§				.144
	$P^\sharp$		<.0001	<.0001				
	Δ0-3		1.26 (0.29-2.50)	1.13 (1.26-4.14)				.937

BOP, bleeding on probing; CAL, clinical attachment level; GI, gingival index; PI, plaque index; PD, probing depth; SIII-GB, Stage III Grade B; SIII-GC, Stage III Grade C.
*Kruskal–Wallis test, †Bonferroni-corrected Mann–Whitney *U* test or Mann–Whitney *U* test, ‡significant difference compared to baseline (Wilcoxon signed-rank test), ♯Friedman test, §significant difference compared to 1 month (Wilcoxon signed-rank test), $P < .05$.

SRP of a small number of teeth in 1/4 quadrant.[21] It has been also shown that the session duration of the full-mouth NPT method is longer than conventional QNPT. Additionally, conventional QNPT applied to 1/4 quadrant of mouth in each session was compared with full-mouth NPT procedure, for PD, BOP, and CAL measurements, neither of these 2 treatment methods was superior to the other.[24,25,26] The European Federation of Periodontology assessed the treatment techniques of stages I, II, and III periodontitis and prepared a guideline for clinical practice.[9] Subgingival instrumentation with curettes or sonic/ultrasonic instruments is suggested in this periodontal treatment guideline. Subgingival laser applications, local or systemic non-steroidal anti-inflammatory drugs are not recommended, and they stated that there is no enough data to support the use of subgingival antiseptics and antibiotics.[27] One of the study findings suggests that application of diode laser as an adjunct to mechanical periodontal treatment does not demonstrate any additional clinical effect on the residual pockets.[14]

It has been reported that various follow-up intervals, ranging from 2 weeks to 6 months, have been used to assess the clinical outcome of NPT.[28] The response of the soft tissues to the NPT reveals the efficacy of therapy. Waerhaug[29] reported that healing of the junctional epithelium occurs within 2 weeks after NPT, but the granulation tissue is still immature and has not been replaced by collagen fibers. It has been suggested that it would

Table 3. Comparisons of the Percentages of 4-6 mm, >6 mm Pocket Depths and ≥5 mm Pocket Depth with Bleeding on Probing Positive Sites within and Between Periodontitis Groups at Baseline and 1 and 3 Months

		Groups		
		SIII-GB Periodontitis	SIII-GC Periodontitis	
		n=15	n=15	
	Time Points	Median (minimum–maximum)	Median (minimum–maximum)	P^*
PD=4-6 mm (%)	Baseline	42.00 (23.00-66.00)	36.00 (12.00-42.00)	.041
	1 month	16.50 (5.00-80.00)‡	30.00 (5.00-51.00)‡	.338
	3 months	10.00 (0.00-26.00)‡,§	17.00 (0.00-25.00)‡,§	.072
	$P^\dagger$	.000	.001	
	Δ0-3	32.50 (8.00-66.00)	15.00 (5.00-34.00)	.008
PD >6 mm (%)	Baseline	4.62(1.86-15.00)	13.28 (7.86-20.00)	.024
	1 month	0.48 (0.00-1.49)‡	1.86 (0.56-7.51)	.000
	3 months	0.00 (0.00-1.94)‡	1.64 (0.68-5.00)‡	.002
	$P^\dagger$	.000	.000	
	Δ0-3	4.12 (1.86-15.00)	9.16 (5.30-19.23)	.063
PD ≥5 mm and BOP+ (%)	Baseline	22.45 (16.67-62.96)	45.51 (4.67-69.87)	.123
	1 month	2.38 (0.00-9.26)‡	8.93 (0.00-19.23)‡	.042
	3 months	1.27 (0.00-9.26)‡	4.93 (0.00-13.58)‡	.041
	$P^\dagger$	.000	.000	
	Δ0-3	20.83 (14.01-57.74)	39.51 (3.34-58.97)	.252

BOP, bleeding on probing; CAL, clinical attachment level; GI, gingival index; PD, probing depth; PI, plaque index; SIII-GB, Stage III Grade B; SIII-GC, Stage III Grade C. *Kruskal–Wallis test, †Bonferroni-corrected Mann–Whitney *U* test or Mann–Whitney *U* test, ‡significant difference compared to baseline (Wilcoxon signed-rank test), ♯Friedman test, §significant difference compared to 1 month (Wilcoxon signed-rank test), $P < .05$.

be appropriate to evaluate the healing of soft tissues 4-6 weeks after NPT, as the collagen fibers in the connective tissue mature completely in 4-6 weeks.[30] Moreover, the clinical severity of periodontitis significantly decreased 1 month after NPT. Decrease in PD and CAL gain have occurred within 1–3 months, and tissue healing was completed within 3 months after NPT.[20] Hence, it has been suggested that baseline and 3 months measurements can be used to evaluate the efficacy of NPT.[12] Therefore, this study aimed to clinically assess the response of SIII-GB-P and SIII-GC-P patients with the same severity and different periodontal disease progression rate to QNPT at 1 and 3 months.

Clinical parameters used to determine periodontal disease severity, response to treatment, and disease activity are useful for assessment. In this study, PI, GI, BOP, CAL, and PD parameters were examined to diagnose periodontal disease and evaluate the effectiveness of NPT. Removal of dental plaque containing periodontopathogens from the tooth surface and providing oral hygiene for patients play an important role in evaluating the effectiveness of NPT.[26] Hence, PI was recorded to determine dental plaque accumulation and to evaluate oral hygiene in our study. In the present study, the PI of the healthy group at the baseline was found to be lower than the SIII periodontitis groups. Comparable to previous studies, in the present study, baseline PI was higher in the SIII periodontitis group than in the healthy group.[21,31] In the comparison of PI values within the group, decreases were found in the SIII-GB-P and SIII-GC-P groups at 1 and 3 months following QNPT. These PI improvement findings of this study are also consistent with the data of other previous studies.[32,33] As a result of removing the dental plaque and providing oral hygiene with NPT, a decrease in the PI occurs. In patients with SIII periodontitis, the decrease in PI during the follow-up periods after NPT and reaching the PI level of healthy individuals show that patients with periodontitis maintain adequate oral hygiene after NPT.

Gingival index is a clinical parameter used to evaluate the color and consistency of the gingiva and the presence of bleeding to determine the level of inflammation.[18] Moreover, BOP is recorded as a percentage and reveals objective information about inflammation in the gingival sulcus or periodontal pocket.[34] In this study, GI and percentage of BOP were higher in SIII periodontitis groups than the healthy group. In previous studies involving patients with SIII-GB-P and SIII-GC-P, the clinical effect was evaluated in conventional NPT, and similar to our study findings, it was observed that GI and BOP percentages of the groups with periodontitis were higher than that in healthy individuals.[32,35] The GI and percentage of BOP within the groups decreased in the SIII-GB-P and SIII-GC-P groups at 1 and 3 months in our study. Previous studies including patients with periodontitis reported a reduction in GI and percentage of BOP after NPT, parallel to our present study results.[31] The reduction in GI and percentage of BOP was associated with the healing of the soft tissue wall of the gingival sulcus due to the resolution of inflammation after NPT. Thus, GI and BOP might be utilized to distinguish between periodontal health and disease sites and patients.

At the examination session, the measurement of PD is used for detecting the existence of periodontal disease and to estimate the degree of soft tissue loss. On the other hand, the CAL is used for measuring periodontal destruction up to the clinical examination. Thus, effective assessment can be made when PD and CAL parameters are measured together in the evaluation of an individual's past and present periodontal status and clinical response to NPT.[24] When compared to the SIII-GB and SIII-GC groups at baseline, the healthy group's PD and CAL were found to be considerably lower. These findings are consistent with previous studies.[32,36] The PDs in the SIII-GC-P group were higher than that in the SIII-GB-P group at the baseline and 1 and 3 months. Although patients with SIII-GB-P and SIII-GC-P are at the same age, deep PD in the SIII-GC-P group before NPT may be explained by severe and excessive soft and hard tissue loss. Throughout 1 and 3 months following NPT, compared to baseline, both periodontitis groups in the current study demonstrated a decrease in CAL and PD. In the other previous studies, PD and CAL outcome also were similar to our findings.[35,37] As a result of NPT, the inflamed connective tissue transforms into organized and tight tissue rich in collagen, and a decrease in PD and attachment loss might be observed clinically with the formation of long junctional epithelium and the increase in the number of collagen fibrils in the connective tissue.[38]

As the PD comprises the average of the full mouth, it includes both healthy (PD <4 mm) and diseased areas (PD ≥4 mm). It is known that the response to NPT varies in different PD categories.[5] Suvan et al[14] in their meta-analysis defined sites with PD of 4-6 mm as medium pocket depth and sites with PD >6 mm as deep pockets. The residual pocket definition is used for areas with PD ≥5 mm + BOP after NPT, and it has been reported that CA loss continues with disease activity.[11,12] In the present study, at baseline, the percentage of sites with PD of 4-6 mm was higher in SIII-GB-P group than in SIII-GC-P group, whereas the percentage of sites with PD >6 mm was detected lower, and percentage of sites with PD ≥5 mm + BOP was found to be similar in both periodontitis groups. In addition, the percentage of sites with PD ≥5 mm + BOP and PD >6 mm in the SIII-GC-P group were found to be significantly higher compared to the SIII-GB-P group in each period after NPT. According to recent research, it may be challenging to completely remove subgingival biofilm and calculus from teeth with deep probing depths (>6 mm) or complex anatomical surfaces, such as root concavities, furcations, or infra bony pockets. As a result, additional treatment may be necessary to help patients with periodontitis reach the endpoints of NPT. After a healing time, the individual response to the NPT should be evaluated. The surgical stage of treatment should be used if the NPT objectives of no periodontal pockets >4 mm with bleeding on probing or deep pocket depth 6 mm have not been met.[27] According to our research, the SIII-GC-P group had a substantially larger percentage of sites with PD 5 mm + BOP and PD >6 mm than the SIII-GB-P group at 1 and 3 months after NPT. These results indicate that SIII-GC-P did not meet the NPT objectives and that additional surgical therapy may be performed on this patient. In our study, similar to other studies, improvements were observed in the percentage of regions with PD of 4-6 mm, PD >6 mm, and PD ≥5 mm + BOP in both periodontitis groups at the 1 and 3 months than baseline.[37,38] In the meta-analysis of Citterio et al,[39] it was reported that residual pockets may remain at a rate of 11.71% after NPT. The baseline PD, tooth root anatomy and surface structure, and clinician's experience have an impact on success of mechanical instrumentation.[25] Deep periodontal pockets are most challenging areas for removing all calculus and biofilm. According to Meseli et al,[13] favorable associations between initial PD and PD decrease, GR increase, and attachment gain were found while analyzing the effects of NPT on clinical parameters. Badersten et al [25] reported that residual pockets with an initial PD greater than 6 mm can still contain up to 44%

of calculus. Since NPT may be insufficient especially in furcation areas of molars, groves, deep pockets, and mobile teeth,[4,7] residual pockets are likely to remain following the NPT.[40] Consequently, the elimination of residual pockets is an important parameter that is used to evaluate the success of NPT.

