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YAZIM KURALLARI

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Orijinal araştırma makalesi: Başlıklar, Özet **(İngilizce ve Türkçe)**, Giriş, Gereç ve Yöntem, Bulgular, Tartışma, Sonuç, Teşekkür, Kaynaklar, Tablolar, Şekiller ve Şekil açıklamaları.

Olgu sunumu: Başlık (Uzun ve kısa), Özet **(İngilizce ve Türkçe),** Giriş, Olgu Sunumu, Tartışma, Sonuç,

Teşekkür, Kaynakça, Tablolar, Şekiller ve Şekil Açıklamaları

Teknik not: Başlık, Özet, Giriş, Sonuçlar, Kaynaklar, Tablolar, Şekiller ve Şekil açıklamaları (gerekli ise)

Editöre Mektup: Başlık, Özet, Giriş, Sonuçlar, Kaynaklar, Tablolar, Şekiller ve Şekil açıklamaları (gerekli ise)

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a- Her yazı normal ve düz yazı tipinde (12 punto Times New Roman), 1,5 satır aralıkla iki yana dayalı olarak yazılmalı ve tüm sayfalar orta alttan art arda numaralandırılmalıdır.

b- Her paragrafta satır girintisi kullanılmalıdır.

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BAŞLIK SAYFASI

Başlık sayfası aşağıdakilerden oluşmalıdır:

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c- Yazarların akademik dereceleri dahil tam adları. Yazarların bağlı oldukları kurum (şehir ve ülke dahil), soyadlarından sonra üst simge numarası verilerek adlar satırının altında belirtilmelidir.

d- Tüm yazarların ORCID tanımlayıcıları. Bir tane almalı veya https://orcid.org/ adresinden kendinizinkini kontrol etmelisiniz.

e- Sorumlu yazarın iletişim bilgileri (posta adresi, iş telefonu, cep telefonu numaraları ve e-posta adresi)

f- Makalenin türü (orijinal araştırma makalesi, editöre mektup, olgu sunumu…)

g- Özet ve ana metinde ayrı ayrı yer alan kelime sayısı (şekil açıklamaları, tablo başlıkları ve kaynaklar hariç), kaynak, şekil ve tablo sayıları.

h- Finansman kaynağı (hibe numarası, protokol numarası vb. belirtiniz)

i- Teşekkür (makalenin herhangi bir bilimsel etkinlikte daha önce sunulmuş olması)

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k-Kayıt sitesi (örn., clinicaltrials.gov), kayıt numarası, kayıt tarihi ve internet bağlantısı (önerilen) dahil olmak üzere klinik araştırma kayıt bilgileri.

ÖZET ve ANAHTAR KELİMELER:

Özet, makalede yer alan bilgileri yansıtmalı ve makalenin ana metninde yer almayan bilgileri içermemelidir. Özet, şu başlıklar kullanılarak yapılandırılmalıdır: Araştırma makalesi için Amaç, Gereç ve Yöntemler, Bulgular ve Sonuç; olgu sunumları için Giriş, Vaka raporu ve Sonuç. Teknik notlar ve editörlere mektupta herhangi bir başlık bulunmamalıdır.

Özet ve anahtar kelimeler hem İngilizce hem de Türkçe olarak sunulmalıdır. Anahtar kelimeler Medical Subject Headings (MESH: www.nlm.nih.gov/mesh/MBrowser.html) ve Türkiye Bilim Terimleri (TBT; http://www.bilimterimleri.com) arasından seçilmelidir. MESH indeksi Türkçe olup alfabetik sıraya göre listelenmeli ve noktalı virgülle (;) ayrılmalıdır. Anahtar kelimeler başlık ve özetten seçilmemelidir çünkü bunlar otomatik olarak indekslenir; bunun yerine ana metinden seçilmelidir.

GİRİŞ

Ana fikir ve önemi anlatılmalıdır. Hiçbir sonuca, tartışmaya ve veriye yer verilmemelidir. Bölümün son paragrafında çalışmanın amacı açıkça belirtilmeli ve varsa araştırma hipotezi verilmelidir.

GEREÇ ve YÖNTEM

Tüm ticari ürün ve cihazların menşei açıklanmalı ve ticari isimleri ve kaynakları belirtilmelidir (isim, üretici, şehir ve ülke).

Bu bölümde etik onay belirtilmelidir (onay alınan Etik Kurul'un tam adı, onay tarihi, onay numarası yazılmalıdır). Varsa, bilgilendirilmiş onam alındığı belirtilmelidir.

Gözlemsel veya deneysel çalışmalarda katılımcıların (hastalar, kontrol grupları dahil laboratuvar hayvanları) seçimine ilişkin dahil etme ve hariç tutma kriterleri açıklanmalıdır.

Bu bölümün son paragrafında, istatistiksel analiz ayrıntılı olarak açıklanmalıdır. İstatistik terimleri ve sembolleri tanımlanmalıdır. Kullanılan bilgisayar yazılımı belirtilmelidir.