One of the limitations of the current study may be the lack of all periodontitis grades or stages. It should be highlighted that while all the participants were non-smokers and systemically healthy, our results might not fully reflect the prevalence of periodontitis in the general population. The present study's short follow-up periods was another limitation. Therefore, a further study including patients with all stages and grades of periodontitis with longer follow-up would reveal the clinical effect of QNPT in periodontal diseases.

According to the findings of this study, it was revealed that all clinical parameters were dramatically improved following QNPT in the SIII periodontitis groups. The clinical response of QNPT was superior in SIII-GB-P than in SIII-GC-P group by residual pocket depths and deep periodontal pockets, and there was a need for periodontal surgical treatment after QNPT in the SIII-GC-P group.

Ethics Committee Approval: Ethics committee approval was received for this study from the clinical study ethics committee of Marmara University Faculty of Dentistry (Date: November 25, 2021, Protocol Number: 2021/27).

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Midede *H. pylori* Eradikasyon Oranları Oral *H. pylorinin* Dişeti (Periodontal) Tedavisi ile Eliminasyonu ile Artırılabilir mi? Literatür Taraması

Can Gastric *Helicobacter Pylori* Eradication Increase by Eradication of Oral *Helicobacter Pylori* by Periodontal Treatment? Literature Review

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ÖZ

Periodontal hastalıklar dişi destekleyen dokularda görülen dişler üzerinde yerleşen lokalize mikrobiyal dental plağın sebep olduğu yerkürede oldukça sık rastlanan kronik enfeksiyon hastalıklardır. Tedavi edilmediğinde zamanla alveolar kemik kaybı, ataçman kaybı ve dişlerde fonksiyon kaybına neden olabilir ve nihai olarak ise diş kaybı meydana gelebilir. *H. pylori* midede ve gastrointestinal sistemde kolanize olabilen Gr- spiral şekilli bir patojendir. Kronik gastrikten gastrik kansere kadar geniş yelpazede hastalıklara sebeb olabilir Bu nedenle bu potansiyel zararlı bakterinin eliminasyonu önemlidir. Klasik sistemik *H. pylori* eradikasyon tedavisi başlangıçta başarılı olmasına rağmen, artan antibiyotik direnci ve yan etkiler nedeniyle klinik ortamda başarı oranları düşürmüştür. Ayrıca artan rekürens oranları araştırmacıları, *H. pylori* için potansiyel ikincil kolonizasyon odağı aramaya itmiştir. Oral kavitede dental plaktan bu bakterinin kültüre edilmesinden sonra, araştırmalar oral kavitenin *H. pylori* için potansiyel barınak olup olamayacağı hipotezine yönelmiştir. Takip eden çalışmalar *H. pylori*yi oral kavitede tespit edildiğini hatta oral *H. pylori* prevelansının mideden daha yüksek olduğunu bulmuştur. Özellikle dental plak içindeki *H. pylori*ye bir biyofilm yapısı içinde yer aldığından sistemik antibiyotikler etkili olamaz. Bu nedenle periodontal hastalıktaki gibi mekanik olarak uzaklaştırılması gerekir. Nitekim, klinik çalışmalar midedeki *H. pylori* enfeksiyon tedavisinin midedeki bakteriyi eradike ederken oral kavitedeki bakteriye etki etmedigi gösterilmiştir. Gittikçe artan çalışmalar periodontal tedavinin gastrik *H. pylori* eradikasyon tedavisiyle eş zamanlı olarak uygulandığında tedavinin başarısını artırdığını göstermektedir. Bu nedenle gastroenterologlar ile diş hekimlerinin koordineli bir şekilde çalışması gastrik *H. pylori* eradikasyon tedavisinin başarı oranlarını artırabilir. Bu derlemenin amacı oral *H. pylori* varlığı konusundaki delilleri ve ilave periodontal tedavinin mide eradikasyon tedavisine katkısı konusunda en güncel araştırmaları gözden geçirmektir.

Anahtar Kelimeler: Periodontal Tıp, *Helicobacter pylori*, Periodontal tedavi

ABSTRACT

Periodontal diseases are chronic infectious diseases caused by microbial dental plaque localized on teeth. Periodontitis is very common worldwide. When not treated, it can cause alveolar bone loss and attachment loss and lead to loss of function in teeth over time, and the final picture may be tooth loss. *Helicobacter pylori* is a spiral-shaped pathogen that can cause a wide range of diseases ranging from chronic gastric to gastric cancer, primarily colonized in the stomach and gastrointestinal system. Therefore, elimination of this potentially harmful bacterium is important. Although initially conventional systemic eradication therapy was successful, increasing antibiotic resistance and side effects decreased their success rates in the clinical setting. Additionally, increasing recurrence rates have prompted researchers to seek for alternative reservoirs for *Helicobacter pylori*. After isolation of *Helicobacter pylori* from dental plaque by culture method, researchers conducted trials to see whether the oral cavity could be a potential shelter for *Helicobacter pylori*. The following studies have detected *Helicobacter pylori* in the oral cavity. Interestingly, the *Helicobacter pylori* prevalence was higher in the oral cavity than in the stomach.

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Systemic antibiotics do not affect particularly *Helicobacter pylori* in dental plaque due to its biofilm structure. Therefore, it must be removed mechanically as in periodontal disease. As a matter of fact, clinical studies have shown that *Helicobacter pylori* infection treatment eradicates the bacteria in the stomach but does not affect the bacteria in the oral cavity. Moreover, clinical studies showed that periodontal treatment increases the success rate of gastric eradication therapy when used as an adjunct to the conventional triple eradication therapy. Based on these data, coordination of gastroenterologists with dentists may increase the success rate of gastric *Helicobacter pylori* eradication treatment. Therefore, the aim of this review is to discuss the existing evidence for the presence of *Helicobacter pylori* in the oral cavity and the contribution of periodontal treatment as an adjunct to gastric *Helicobacter pylori* eradication therapy.

Keywords: *Helicobacter pylori*, periodontal medicine, periodontal treatment

Periodontitis dişi destekleyen destek dokuların yıkımı ile karakterize diş üzerine yerleşen mikrobiyal dental plağın disbiyozinin sebeb olduğu enfeksiyoz hastalıktır.[1] Tedavi edilmediği zaman nihai tablo diş kaybıyla sonuçlanabilir. Dental plak, diş yüzeyinde bulunan bakteri ve tükürük kaynaklı organizmaları içeren, polimer bir matriktir.[2] Bir biyofilm olan dental plak antimikrobiyal ajanlara duyarsızlığı nedeni ile önem taşır. Biyofilm içersindeki bakterinin antimkrobiyal ajanlara minimal inhibitör konsantrasyonunda laboratuar kültürüne göre 500 kat daha dirençli olduğu bulunmuştur.[3] Oral kavite mikroorganizmaların barınması için elverişli bir ortamdır 700 den fazla bakteri türü bu bölgede yaşayabilirken 400 üzerinde tür ise periodontal cepte tespit edilmiştir.[4,5] Herhangi bireyde ise yaklaşık 100–200 tür bulunur.[6] *Helicobacter pylori (H. Pylori)* dental plaktan kültür yöntemiyle elde edilmesi,[7] oral kavitenin *H. pylori* enfeksiyonları için potansiyel bir rezervuar olabileceği görüşünü ortaya çıkarmıştır.

H. pylori mide ve duodenum'un çeşitli alanlarında yerleşerek kronik gastritis, peptik ülsere yolaçabilen önemli bir gastrointestinal patojendir.[8] Ayrıca, mide kanseri ve gastrik lenfoma (MALToma: Mucosa Associated Lymphoid Tumor), riskini artırdığı, gösterilmiştir.[9] Dünya Sağlık Örgütü (DSÖ) bu bakteriyi grade I kanserojen olarak tanımlamaktadır.[10] Mide kanserinin dünya genelinde en sık görülen ikinci ölümcül ikinci ölümcül kanser türü olması bu bakterinin önemini artırmaktadır.[11] Ayrıca, H. pylori enfeksiyonu açıklanamayan demir eksikliği anemisi,[12] idiopatik trombositopenik purpura,[13] felç[14] ve kardiovasküler hastalıklarla[15] ilişkilendirilmiştir.

Dünya nufusunun yaklaşık yarısının *H. pylori* ile enfekte olduğu tahmin edilmektedir.[16] Bununla birlikte bu patojenin prevelansı ülkeler arasında değiştiği gibi ülkelerin değişik bölgelerinde de farklılık göstermektedir.[8] Ülkemizde; prevelansı %41–96 arasında rapor edilmiştir (Sokucu ve ark., 2002; Aksoy ve ark., 2003; Uzunismailgil ve ark., 2004; Karaaslan ve ark., 2003).

Marshall ve Warren'ın[17] midede *H. pylori* varlığını keşfetmesinden sonra gastrointestinal hastalıklar enfeksiyon hastalıkları olarak kabul edilmiştir.[16] *H. pylori* enfeksiyonunun tedavisi diğer ilaçlarla birlikte antibiyotik tedavisi içermektedir. Tüm dünyada ve ülkemizde proton pompa inhibitörü,[13] klaritromisin, amoksisilin (veya Metronidazol) içeren kombinasyonlar halen hâlen birincil tedavi seçenekleri olarak kullanılmaktadır.[16] İlk başlarda bu kombinasyonlardan elde edilen başarı oranları oldukça yüksek olsa dason yıllarda ülkemiz dahil olmak üzere belirgin düşüşler ve rekürensler yaşanmıştır. Yapılan tek kür tedavisi %90 başarı oranı ideal olmasına rağmen,[18] kontrollu randomize çalışmaların sonuçlarır %73–87 arasında bir başarı oranının daha yaygın olduğunu göstermektedir. Günlük uygulamada ise bu oran uygulanan rejime yada hekimin ilgisine göre %64 veya daha düşük olabilmektedir.[18]

Standart üçlü tedavisinin başarı oranının düşük olması nedeniyle; *H. pylori* eradikasyonunu artırmak için ardışık tedavi, dörtlü tedavi, hibrid tedavi, bizmut bazlı dörtlü tedavi gibi alternatif tedavi rejimleri uygulanmıştır,[19] Bununla birlikte bu tedavi rejimlerinde de zamanla bakteri eradikasyon oranını azaldığı gözlenmiştir.[20] Burada, antibiyotik direnci, hasta uyumu, bakteri virulansı ve yogunlugu, cografi özellikler, genetik farklılıklar gibi pek çok faktörün rol aldığı düşünülmektedir.[16,19]

Ayrıca, *H. pylori*'nin sebep olduğu gastritin tedavi sonrası sık tekrarlaması araştırmacıları sürekli kontaminasyon yapan gizli bir odak arayışına yönlendirmiştir.[21] Helikobakter pilorinin mideye buluşma yolları, rezervuarları ve yayılma yolları hakkında çok az bilgi olmasına ragmen, bakterinin dental plakta,[7] dilin dorsumunda ve tükürükte tespit edilmesi oral kaviteyi hastalığın yayılmasında,[22,23] eradikasyon tedavisinden sonra makul bir reinfeksiyon kaynağı yapmaktadır.

Günümüzde kullanılan tedavi yöntemleri *H. pylori* infeksiyonu midede etkili bir şekilde tedavi edebilmektedir. Ancak aynı tedavi yöntemleri dental plak üzerinde etkili değildir. [21,24-26] Dental plak biyofilm olduğu için hiç bir antibiyotik penetre olamaz.[2] Bu nedenle dental plak periodontal hastalıklarda olduğu gibi mekanik olarak ve oral hijyenle ortamdan uzaklaştırılmalıdır. *H. pylori* tedavisinde bu mikroorganizmanın rezervuarlarının ortadan kaldırılması tedavinin başarı oranını artıracağı gibi nüksünü de azaltacaktır.

Antibiyotiklere karşı gelişen direnç ve klasik tedavi protokolerinin klinik ortamda görülen düşük başarı oranları [8] araştırmacıları alterantif tedavi şeçekneklerini araştırmaya itmiştir. Çok sayıda randomize ve non randimeze kontrolu çalışmalar[27-31] ve meta-analizleri[32-34] periodontal tedavinin sistemik eradikasyon tedavisi ile birleştirilmesini ve periodontal tedavinin gastrik *H. pylori* eradikasyon tedavisine etkisini desteklemektedir. Ancak bu protokolün klinik uygulamaya yeri ve farkındalıgı sınırlıdır. Bu nedenle bu derlemede periodontal tedavinin gastrik *H. plori* eradikasyonu üzerine etkileri, oral *H. pylori*nin ve ağız bakımının gastrik *H. pylori* eradikasyon tedavisi üzerine olası etkileri konusundaki en güncel araştırmaları gözden geçirilecektir.

ORAL KAVİTEDE *H. PYLORI* VE GASTRİK ENFEKSİYONLAR ARASINDAKİ İLİŞKİ:

Mide dışında ağız ortamı da *H. pylori* için potansiyel bir barınak olarak görülmektedir. Çok sayıda çalışma *H. pylori*yi oral kavitede bulunduğunu göstermiştir.[23,35] Bu bulgularoral kavitenin *H. pylori* için potansiyel bir rezervuar olabileceğini görüşünü desteklemektedir.[35] *H. pylori*nin oral kavitede varlığı eradikasyon tedavisinin başarı şansını etkileyebilir ve aynı zamanda bu bakteri için bir reinfeksiyon kaynağı olabilir. Antibiyotikler midede *H. pylori*nin

eliminasyonuna katkıda bulunuken ağız ortamında özellikle mikrobiyal dental plağa bir biyofilm olduğu için etkili değildirler.[21,24,25].

Bu mikroorganizma ağız içinde çeşitli ortamlarda tespit edilmiştir. Örnegin; tükrük, dilin dorsumu, subgingival ve subragingival dental plak gibi alanlarda, ayrıca dental plak, periodontal cep, oral ülserlerin yüzeyleri ve oral neoplasmaların yüzeylerinde bulunmuştur.[22,23,36-38]. Ayrıca bu bakterinin ağız içinde dağılımın spesifik olduğu, ağzın farklı bölgelerinde farklı prevelansta bulunduğu rapor edilmiştir. Örnegin, *H. pylori* molar dişlerdeki plakta, premolar ve keser dişlerdeki plağa göre daha yüksek prevelansta tespit edilmiştir.[39] Bu durumun bakterinin mikro-aerofilik yapısından kaynaklanabileceği ileri sürülmüştür. Molar dişlerde oksijenlenme oranının keser ve küçük azılara göre daha az olabileceği, bununda bakterinin gelişimin destekleyebileceği düşünülmektedir.[39]

Özellikle *H. pylori*nin dental plaktan Krajden ve ark. tarafından (1989) yılında kültür yöntemiyle izole edilmesi, oral kavitenin oldukça önemli bir transfer kaynağı olabileceğini görtermiştir.[7] Subgingival plak, periodotal cebin sağladığı anaerob ortam sebebiyle *H. pylori* için uygun bir ortamdır. Dental plagın bir biyofilm olması konağın savunma sistemine karşı ek bir koruma sağlar. Ayrıca biyofilm içinde büyüyen bakteriler antimikrobiyal ajanlara karşı dirençlidirler.[40] Nitekim, klinik çalışmalar da üçlü eradikasyon tedavisinin midede oral kaviteden daha başarılı oldugunu göstermiştir. Oral *H. pylori*nin elimine edilmesinde etkisinin ya çok az ya da %40'ın altında olduğu rapor edilmiştir.[21,24,25]

Bu patojen hem periodontal açıdan sağlıklı olan hem de perio dontitishastalarada tespit edilmiştir. Ancak periodontal sağlıkta ve hastalıkta bu patojenin oranlarının farklı olduğu gösterilmiştir. Sağlıklı bölgede H. pylori miktarI %11 ikenperiodontitis hastalarında bu oranın % 50'ye kadar arttığı belirlenmiştir.[41]

Ağız ortamındaki *H. pylori* ve mide ortamındaki *H. pylori*nin aynı bakteri olup olmadığını test etmek amacıyla; gastrik biyopsi örneklerinden alınan *H. pylori* ve oral kavitede elde edilen örnekler PCR,PCR –restriction endonüklez, çözünür protein elektroforezi[42] ve scanning eleron mikroskobu[43] gibi farklı yöntemler kullanılarak karşılaştırılmış ve her iki örnekten alınan bakteri DNA örneklerinin benzer olduğu tespit edilmiştir.

Literatürde kronik gastriti olan hastaların dental plağında (%92) midelerinden (%61) daha yüksek oranda *H. pylori* bulunduğu gösterilmiştir. Bu da oral bakteri kolanizasyonunun ilk ağızda başlayabileceğini ve mide enfeksiyonunun bu kolonizasyonda sonra olabileceğini işaret etmektedir.[44]

Bu verilerle paralel olarak 22 çalışmanın değerlendirildiği bir meta-analizinde[45] oral kavitede bakteri bulunması ile midedeki bakteri bulunması arasında güçlü bir korelasyon olduğunu göstermiştir. Bu araştırmada oral kavitesinde *H. pylori* bulunan hastalar (582) bulunmayan hastalar (486 vaka) ile karşılaştırılmış, ve oral *H. pylori* prevelansının midesinde bakteri bulunan vakalarda daha yüksek olduğu bulunmuştur (Odds oranı (OR) 3,61). Bu sonuçlar oral *H. pylori*nin gastrik *H. pylori* ile ilişkisini desteklemektedir. İlginç bir şekilde, bu meta-analizinde veriler *H. pylori*nin tespiti için kullanılan yöntemlere göre alt gruplara ayrılarak değerlendirildiğinde, PCR yönteminin en hassas yöntem olduğu (OR:15,6 mide ağız korelesyonu) kültür yönteminin ise en düşük sensitiviteye sahip olduğu gözlemlenmiştir.[45] Bu da bize farklı çalışmalardan elde edilen farklı sonuçların kullanılan yönteme bağlı olabileceği düşüncesini yansıtmaktadır.

Eğer ağızda bu bakterinin bulunması bir enfeksiyon kaynağı ise sistemik eradikasyon tedavisinin oral *H. pylori* negatif hastalarda daha başarılı olması gerekir. Bu teoriye paralel şekilde ağız ortamında *H. pylori* barındıran hastalar barındırmayan hastalara göre, sistemik eradikasyon tedavisinden sonra midede daha düşük eradikasyon oranı göstermiştir.[25] Ancak oral *H. Pylori'nin* kütür yöntemiyle elde edilememesi, ve bazı çalışmaların bakterinin canlı olmadığını ileri sürmesi, bu konuda bazı tartışmalara neden olmuştur. PCR yöntemiyle ağız ortamından elde edilen pozitif sonuçların baterinin canlılığını göstermediğini, reflü sonucu mideden ağız ortamında gelen bakteri parçalarından kaynaklanabilecegini iddia edilmiştir.[35] Ancak bu iddialar doğru olsaydı, ağız ortamındaki ölü *H. pylori*nin midedeki triple ilaç tedavisine herhangi bir etkisinin olmaması gerekirdi. Halbuki 22 çalışmadan oluşan meta-analizinde de görüldüğü gibi ağız ortamında *H. pylori* tespit edilen hastalarda midedeki *H. pylori* eradikasyon oranları daha düşük çıkmıştır.[45] Yine oral *H. pylori* oranlarının mide *H. pylori* oranlarından daha yüksek olması[44] canlı oral *H. pylori* varlığının delilleridir. Diğer deliller arasında üçlü eradikasyon tedavisinin midedeki *H. pyloriyi* elimine ederken ağız ortamında hala *H. pylori* tespit edilmesi sayılabilir.[35]

PERİODONTAL TEDAVİNİN GASTRİK *H. PYLORI* ERADİKASYONU ÜZERİNE ETKİSİ

Bu veriler ışığı altında bazı araştırmacılar oral kaviteden *H. pylori* eliminasyonun başarılı bir gastrik eradikasyon tedavisi için elzem olduğu hipotezini ileri sürdüler. Özellikle dental plakta bulunan *H. pylori*nin, periodontal hastalıklarda olduğu gibi dental plakla birlikte mekanik olarak uzaklaştırılmalıdır.[2,40,46] Bu nedenle bazı çalışmalar oral *H. pylori*nin mekanik periodontal tedaviyle uzaklaştırılmasının gastrik *H. pylori* eradikasyonuna etkisini incelemiştir.[32-34]

Sistemik eradikasyon tedavisine ilave olarak periodontal tedavinin, gastrik *H. pylori* eradikasyon oranlarını artırabileceğini gösteren ilk çalışma Zaric ark. tarafından Sırbistan'da gerçekleştirilmiştir. Bu çalışmada sistemik eradikasyon tedavisi periodontal tedavi ile eş zamanlı uygulandığında (%77,3) sadece konvansiyonel sistemik eradikasyon tedavisine kıyasla (%46,7) daha yüksek eradikasyon oranları elde edilmiştir.[47] Bunu takip eden ve dünyanın farklı bölgelerinde gerçekleştirilen hemen hemen bütün çalışmalar bu sonuçları doğrulamış ve triple tedaviye ilave edilen periodontal tedavinin gastrik *H. pylori* eradikasyon oranlarını artırdığını göstermiştir.(Tablo 1) bu çalışmalar arasında sadece 2

Tablo 1. Periodontal Tedavinin Sistemik Eradikasyon Tedavisine Katkısını Araştıran Çalışmalar