BULGULAR

İstatistiksel bulgular rapor edilmelidir, ancak bunların tartışılmasından veya yorumlanmasından kaçınılmalıdır. Gerekiyorsa tablo, grafik veya illüstrasyonlardan yararlanılmalıdır. Bu bölümde gerekli ise alt başlıklar kullanılabilir.

TARTIŞMA

Araştırmanın bulgularını tartışılmalı ve diğer çalışmalarla uyumu veya uyumsuzluğu belirtilmeli ve çalışmanın sınırlılıklarına yer verilmelidir. Giriş ve sonuç bölümlerinde verilen bilgilerin tekrarından kaçınılmalıdır.

SONUÇ

Bu bölümde yazarlar çalışmanın sonuçlarını kısaca ve net bir şekilde sıralamalı ve çalışmanın temel mesajlarını belirtmelidir. İstatistiksel ayrıntılara yer verilmemelidir.

TEŞEKKÜR

Çalışma bir hibe ya da başka bir fonla desteklenmişse bu bölümde destekleyen kuruluşun adı ya da hibe numarası verilmelidir.

ÇIKAR ÇATIŞMASI

Herhangi bir çıkar çatışması olmadığı belirtilmelidir.

KAYNAKLAR

ADO Klinik Bilimler Dergisi'nde alıntıların etiketlenmesi Vancouver sistemine göre yapılır. Kaynaklar ana metinde üst simge Arap rakamlarıyla ardışık olarak belirtilmelidir. Tam referans listesi numara sırasına göre verilmelidir.

Dergilerin başlıkları MEDLINE için İndekslenen Dergiler listesinde kullanılan stile göre kısaltılmalıdır. (http://www.ncbi.nlm.nih.gov/nlmcatalog/journals)

Yayınlanmamış veriler veya kişisel iletişimler referans olarak kabul edilmez.

Metinde alıntı yapma örnekleri:

…önceki bir çalışmada belirtildi.[1]

…önceki çalışmalarda belirtildi.[2,4-6,8]

Yılmaz[9] tarafından yakın zamanda yapılan bir araştırmada şöyle bildirildi:

Yılmaz ve Akın tarafından yakın zamanda yapılan bir çalışmada[10] şu rapor edildi:

Yılmaz ve ark.[11] tarafından yakın zamanda yapılan bir çalışmada şu rapor edilmiştir:

Standart dergi makalesi

1. Erkmen E, Şimşek B, Yücel E, Kurt A. Comparison of different fixation methods following sagittal split ramus osteotomies using three dimensional finite element analysis: Part 1: Advancement surgery-posterior loading. Int J Oral Maxillofac Surg 2005;34:551-8.

Altıdan fazla yazarlı standart dergi makalesi

2. Tüter G, Kurtiş B, Serdar M, Aykan T, Okyay K, Yücel A, et al. Effects of scaling and root planing and sub-antimicrobial dose doxycycline on oral and systemic biomarkers of disease in patients with both chronic periodontitis and coronary artery disease. J Clin Periodontol 2007;34:673-81.

Tez

3. Kayaoğlu G. Endodontik hastalık açısından Enterococcus faecalis'in Kahve ve direnç çıkışının incelenmesi [tez]. Ankara: Gazi Üniversitesi; 2007.

Kitap ve kitapta bölüm

4.Okeson JP. Management of Temporomandibular Disorders and Occlusion. 7th ed. St. Louis, Missouri: Elsevier Mosby; 2013. p. 171-174.

5. Alaçam A. Pedodontik Endodonti. Alaçam T, Editör. Endodonti. 1.baskı. Ankara: GÜ Yayınları; 1990. s.809-859.

TABLOLAR ve ŞEKİLLER

Tüm tablo ve şekiller ana metinde yer alma sırasına göre Latin rakamlarıyla ardışık olarak numaralandırılmalı ve ayrıntılı olarak tartışılmalıdır. Yazılarda tablo ve şekiller ana metnin sonunda Kaynaklar kısmından sonra verilmelidir.

Tüm şekiller yüksek kalitede JPG, PNG, PDF veya TIFF formatında olmalı ve gönderim sırasında ayrı bir belge ile yüklenmelidir. Histopatolojik görüntülerde kullanılan renklendirici ve büyütme miktarı belirtilmelidir.

Kişi görüntülerinin yer aldığı yazılarda, bunların kullanılması için yazılı izin alınmalı ve yazıyla birlikte sunulmalıdır.

Tablo hazırlanırken ADO Klinik Bilimler Dergisi'nde daha önce yayınlanmış makaleler örnek olarak alınabilir. Tüm tabloların tablonun üst kısmında bir başlığı bulunmalı ve birlikte yüklenmelidir. Kısaltmalar, istatistiksel bilgiler (p değerleri veya istatistiksel analiz yöntemi vb.) tablonun altına dipnot olarak verilmelidir. Gerektiğinde yıldız işareti veya üst simge kullanılmalıdır.

Bir yazıdaki tablo ve şekillerin toplam sayısı 6'yı geçmemelidir.

ÇIKAR ÇATIŞMASI FORMU (ICMJE FORMU)

Dosyanın tamamını indirmek için lütfen tıklayın.