Araştırmalar	Triple	Triple + Diş Tedavisi	Takip Süresi
	Eradikasyon oranı (n)	Eradikasyon oranı (n)	
Zaric et al. 2009 Sırbistan	%47,6 (21)	%77,3 (22)*	3 ay
Jia et al. 2009a Çin	%17,95 (39)	%80,85 (47)*	6 ay
2009b	%15,69 (51)	%81,36 (56)*	6 ay
Gao et al. 2011 Çin	%73 (43)	%81,40 (37)	1 ay
	%32,4 (43)	%62,80 (37)*	12 ay
Song et al.2013 Çin	%78 (62)	%94,7 (53)*	1 ay
Sert et al. 2019 Türkiye	%51,06 (51)	%64,71 (47)	3 ay
	%87,60 (347)	%96,78 (342)	1 ay
Tayland	%84,73 (347)	%97,9 (342)*	12 ay

n: (denek sayısı); * istatiksel olarak sanlamlı fark

çalışmada,[27,31] sistemik eradikasyon tedavisi ile gerçekleştirilen periodontal tedavi, sadece sistemik eradikasyon tedavisi ile karşılaştırıldığında; 1 aylık eradikasyon oranları kombine periodontal tedavide daha yüksek olmasına rağmen istatiksel olarak anlamlı bir fark bulunamamıştır. Bununla birlikte, uzun dönemde (6 ay ve 12 ay) her iki çalışmada da ilave periodontal tedaviyle gerçekleştirilen eradikasyon oranlarında istatiksel olarak anlamlı fark bulunmuştur. (Tablo 1) Yüksel-Sert[29] ve arkadaşları bu bulgulara ek olarak eğer hastalar periodontal tedavi ile elde ettikleri sağlıklı ortamı iyi bir ağız hijyeni ile koruyabilmişlerse bu hasta grubunda ağız hijyeni kötü olan hastalara göre daha yüksek eradikasyon oranları bulunduğunu göstermiştir. Yüksel-Sert ve ark. çalışması periodontal tedaviye ilave olarak iyi bir oral hijyen sağlanmasının eradikasyon oranlarını daha da artırabileceğini göstermektedir. Ayrıca bu konuda yapılan bütün meta-analizlerde periodontal tedavinin midedeki *H. pylori* eradikasyonunun başarı oranlarını artırdığını göstermiştir.[32-34]

Farklı bölgelerde ve farklı toplumlardan elde edilen sonuçların hepsinin aynı yönde olması, ilave perioodontal tedavinin gastrik *H. pylori* eradikasyonundaki katkısını desteklemektedir. Mideden H. Pyloriyi etkin bir şekilde elimine etmek için kişinin ağız sağlığıda değerlendirilmelidir. Başarılı bir tedavi ancak bütün bakteri odakları elimine edilirse mümkün olur. Bu nedenle gastroenterologların ve diş hekimlerinin koordineli şekilde el ele çalışması hem günümüzde artan antibiyotik direncinin azalmasına hem de artan rekürenslerin azalmasına katkı sağlayabilir.

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Pediatric Dentistry During and After COVID-19

Covid-19 Süresince ve Sonrasında Çocuk Diş Hekimliği

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ABSTRACT

COVID-19 emerged in China in the last month of 2019 and caused a global pandemic. It was stated that it is more rapidly spreading and contagious than SARS-COV and MERS-COV. Aerosol and droplet spreading are the most common modes of transmission of COVID-19 and are a concern in most dental procedures. For this reason, the popularity of minimally invasive dental procedures is increasing due to the advantage of minimal aerosol formation and reducing the risk of COVID-19 cross-infection. Pediatric dentists may also prefer these procedures more frequently because of their high acceptability by children. This review article aims to explain the changes that may occur in dentistry and pediatric dentistry procedures as a result of the COVID-19 pandemic.

Keywords: COVID-19, aerosol, pediatric dentistry, minimally invasive dentistry

ÖZ

COVID-19, 2019 yılının son döneminde Çin'de ortaya çıkmıştır ve tüm dünyaya yayılarak pandemiye neden olmuştur. SARS-CoV ve MERS-CoV'a göre daha hızlı yayıldığı ve bulaştırıcılığının daha fazla olduğu belirtilmektedir. COVID-19'un en önemli bulaş yolu aerosol ve damlacık yayılımı ile olmaktadır. Hemen hemen çoğu diş hekimliği prosedürü de aerosol ve damlacık oluşmasına ve yayılmasına neden olabilmektedir. Bu nedenle hem diş hekimlerini hem de hastaları koruyabilmek ve çapraz enfeksiyon riskini azaltabilmek için aerosol oluşumunun hiç veya minimal olması avantajı nedeniyle minimal invaziv diş hekimliği uygulamalarının popülerliği COVID-19 pandemisiyle birlikte giderek artmaktadır. Çocuklar tarafından kabul edilebilirliğinin yüksek olması da çocuk diş hekimlerinin bu prosedürleri daha sık tercih etmesini sağlayabilmektedir. Bu derlemenin amacı COVID-19 pandemisiyle birlikte diş hekimliği ve çocuk diş hekimliği prosedürlerinde oluşabilecek değişiklikleri anlatmaktır.

Anahtar Kelimeler: Covid-19, aerosol, çocuk diş hekimliği, minimal invaziv diş hekimliği

INTRODUCTION

COVID-19 emerged in China in the last month of 2019 and caused a global pandemic. It is also called SARS-COV-2 because of its close phylogenetic resemblance to the SARS-COV, which caused a worldwide pandemic.[1] The virus is transmitted directly from an infected individual to healthy individuals through aerosols and droplets caused by close contact, speech, sneezing, and coughing.[2] Indirect transmission can also occur through the mucous membranes by touching the mouth, nose, or eyes because of surface contact with the droplets emitted by another infected person.[3] There are uncertainties and different studies regarding how long the virus remains infective in the external environment.[4]

In studies examining the genetic structure of COVID-19, variations and mutations have been observed over time. RNA viruses such as COVID-19 have high mutation rates and are likely to undergo mutations in order to evade host defense mechanisms.[5] The resulting mutations also raise questions about whether vaccines developed against the COVID-19 virus should be updated periodically.[6] According to the World Health Organization (WHO), mutating COVID-19 variants that have occurred are currently not resistant to vaccines, but it is possible that they develop a resistant phenotype earlier than expected. This possibility demonstrates that emerging new variants of COVID-19 should be followed closely.[7]

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COVID-19 in Children

The general source of transmission in children infected with COVID-19 is family contact. General COVID-19 symptoms in children include fever, dry cough, difficulty breathing, nasal congestion, and sore throat. Gastrointestinal symptoms such as vomiting, abdominal pain, and diarrhea occur more frequently in children than in adults.[8] It is stated that the clinical symptoms of COVID-19 in children are similar to those of influenza, and in most pediatric cases, recovery is observed within 1-2 weeks.[9] Hospitalization and death rates as a result of infection are reported to be lower in children compared to adults.[10,11] Children of all age groups can be infected with COVID-19, and there is no gender discrimination.[12] Since cases in children are generally asymptomatic, fewer cases may have been detected compared to adults. The WHO states that asymptomatic people have a lower risk of transmitting the virus compared to symptomatic patients, but asymptomatic patients may still increase the spread of the virus.[13] Recent studies also show that children are less affected by the spread of the virus than adults.[14]

Surprisingly, the number of pediatric COVID-19 cases is less compared with adults. The reason may depend on both the exposure rate and the host. Children are generally well taken care of at home. For this reason, exposure rates to viruses and pathogens are relatively lower than in adults. The fact that the maturity, level of development, and function of the COVID-19 cell receptor angiotensin-converting enzyme-2 (ACE-2) are lower in children than in adults can explain the less severe course of the disease. Children often have respiratory tract infections during the winter months, so they have greater resistance to viruses and higher levels of antibodies. Furthermore, a child's immune system is still in the development process and may respond to pathogens differently than the adult immune system.[12,15,16] In childhood, the innate immune system is more active and the rate of concomitant chronic diseases is lower.[17] In adults, the inflammatory response and cytokine storm are more intense than in children, so lung damage and a more severe course of the disease are more frequently observed in adults than in children.[18] Age-related decrease in the production of the hormone melatonin may also explain the milder infection in children compared to adults, as melatonin reduces oxidative lung injury and inflammatory cell migration during viral infections.[19]

Kawasaki syndrome, which affects many systems in which angular cheilitis and strawberry tongue are common,[20] is a seasonal and rare severe inflammatory disease that occurs mostly in children under the age of 5. The cause is unclear, but as yet, unidentified infectious pathogens may be the major cause. One serious complication of Kawasaki syndrome is coronary artery aneurysm, which can lead to arterial rupture, thrombosis formation, and myocardial infarction.[21] It has been observed that inflammatory syndrome-like clinical features similar to Kawasaki syndrome, which can affect over one system, occur in some children hospitalized with COVID-19 infection.[22] Many of the hypotheses regarding the cause are that some children may be genetically predisposed to have a stronger inflammatory response to certain viruses. It has been shown that viral factors and even COVID-19 may be effective in the emergence of Kawasaki syndrome.[23] Because of the increase in the accumulation of inflammatory cells due to the increase in ACE-2 in endothelial cells with COVID-19 infection, endothelial cell damage and dysfunction may occur, and therefore, COVID-19 may be a trigger for clinical features like those of Kawasaki syndrome.[21] Centers for Disease Control and Prevention (CDC) defined the clinical features, which can affect more than one system in children, including the heart, lungs, kidneys, brain, skin, eyes, or gastrointestinal organs, as COVID-19-associated multisystem inflammatory syndrome (MIS-C). It can cause a variety of symptoms in children, including fever, stomachache, vomiting, diarrhea, sore throat, rash, bloodshot eyes, or extreme fatigue. It is not yet known what causes this clinical picture, but the medical histories of these children do reveal that they have had the virus that causes COVID-19 or been in contact with someone with COVID-19.[24] The presence of oral or pharyngeal findings such as red and edematous lips and strawberry tongue may be early signs of MIS-C in children. Pediatric dentists can play an important role in both the early detection of MIS-C through its oral manifestations and the identification of oral lesions in children with confirmed MIS-C.[25]

Dentistry and COVID-19

Epidemiological studies have shown that COVID-19 is more contagious than SARS-COV and MERS-COV.[26] Therefore, clinics and consulting rooms cannot continue to operate as they did in the period before the epidemic, and dentists must take extra precautions. The following are some of the precautions that are being taken: evaluating and offering guidance to patients through telephone calls before they come to clinics, creating large and well-ventilated patient reception areas, establishing triage areas in clinics where patients are pre-checked and evaluated, using extra-oral high volume suction systems, negative pressure rooms, strict sterilization protocols, N95 masks, and other extra personal protective equipment, ensuring accurate and necessary appointment planning,[27] and also using rubber-dam isolation and the four-hand technique by working with an assistant. Some of the dental needs of patients can be satisfied through telephone conversations, photography, video conferences, and emails. These applications can also be employed as preventive treatment procedures.[28] Indeed, teledentistry is aimed at facilitating dental care and providing guidance, education, and treatment to patients without face-to-face meetings. Teledentistry also has various sub-groups such as teleconsultation, telediagnosis, telemonitoring, and teletriage.[29]

The use of mouthwashes before dental treatments can reduce the number of microorganisms in the patients' oral cavities. However, it has been reported that chlorhexidine mouthwashes are not effective because COVID-19 is very sensitive to oxidation.[30] Yet, a study conducted by Yoon et al[31] found that gargling with 15 mL of 0.12% chlorhexidine mouthwash suppressed COVID-19 for 2 hours. Another recent study showed that chlorhexidine along with flavonoid group agents had an inhibitory effect on some of the main protease regions that play a critical role in the life cycle of the virus that causes COVID-19.[32] The use of mouthwashes with oxidative properties such as 1% hydrogen peroxide or 0.2% povidone-iodine is recommended.[33] However, iodine allergies must be taken into consideration, and povidone-iodine should not be used in patients with iodine allergies[34] because it has higher virucidal activity than antiseptics such as chlorhexidine and benzalkonium chloride.[31] The use of 9 mL of 1% or 1.5% hydrogen peroxide mouthwash for 30 seconds before procedures has also been reported to be effective.[35] In addition, cetylpyridinium chloride, which is a quaternary ammonium compound, has been found to be effective against enveloped viruses such as coronavirus because it can disintegrate the viral capsule with its lysosomotropic mechanism.[31] In pediatric patients and disabled individuals who are not capable of using mouthwash, an

antiseptic mouthwash should be applied by wiping the inside of the mouth with the help of gauze.[28]

The use of air–water sprays should be avoided as much as possible because they may produce aerosols during the inspection.[36] Dental procedures that generate aerosols should not last longer than 45 minutes, and appointments should be set for 1 hour.[28] Clinics must also be ventilated for at least 15 minutes after each patient, and to increase aerosol dissipation, it is recommended that patients do not spit. Since the risk of exposure to the virus increases when the air conditioners available in clinics work with indoor air systems, central air conditioning systems that work with outside air and expel the air into the environment are preferred.[37] High volume evacuators (HVE) and high-efficiency particulate arresting (HEPA) filters can be used to clean the ambient air as well.[38] The use of ultraviolet light with wavelengths of 250-280 nanometers is also recommended for disinfecting the environment and surfaces.[39] Ozone gas, which consists of 3 oxygen atoms (O_3), is a strong oxidizing agent and antiseptic, and this gas can be used to treat contaminated surfaces, water, and ambient air. It has been reported that the application of ozone for 8-10 minutes is sufficient to destroy 99.9% of the viral particles that are suspended in the air.[40]

It has also been shown that when cavity preparations that cause aerosol formation with rotary instruments are performed using rubber dams, the aerosol spread is 70%-90% less.[33] To reduce aerosol formation during canal shaping, it is recommended that hand instruments be used instead of rotary instruments, and rubber-dam isolation is also necessary for crowns, bridges, and other prosthetic preparations. Changes such as the use of supra-gingival margins can be considered for rubber dams in treatment planning as well.[30] However, the split-dam technique may be preferred when gingival areas are involved, such as for Class V restorations, crowns, and bridge preparations.[41] It is also recommended that single-stage self-etching systems be used rather than total-etch systems as adhesive systems in patients for whom composite resin-containing filling materials will be applied because total-etch systems require multi-stage washing and drying processes. If problems arise in existing restorations, the option of repair should be considered as a priority over renovation.[42]

The aerosol formation can also be prevented by using techniques such as chemomechanical and atraumatic restorative treatments (ART) rather than rotary instruments in the caries removal process.[38] The removal of caries through chemomechanical techniques is a non-invasive method in which infected dentin is softened with a suitable chemical agent and removed with the help of hand instruments. This process not only ensures the removal of infected dentin but also preserves the healthy tooth structure and does not cause pulpal irritation. Because it does not require the application of local anesthesia or the use of burs, this process facilitates the removal of caries tissue in anxious and non-cooperative patients.[43] Studies that have compared the use of this method in primary, and permanent teeth have found that because the cavities are generally open in primary teeth, a reduced volume of solution is required, access to the cavities is easier, and caries can be removed more effectively.[44]

Care should be taken to avoid the nausea reflex during the measurement process, so the saliva ejector should be used carefully, and the size of the measuring spoon should be chosen appropriately. The gag reflex can be suppressed by applying a topical anesthetic to the oral mucosa.[38] Impression materials have also been cited as a source for infection transmission between clinical and dental laboratories.[45] In addition, intraoral methods of taking digital impressions are preferred over other methods because of the advantages they offer such as reducing stress and fear among patients, not causing the nausea reflex, not requiring plaster models, saving time and space, and providing laboratory safety.[46]

Extraoral radiographs are preferred over intraoral radiographs to avoid the risk of aerosol formation that may cause cough and vomiting reflexes,[47] but panoramic and cone-beam computed tomography (CBCT) require the patient to stand or sit still during the irradiation period, while intraoral radiographs can be used in patients in the supine position with a mobile x-ray device. The diagnostic quality of intraoral radiographs is higher than panoramic radiographs, and CBCT is not an alternative to intraoral radiographs due to its lower resolution, the visualization of artifacts from motion and metallic restorations, and much higher radiation dose.[48]

In patients undergoing orthodontic treatment, if there is a wound on the mucosa due to the bracket, the use of candles and mouthwashes is recommended. Applying topical anesthetic gels can reduce pain. In the presence of a broken or displaced fixed lingual arch, palatal arch, or expansion appliance, if the appliance is partially displaced, it is recommended to try to replace it; screw activations should be stopped until consultation with the orthodontist. If an appliance has completely exited, the patient should store it in a safe place until seeing the orthodontist.[49] The presence of an orthodontic appliance embedded in the gingiva causing severe pain and infection is an emergency; the patient should immediately consult the orthodontist.[50]

Performing dental treatments under sedation can be risky during a COVID-19 outbreak. For example, in inhalation sedation using nitrous oxide and oxygen gases, aerosols are produced by the flow of gases in a semi-closed circulation, and aerosols can easily spread when the nasal mask is not completely sealed.[51] For the application of inhalation sedation, the nose cap should be chosen in such a way that there is no space for the patient, and all sterilization rules should be strictly followed. An extraoral vacuum device can reduce the risk of aerosol spread.[52] The use of disposable nose caps and tubing is also recommended to reduce the risk of viral transmission.[53] Symptoms such as coughing, sneezing, and difficulty breathing seen in COVID-19 may limit the choice of inhalation sedation. For this reason, other sedation methods such as intravenous and oral sedation may be preferred. In order to prevent possible virus spread through aerosols, general anesthesia can be chosen in the treatment of patients who cannot be treated with routine dentistry practices and who have sedation contraindications to reduce the risk of aerosols.[51] It is recommended to perform a PCR test for COVID-19 at least 48 hours before the planned procedures under general anesthesia and that the test be repeated after at least 24 hours in patients with negative results but suspicious findings. Surgery should be performed within 7 days of a negative test result.[54]

Pediatric Dentistry and COVID-19

The fundamental challenge for dentists is to provide appropriate infection control for children and adolescents depending on their different levels of physical, intellectual, emotional, and social

development, with special regard to their psychological states. It is stated that toys used in the clinic for pediatric patients can be a potential source of cross-infection. Soft toys are more likely to be contaminated than toys with hard surfaces, are more difficult to disinfect, and can be recontaminated more quickly. In addition, instruments that are used to control and restrict the movements of pediatric patients, such as Velcro, can be contaminated and therefore need to be disinfected.[55] Special sessions and more time should be allocated for the dental procedures of uncooperative patients, which may require behavioral management techniques and physical contact.[28] Because restless, crying, and uncooperative children cause more aerosol emissions than calm and cooperative children,[56] it is recommended that the dental treatments of immunocompromised children be scheduled as the first appointment of the day to minimize the risk of exposure to possible sources of infection.[57]

The important thing is to help children improve their oral hygiene, reduce their risk of caries formation, and ensure that they do not need dental interventions that require a visit to the clinic. Protection against caries depends on the provision of adequate and effective oral hygiene and a correct diet that limits carbohydrate intake. With the increase in time spent at home, the frequency of consumption of cariogenic foods may increase. This situation increases the risk of developing early childhood caries (ECC), especially in children aged 3-5 years.[58] It is stated that there is a relationship between a family's socioeconomic status and the risk of their children developing caries. At the same time, it has been observed that the oral hygiene of parents influences the oral health of their children.[59] It is reported that the risk of domestic trauma in children increases as their time spent at home increases. It is recommended that children with high trauma risk be protected with mouthguards to avoid risky situations that may require urgent intervention.[60]

It is recommended to avoid aerosol-generating procedures and to use minimally invasive procedures as much as possible due to the COVID-19 outbreak.[61] Minimally invasive dentistry (MID) procedures constitute an approach that includes a range of techniques to treat carious lesions, from non-removal to selective removal of carious tissue. Many MID techniques include procedures that are safe, acceptable to children, and effective in reducing aerosol formation. These procedures ensure that tooth structure is preserved and that the risk of pulp perforation is reduced. Reducing the need for local anesthesia reduces the child's tension and fear, thus lessening the diffusion of aerosols. In addition, since most MID procedures can be completed in a short period of time, they shorten the waiting time for other patients and reduce the number of patients in the waiting room. These techniques include the application of fissure sealant, the resin infiltration technique, the Silver Diamine Fluoride (SDF) application, the Hall technique, the ART technique, and the selective removal of carious tissue.[62]

In the treatment of caries lesions without cavitation, the fluoride varnish application, resin infiltration application, or healing with fissure sealant can be preferred. Depending on the circumstances of caries lesions with cavitation, the SDF application, the Hall technique, the ART technique, interim therapeutic restorations, or indirect pulp capping can be applied.[63] While all sound and soft caries tissue is removed in traditional (total) caries removal methods, different procedures have been developed to reduce the possibility of pulp perforation and to protect the tooth.[64] In studies examining stainless steel crowns applied without removing caries tissue in primary teeth or healing fissures with sealant, it was reported that caries changed from an active form to an inactive form and that there was a decrease in the number of bacteria. In one-step selective removal of caries, partially soft infected caries are removed and a permanent restoration is performed. In this treatment, it is reported that the number of microorganisms in the lesion, which is disconnected from the oral environment, decreases and that the progression of caries is stopped. In the first session of the two-step caries removal method, the periphery caries tissue is removed, the infected caries tissue on the pulp is left untouched, and the tooth is temporarily restored by applying a capping material on it. In the second session 3-6 months later, it was reported that the caries had passed into the inactive form and a permanent restoration was applied.[65]

The Hall technique is a method in which dental caries is treated with a stainless steel crown without any tooth preparation or local anesthesia applications. It aims to change the bacterial content of caries by disconnecting its relationship with the oral environment and stopping its progression. Although it has a high success rate in primary teeth, it can only be applied temporarily until permanent restorations are made in permanent teeth with high substance loss.[66]

In the ART technique, dental caries tissue is removed with the help of hand instruments. The prepared cavity is restored with glass ionomer filling material, which can release fluoride and prevent secondary caries formation. Local anesthesia is rarely required. This technique is preferred mostly in underdeveloped countries because of its low cost. Since its application steps do not cause fear in children, its acceptability is high.[67]

Interim therapeutic restorations is the preferred approach when there are barriers to ideal conventional dental treatment. These barriers may be related to the patient's oral hygiene, difficulties in preparation, and restoration of the cavity. Interim therapeutic restorations can be applied to both primary and permanent teeth in uncooperative children, patients with disabilities, and patients who require special health care. In this caries removal process, hand or rotary instruments can be partially used. As in the ART technique, the restoration process is carried out with glass ionomer filling material. The restoration should be replaced with permanent filling material after 6 months.[68]

Silver diamine fluoride is a colorless solution that stops the progression of dental caries. It is applied topically to tooth surfaces. It offers the advantages of not requiring local anesthesia, being cost-effective, simple to apply, not requiring the use of expensive equipment, and being noninvasive. However, the fact that it stains teeth black and has a metallic taste can disturb the patients. Potassium iodide (KI) application is recommended to address the discoloration problem.[69] It is thought that after the SDF application destroys bacteria and stops the progression of the caries lesion, the lesion should be restored in order to disconnect it from the oral environment and restore the old form of the tooth. As in the ART technique, a glass ionomer filling material that is chemically bonded to the tooth is preferred. This approach aims to protect the vitality of pulp by severing the relationship between caries and the oral environment.[70]

Resin infiltration application is used in the treatment of initial enamel lesions. The aim is to increase the porosity of the hypermineralized layer on the surface of initial enamel lesions with strong acid and to allow the low-viscosity resin to penetrate

the lower layers of the lesion. Opaque white spot lesions caused by mineral loss and enamel demineralization in initial enamel lesions need to be treated so that caries does not progress and may disturb the patient aesthetically.[71]

CONCLUSION

Studies related to transmission routes, symptoms, diagnosis, treatment, and vaccines related to COVID-19 are ongoing. Dentists are among the occupational groups most frequently affected by the virus, which has made disinfection and sterilization rules even more important. In addition, the thought that the epidemic will become endemic makes it necessary to get used to COVID-19 and a new normal in the coming years.

During COVID-19 outbreaks, dentists can recommend the use of chlorhexidine and propolis-containing dental products that are in the flavonoid group, because the COVID-19 virus has features such as viral inactivation on the main protease regions. Besides advantages such as little or no aerosol formation and reducing the risk of cross-infection, its high acceptability among children may enable pediatric dentists to prefer MID procedures for their ease of application.

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Case Report *Olgu Sunumu*

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Total Maksillektomi Yapılmış Hastanın Maksiller Obturatör İle Protetik Rehabilitasyonu: Olgu Raporu

Prosthetic Rehabilitation of a Patient with Total Maxillectomy with a Maxillary Obturator: A Case Report

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ÖZ

Rezeksiyon sonrası oluşan maksillofasiyal defektler, oral ve nasal açıklıkların birleşmesiyle çiğneme, yutkunma, konuşma gibi fonksiyonel, fonetik ve estetik problemlere neden olmaktadır. Özellikle geniş deformitelerin varlığı, retantif alanlarının eksikliğiyle sonuçlanmakta ve protetik tedaviyi zorlaştırmaktadır. Bu olgu raporu, yassı hücreli karsinoma tanısıyla opere edildikten sonra kliniğimize başvuran hastanın obturatör protez ile rehabilitasyonunu anlatmaktadır. Geniş bir maksiller rezeksiyon sahasına sahip ve postoperatif radyoterapi alan hasta, konvansiyonel yolla tedavi edilmiştir. Retansiyon alanlarının eksikliği nedeniyle obturatör mümkün olan en hafif formda hazırlanmış ve ağırlığı arttırmamak için okluzyon oluşturulmamıştır. Elde edilen obturatör, oral ve nasal boşluklar arasında seperasyon sağlayıp hastanın nazogastrik sonda ihtiyacını elimine etmiş ve hipernasal konuşmayı iyileştirmiştir. Ancak beslenme, yumuşak ve sıvı gıdalarla idame edilmiştir. Bu yüzden hasta memnuniyeti sınırlı düzeyde kalmıştır.

Anahtar Kelimeler: maksillektomi, obturatör, yassı hücreli karsinoma

ABSTRACT

Maxillofacial defects that occur after resection cause functional, phonetic, and aesthetic problems such as chewing, swallowing, and speech especially when oral and nasal openings are involved. The large deformities results in a lack of retentive areas and complicates prosthetic treatment. This case report describes the rehabilitation of a patient with maxillary obturator prosthesis who presented to our clinic after being operated with the diagnosis of squamous cell carcinoma. The patient, who had a large maxillary resection site and received postoperative radiotherapy, was treated in a conventional way. Due to the lack of retention areas, the obturator was prepared in the lightest form possible and no occlusion was created to avoid increasing weight. The obturator provided separation between the oral and nasal cavities, eliminating the patient's need for nasogastric catheter and improved hypernasal speech. However, nutrition has been maintained with soft and liquid foods. Therefore, patient satisfaction remained limited.

Keywords: Maxillectomy, obturator, squamosa cell carsinoma

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Malignite gösteren lezyonların büyük kısmı maksillada görülmektedir.[1-3] Genellikle cerrahi rezeksiyon ile tedavisi yapılan bu lezyonlar, operasyon sonrası farklı şekil ve büyüklüklerde deformiteler oluşturmaktadır. Bu durum hastada estetik, fonasyon ve fonksiyonla ilgili problemlerinin oluşmasına neden olmaktadır.[4,5] Maksillofasiyal defektler hastaların yaşam kalitesini düşüren ve rehabilite edilmesi gereken durumlardır.

Kazanılmış çene yüz deformitelerinin rekonstrüksiyonunda öncelikli tedavi cerrahi yönündedir.[5] Flep kaydırılması, otojen ve allojen greft uygulamaları ile küçük defektler kapatılabilmekte, ancak sistemik durum, rezeksiyon sonrası nüksün gözlenmesi, hastanın ilerleyen yaşı ve defektin genişliği gibi kısıtlamalar nedeniyle her zaman cerrahi tedavi mümkün olmamaktadır.[3,5-7] Obturatörler, kaybedilen fonksiyon ve estetiğin rehabilitasyonu amacıyla sıklıkla kullanılan protetik çözümlerdir.[2,5] Tercih edilmelerine

rağmen yapımı ve kullanımı oldukça zor protezlerdir.[8] Obturatörlerin ortak sorunu yeterli retansiyon ve stabilite sağlayacak destek dokuların bulunmamasıdır.[1,7,9] Sıklıkla operasyon sahasında veya yakınında bulunan alveolar kemik ve dişler ameliyat sırasında rezeke edilmektedir.[2] Bu durum obturatör yaparken mevcut dokuların en efektif şekilde kullanılmasını ve ileri tekniklerin uygulanması gerektirmektedir.

Planlanan obturatöre okluzal temas elde etmek için diş ilavesi yapılması stabilizasyon sorununu daha da arttırmaktadır. Osseointegre implantların geliştirilmesiyle birlikte farklı tutucu tasarımlarıyla protetik çözüm skalası genişlemekteve retansiyon ve stabilite problemlerinin önüne geçilmeye çalışılmaktadır.[6,9] Hastalarda mevcut deformiteler, sistemik durum, beklentiler ve ekonomik faktörler farklılık gösterdiği için yapılan obturatörler de genel protez kurallarının yanı sıra çoğunlukla her hasta için kendine özgü uygulamalar ve planlamalar gerektirmektedir.[2,5,8,9]

Deformiteler; büyüklükleri, sinonazal alanlara yakınlıkları veya iyileşme dönemlerine göre farklı obturatörlerle tedavi edilmektedir. Obturatörler genel olarak 3 başlıkta toplanmaktadır.[10]

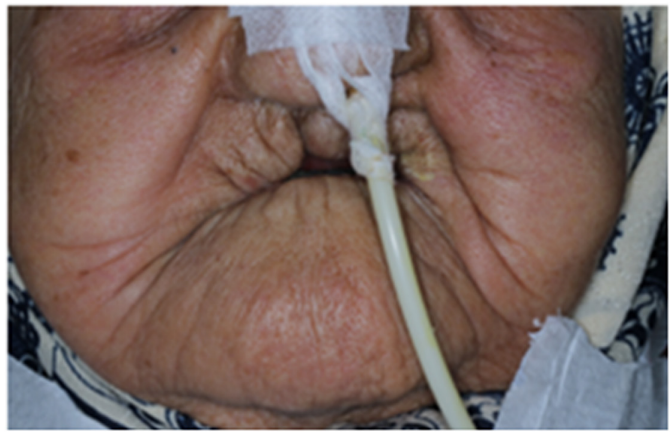
1. Cerrahi obturatörler: Önceden hazırlanıp operasyon sırasında ilgili bölgeye yerleştirilen protezlerdir. İyileşme fazında, 1-2 hafta süresince kullanılır.
2. Tedavi obturatörleri: Genellikle cerrahi obturatörlere astar maddesi uygulanıp daimi obturatör yapımı için gerekli şartlar elde edilinceye kadar kullanılır.[8]
3. Daimi Obturatörler: Final protezlerdir. Hastanın çiğneme, yutkunma, konuşma ve estetik ihtiyaçlarını karşılayacak şekilde mümkünse akrilik dişlerle birlikte hazırlanan protezlerdir.

Yapılan tüm protetik obstrüksiyonların başlıca amacı; hipernazal konuşmayı önlemek ve nazal kaviteye sıvı kaçışını engellemek için oral kaviteyi nazal kaviteden ayırmaktır.[2-5] Total üst çene rezeksiyonlu hastalarda obturatör için yeterli destek ve retansiyonu sağlayacak anatomik yapıların olmaması, karşılaşılan en büyük sorunlardan biridir.[2,7] Bu çalışmada, total maksillektomi sonrası nazogastrik beslenen hastanın oronasal açıklığın kapatılması ve yutkunma, konuşma gibi fonksiyonlarının tekrar kazandırılması amaçlanmıştır.

OLGU SUNUMU

Yassı hücreli karsinom (squamous cell carcinoma) tanısıyla Çukurova Üniversitesi Tıp Fakültesi Kulak Burun Boğaz bölümü tarafından opere edildikten sonra Çukurova Üniversitesi Diş Hekimliği Fakültesi Protez kliniğine gönderilen hastanın anamnezi alınmış ve muayenesi yapılmıştır (Resim 1). 87 yaşındaki kadın hastanın anamnezinde operasyon sonrası radyoterapi aldığı öğrenilmiştir. İntraoral muayene sırasında, maksilla, nazal ve palatal kemiğin tamamının rezeke edildiği gözlenmiş olup yapılacak obturatöre retansiyon ve desteklik sağlayacak diş veya kemik dokusunun bulunmadığı tespit edilmiştir (Resim 2). Detaylı muayene amacıyla hasta konik ışınlı bilgisayarlı tomografi (KIBT) için yönlendirilmiştir (Resim 3 ve 4). Muayene ve radyografik değerlendirmeler sonucunda hastanın sistemik durumu ve postoperatif radyoterapi almış olması implant kontrendikasyonu oluşturduğundan, konvansiyonel obturatör yapılmasına karar verilmiştir.

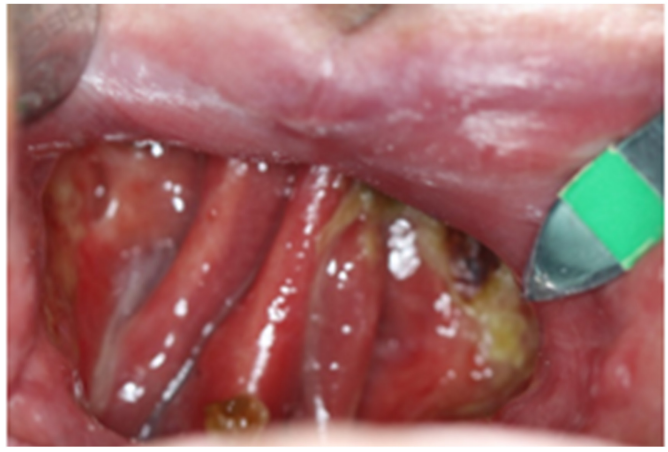
Bu amaçla fabrikasyon kaşık defekt alanına uyacak şekilde kesildi ve kenarları mum duvarlar ile yükseltildi. İlk ölçü irreversible hidrokolloid ölçü materyali (Tulip, Cavex, Hollanda) ile alındı. Alınan ölçü



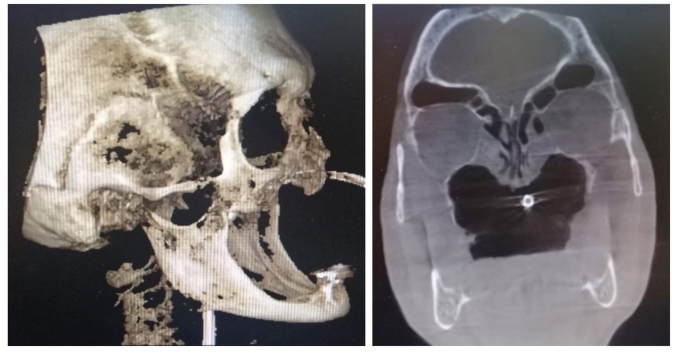
Resim 1. Operasyon sonrası nazogastrik sonda ile başvuran hasta.

dezenfekte edildikten sonra defekt sınırları çizildi ve model eldesi için laboratuvara gönderildi. Sert alçıdan elde edilen modelde defekt içi, sınırlara kadar pomza ile dolduruldu (Resim 5). 2. Ölçü için retantif alanlar elde etmek amacıyla, 4 farklı defekt sınırında 3 mm yükseklikte ve 8 mm genişlikte çentikler açıldı. Otopolimerizan akrilik rezin (Dentreal, Konya, Türkiye) ile kişisel kaşık elde edildi (Resim 6).

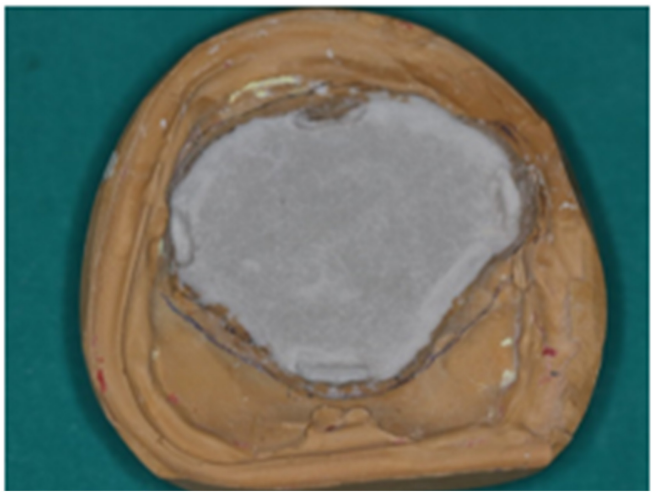
Hasta ağzında kontrol edilip gerekli uyumlamalar yapıldıktan sonra kenar şekillendirilmesi için ölçü stenci (Kerr, Kerr Italia S.P.A, Salerno-İtalya) kullanıldı. 2. ölçü polivinil siloksan ölçü materyali (Elite HD+, Zhermack, Almanya) ile elde edildi. Ölçülerin etrafına



Resim 2. Hastanın intraoral görüntüsü.



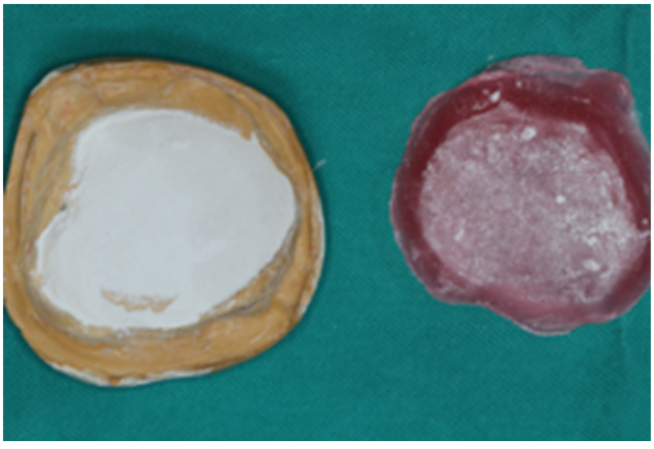
Resim 3,4. Operasyon sonrası tomografi görüntüleri.



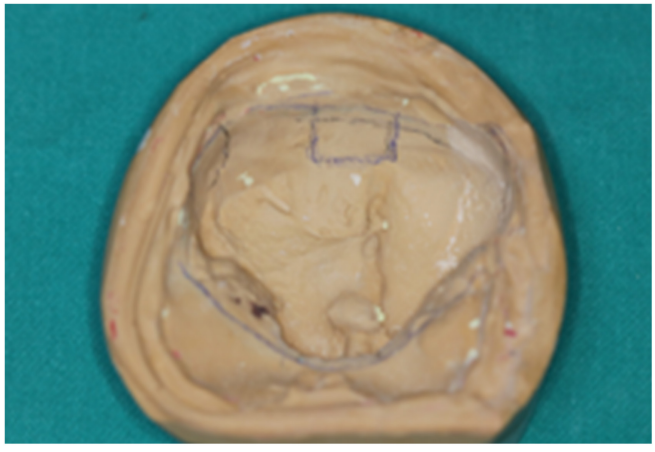
Resim 5. Alçı modele pomza uygulanması.

kutulama yapılarak (Modelling Wax, Dentsply Detrey, İngiltere) sert alçı döküldü (Resim 7).

Akrilik tepimi ve polimerizasyonundan sonra, defekt kenarlarıyla ilişkide olan kısımlara hem tutuculuğu artırmak hem de obturatörün kullanımı sırasında defekti çevreleyen yumuşak dokuda oluşacak travmatik etkiyi azaltmak için silikon esaslı yumuşak astar



Resim 6. Pomza uygulanmış modelden elde edilen kişisel kaşık.



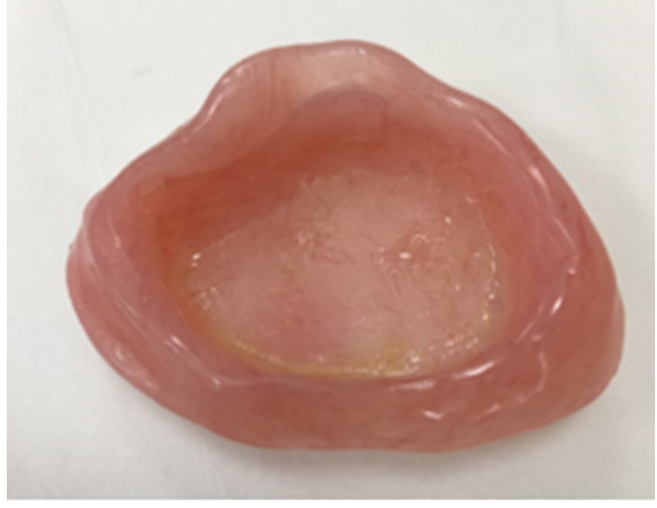
Resim 7. Ana model.

Resim 8. Obturatörün dış yüzey görüntüsü.

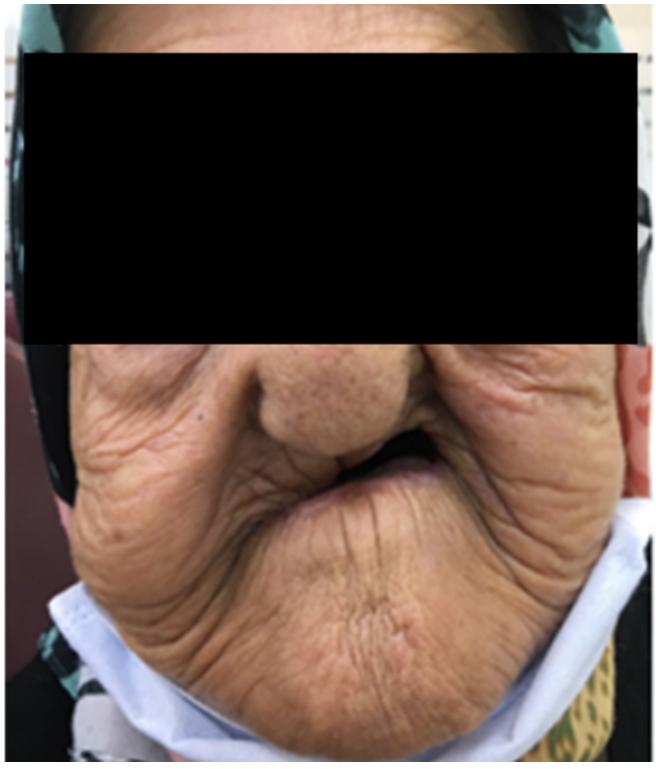
materyali (MolloplastB, DETAX, Ettlingen, Almanya) uygulanarak polimerize edildi.

Obturatörün ağırlığını azaltmak ve hastanın daha rahat kullanmasını sağlayabilmek adına obturatör mümkün olduğunca inceltildi ve dış yüzeyine küçük bir sap eklendi (Resim 8).

Defekt bölgesinde retansiyon ve stabilizasyon sağlayacak herhangi bir doku andırkatının bulunmaması nedeniyle yumuşak damağın anterior sınırından içeri doğru yaklaşık 5 mm'lik bir uzantı oluşturuldu (Resim 9). Kalan tüm sınırlarda tam tıkama sağlanmış, nazofarinks ve sinonasal bölgeye sıvı geçişi veya tersi engellenmiştir. Polisajı yapılan obturatör ağızda kontrol edildikten sonra kullanımı, bakımı ve temizliği hakkında hasta eğitildi. Ayrıca defekt bölgesinin hijyeninin sağlanması konusunda bilgilendirildi. Uyumadan önce çıkarılması ve kullanılmadığı zamanlarda suda saklanması talimatı verildi. Protezin tesliminden 24 saat sonra işlevini değerlendirmek, olası tahrişlerin ve vurukların erken dönem belirtilerini incelemek için hasta ertesi gün tekrar çağırıldı. Gereken uyumlamalar yapıldı ve hastaya sonraki kontrol için randevu oluşturuldu. 2 hafta sonra fonksiyon ve fonasyonun etkinliğini değerlendirildi. Hipernasal konuşmada azalma ve beslenmenin sıvı-yumuşak-gıdalarla gerçekleştirilebildiği gözlendi.



Resim 9. Obturatörün iç yüzey görüntüsü.



Resim 10. Obturatörün hasta ağzındaki görüntüsü.

Yapılan obturatör ile nasogastrik sonda kullanma ihtiyacı olmadan hastanın beslenebilmesi sağlandı (Resim 10).

Tartışma

Neoplaziler nedeniyle maksiller ve mandibular rezeksiyon yapılan hastalarda dişler, kemik ve mukozada meydana gelen madde kayıpları; estetik, fonetik ve fonksiyonel problemlerle birlikte kozmetik sorunlara ve sonucunda büyük sosyal ve psikolojik problemlere neden olmaktadır.[1,4]

Maksillofasiyal bölgede gözlenen tümoral oluşumların büyük kısmını (%90-95) yassı hücreli karsinoma oluşturmaktadır. Özellikle sinüs tutulumu gösteren bu lezyonlar erken dönemde semptom vermemeleri nedeniyle müdahale edildiğinde geç kalınabilmektedir. Sinüs kanserleri maksillanın rezeksiyonunu gerektiren malignitelerin başında yer alır. Hastalar genellikle burun tıkanıklığı, burun kanaması konuşmada farklılıkların gözlenmesi, dişlerde mobilite gibi şikâyetlerden bahsetmektedir.[5,11] Paranazal sinüslerin tedavileri incelendiğinde radikal bir cerrahi operasyonla birlikte preoperatif veya postoperatif radyoterapi uygulamanın en etkili yöntem olduğunu söyleyen çalışmalar mevcuttur.[12] Ancak rezeksiyon öncesi veya sonrası radyoterapi uygulaması ile ilgili literatür fikir birliği sağlamamıştır. Bazı yazarlar operasyon sonrası radyoterapi ile tedavi edilen hastalarda sonuçların daha az elverişli olduğunu belirtmişlerdir. Radyoterapi sonrası dokuların vazkülarizasyonu ve iyileşme kapasitelerinin değiştiğini biliyoruz. Mevcut vakaya, postoperatif radyoterapi uygulandığından sekonder yara oluşması, nekroz ve doku kaybı gibi komplikasyonlara engel olmak amacıyla defekt kenarlarına yumuşak astar materyali uygulanmıştır.

Maksiller neoplazilerin tedavisinde ve rehabilite edilmesinde multidisipliner bir yol izlenmelidir. Cerrahi rezeksiyonu yapacak hekim, operasyondan önce hastayı mutlaka bir çene-yüz protez uzmanına yönlendirmelidir.[7] Planlanan operasyon ve obturatör, uzman görüşlerin doğrultusunda değerlendirilmelidir. Cerrahi operasyondan sonra iyileşme fazında geçici obturatörlerin yapılması, dokuların kontrakte olmasını azaltacak ve yapılacak daimi obturatörün kozmetik desteğine katkıda bulunacaktır. Kliniğimize başvuran hasta cerrahi işlem sonrası görüldüğünden obturatör yapımı ve kullanımı hasta ve hekim açısından daha karmaşık hale gelmiştir. Labial bölgede rezeksiyon sonrası kollabe olan dokular, işlemler sırasında oral kaviteye girişi sınırlandırmıştır. Bu da hem bizim çalışma şartlarımızı hem de hastanın dayanma sınırlarını zorlamıştır.

Sert ve yumuşak dokuların miktarı, kalitesi; destek olarak kullanılabilecek dişlerin sayısı defektin tedavisinde yaklaşım biçiminin belirlenmesine yardımcı olur.[8] Ancak maksiller defektlerin protetik rehabilitasyonunda çoğunlukla defektle birlikte geniş bir rezeksiyon sahası bulunduğundan, retansiyon ve stabilizasyon sorunlarıyla karşılaşılmaktadır.[2,3,7] İmplantolojinin gelişmesiyle birlikte farklı tasarımlar ve tutucu elemanlar kullanılarak bu sorunlar giderilmeye çalışılmıştır.[3,9] Obturatörün retansiyonu arttırılmış olup yükleme kuvvetlerinin implantlara iletilmesi ve rezeksiyon boşluğundaki yumuşak dokuların korunması sağlanmıştır. B. Lethaus ve ark.ları, değerlendirdikleri 11 maksillektomi vakasında rezeksiyon protezlerinin implantlar ile sabitlenmesi gerektiğini ve mevcut yumuşak doku andırkatlarının kullanılmasının yeterli olmadığı kanısına varmışlardır. Ayrıca skar oluşumu sonucu ağız açıklığı azalan hastalarda implant kullanılması, obturatörün hacminde azalmayla birlikte protezin daha rahat takılıp çıkarılmasını sağlar.[6] Yenisey ve arkadaşlarının yaptıkları çalışmada ise fibröz doku andırkatlarının, implantın kontrendike olduğu durumlarda hala başarılı bir şekilde kullanılabildiğini göstermiştir. Total maksillektomi defekti bulunan hastaya OFFRD (orthodontic forsus fatigue resistant device) olarak adlandırılan ortodontik cihaz ve Herbst apareyini kullanarak, alternatif bir yöntemle hazırladıkları obturatör; estetik, fonetik ve fonksiyonel ihtiyaçları başarılı bir şekilde karşılamıştır.[2] Aynı çalışmada bir diğer maksillektomi hastasına implant yerleştirerek ortodontik sistemi tekrar kullanmış olup implant ile elde ettikleri retansiyon ve stabilitenin daha yüksek olduğunu gözlemlemişlerdir.

Hastaların protez tesliminden sonra yapılan periyodik kontrollerinde, gerek retansiyon ve stabilite açısından gerekse hasta konforu ve kullanılabilirlik açısından implant destekli rehabilite edilen olgular, konvansiyonel uygulamalara göre daha etkin bulunmuştur.[9] İmplant destekli obtüratörlerin bu avantajlarına rağmen maliyetinin yüksek olması ve yerleştirilmeleri için ikinci bir cerrahi işlem gerektirmeleri gibi hasta açısından bazı dezavantajları mevcuttur.[2,3,7] Bununla beraber kalan kemik yapıların yüksekliği, genişliği, kalitesi ve maruz kaldığı radyasyon miktarı yerleştirilecek implantın başarısını etkileyen faktörler arasındadır.[2,12]

Tümör rezeksiyonu sonrası, defekt bölgesindeki anatomik yapıların ve andırkatların protez retansiyonu üzerinde önemli bir etkisi vardır. Total maksillektomi yapılmış hastalarda ne yazık ki bu alanların eksikliği nedeniyle retansiyon ve stabilite problemleri meydana gelmektedir.[2] Gupta ve arkadaşları yaptıkları vakada hastanın mevcut yumuşak doku andırkatlarını kullanarak 2 parçalı bir obturatör hazırlanmışlardır.[13] Dişsiz ilk parça yumuşak damak içerisine yerleştirilerek dişli parça mıknatıslarla tutturtulmuştur. Bu sayede hastanın çiğneme ve yutkunma fonksiyonlarını gerçekleştirmesi sağlanmıştır. Mevcut vakamızda orbita tabanına kadar tüm sert dokuların rezeke edilmesi sonucu yeterli retantif dokular olmadığından hastaya çiğneme fonksiyonunu gerçekleştirecek dişli bir obturatör yapılamamıştır.

Mevcut vakamızda defektin sınırlarının geniş olması, yeterli kemik dokunun olmaması, sistemik hastalıklar ve hastanın radyoterapi almış olması implant kontrendikasyonu sebep olmuştur. Bu nedenle konvansiyonel obturatör yapılması kararlaştırılmıştır. Oral muayene ve KIBT incelemesi sonrasında kullanılabilecek tek retantif alanın yumuşak damak anterior sınırı olduğu tespit edilmiştir. Retansiyon alanlarının eksikliği nedeniyle planlanan obturatör, mümkün olabilecek en hafif formda hazırlandı. Yumuşak damaktaki uzantıyla birlikte çevre yumuşak dokudan tutuculuk sağlamak için defekt sınırlarına yumuşak astar materyali uygulanmıştır. Literatürde ağırlığı azaltmak ve protezin hareketini önlemek adına farklı materyaller de kullanılmıştır. Son yıllarda diş hekimliğinde popülarite kazanan PEEK (polieter eter keton) materyali maksillofasiyal protezlerde de denenmiştir.[14,15]Santiago ve ark. larının yaptıkları bir çalışmada obturatör ağırlığını azaltmak için kaide materyali olarak biyouyumlu ve düşük özgül ağırlığa sahip PEEK polimeri kullanılmıştır. Retansiyon ve stabilitenin sağlanmasına yardımcı olunacağı düşünülerek hazırlanan obturatörde, akril ile kimyasal bağlantı elde edilemediği için çentikler hazırlanıp mekanik retansiyon sağlanmıştır.[14]

Maksillofasiyal defektler oldukça bireyseldir ve klinisyenin fonksiyonel bir protez üretmek için tüm bilgi ve deneyimini kullanmasını gerektirir. Defekt alanının çok geniş olduğu durumlarda klinisyenin farklı çözümler üretmesi gerekebilir. Yenisey ve arkadaşlarının yaptıkları çalışmada ortodontik apareylerden (OFFRD ve Herbst apareyi) faydalanılmıştır.[2] Gueutier ve ark.ları dijital sistemleri kullanarak maksiller kemiği simüle edecek 2 parçalı metal plakayı lazer sistemle üretmiş, cerrahi bir girişimle mevcut sert dokulara sabitlemişlerdir.[16] Bu sayede yerleştirilen metal plakalardan retansiyon ve desleklik sağlayarak hastaya kullanabileceği fonksiyonel bir obturatör protez hazırlamışlardır. Vakada tomografi dataları ile 3 boyutlu yazıcılardan elde ettikleri modelde zigomatik kemiğe sabitlenecek plakalar tasarlanmış ve sonrasında eklemeli üretimle titanyumdan elde dilmiştir. Ancak mevcut vakamızda var olan dokuların kollabe olması, yeterli sert dokunun olmaması, hastanın ileri yaşı, sistemik durumu ve motor yeteneklerinde azalma nedenleriyle bahsedilen sistemler uygulanamamıştır.

Maksillektomi sonrası yaygın görülen sorunlardan biri de hipernazal konuşmadır.[2,4,5,17] B. Lethaus ve arkadaşları çalışmalarında, maksillektomi sonrası hastaların büyük kısmında sosyal yaşantılarını etkileyen nazal konuşma probleminin olduğunu gözlemlemişlerdir. Oronasal açıklıkların neden olduğu rezonans farklılıklarının giderilmesinde obturatör dizaynı da rol oynamaktadır. Bazı çalışmalarda hallow bulb tasarımının nazal kaviteyi daralttığı, alternatif olarak bukkal falanjlı obturatörlerin kullanılmasıyla bu problemin önüne geçilebileceği vurgulanmıştır.[6,18] Vakamızda nazal geçişin kapatılmasıyla hastanın hipernazal konuşmasında olumlu yönde iyileşme gözlenirken obturatöre diş ilavesi yapılamadığından fonetik sorunlar tam anlamıyla aşılamamıştır.

SONUÇ

Maksillofasiyal defektlerin protetik rehabilitasyonda multidisipliner bir yol izlenmelidir. İntraoral retantif alanların eksikliği obturatörün kullanımını zorlaştırmıştır. Okluzyon oluşturulamaması, beslenmenin yumuşak ve sıvı gıdalarla idame edilmesine neden olmuş ve hasta memnuniyeti sınırlı düzeyde kalmıştır.

Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastalardan alınmıştır.

Hakem Değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir– D.K.; Tasarım – O.E.; Denetleme – O.E.; Kaynaklar – D.E., O.E.; Malzemeler – D.E., O.E.; Veri Toplanması ve/veya İşlemesi – D.E., O.E.; Analiz ve/veya Yorum – D.E., O.E.; Literatür Taraması – D.E., O.E.; Yazıyı Yazan – D.E., O.E.; Eleştirel İnceleme – D.E., O.E.

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Peer-review: Externally peer-reviewed.

Author Contributions: Concept – D.K.; Design – O.E.; Supervision – O.E.; Resources – D.E., O.E.; Materials – D.E., O.E.; Data Collection and/or Processing – D.E., O.E.; Analysis and/or Interpretation – D.E., O.E.; Literature Search – D.E., O.E.; Writing Manuscript – D.E., O.E.; Critical Review – D.E., O.E.

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KAYNAKLAR

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