TELİF HAKKI FORMU VE YAZAR SÖZLEŞMESİ

Makale dosyalarının yükleme aşamasında telif hakkı formu ve yazar sözleşmesini indirebilirsiniz.

ÖN DÜZELTME VE MAKALE İADE SÜRECİ

Sisteme yüklenen makaleler Editör Kurulu'muzun değerlendirmesi sonucu ilk olarak ön kontrole alınır. DergiPark sisteminde yazılı dergimiz yazım kuralları doğrultusunda makaleler incelenir. **Ön kontrolde 2 kez düzeltme isteği alması ve gerekli düzeltmelerin verilen süre içerisinde yapılmaması halinde, makale sorumlu yazara iade edilir ve hakem değerlendirme sürecine alınmaz.**

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Olgu Sunumu/Case Report

HAKEMLERE TEŞEKKÜR

15. Cilt 1. Sayı için değerlendirilen taslak makaleleri bilimsel ve tarafsız gözle inceleyen ve aşağıda isimleri belirtilmiş olan hakemlerimize ve bütün danışma kurulu üyelerimize teşekkür ederiz.

Ahmet Hazar

Akif Demirel

Arzu Kaya Mumcu

Aydın Özkan

Aysenur Oncu

Ayşenur Altuğ

Burcu Gözetici Çil

Eda Gürsu Şahin

Elif Çoban

Gökhan Gürses

Gülin Acar

Merve Nezir

Metin Şençimen

Mihriban Gökcek Taraç

Mustafa Ercüment Önder

Mügem Gürel Ekici

Nagehan Aktaş

Salih Eren Meral

Sıla Nur Usta

Taha Özer

Taibe Tokgöz Kaplan

Editorial
Editörden

Dear Colleagues and Esteemed Readers of ADO Journal of Clinical Sciences,

On behalf of the **Editorial Board,** we are pleased to extend our sincere wishes for the year **2026.** We hope that the new year brings health, peace, prosperity, and professional success to our colleagues, and contributes positively to the advancement and well-being of our country.

May the year ahead be filled with achievement, inspiration, and fulfillment for you all.

With our kindest regards and best wishes for a **Happy New Year,**

Prof. Dr. Nur Mollaoğlu
Prof. Dr. S. Elif Gültekin
Assoc. Prof. Dr. Yeliz Kılınç
Assoc. Prof. Dr. Sinem Akgül
Asst. Prof. Dr. Özgün Yıldırım

Değerli Meslektaşlarımız ve Kıymetli ADO Klinik Bilimler Dergisi Okuyucularına,

Editörler Kurulu adına, **2026 yılının** meslektaşlarımıza sağlık, huzur, refah ve mesleki başarılar getirmesini; Ülkemizin gelişimine ve esenliğine katkı sağlamasını temenni ederiz.

Yeni yılın hepimiz için başarı, ilham ve memnuniyetle dolu bir yıl olmasını diliyor, **Mutlu Yıllar diliyoruz.**

Saygılarımızla,

Prof. Dr. Nur Mollaoğlu
Prof. Dr. S. Elif Gültekin
Doç. Dr. Yeliz Kılınç
Doç. Dr. Sinem Akgül
Dr. Öğr. Üyesi Özgün Yıldırım

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Original Research Article

Effect of Bevel Preparation on Color Adjustment Potential of One-Shade Composites

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[3]DDS, PhD, Associate Professor, Department of Restorative Dentistry, Faculty of Dentistry, Gazi University, Türkiye.

ABSTRACT

Aim: This study aimed to evaluate the effect of bevel preparation on the color adjustment potential (CAP) of three universal one-shade and one conventional resin composite used in anterior restorations.

Materials and Methods: Three universal one-shade (Omnichroma, Vitra APS Unique, Charisma Topaz One and one conventional resin composite (Estellite Sigma Quick) were tested. Standardized cavities (6 mm diameter, 2 mm depth) were prepared in A2-shade acrylic molds, either without bevel or with a 2 mm, 45° bevel. Each group consisted of ten specimens (n=10). Restorations were placed in a single increment, light-cured, polished, and stored in distilled water for 24 hours. Color parameters (L*, a*, b*) were measured using a spectrophotometer (VITA Easyshade V), and ΔE values were calculated with the CIEDE2000 formula. The color adjustment potential index (CAP-I) was determined as CAP-I = 1 – (ΔEDUAL/ΔESINGLE). Data were analyzed using the t- test, ANOVA and Tamhane post hoc tests (α=0.05).

Results: CAP-I values ranged from 0.57 to 0.86 in non-beveled and 0.85 to 0.94 in beveled groups. No statistically significant differences were found between bevel and and non-bevel designs except Omnichroma group (p=0.003). Omnichroma showed the lowest CAP in non-beveled groups (p<0.05), whereas Estellite demonstrated the highest overall values.

Conclusion: Bevel preparation did not significantly affect the color adjustment potential of tested composites except Omnichroma groups. The optical characteristics of restorative materials appear to have a greater influence than cavity design on esthetic blending. Therefore, appropriate composite selection remains critical for achieving natural integration in anterior restorations.

Keywords: Color; Composite dental resin; Dental cavity preparation

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INTRODUCTION

Composite restorations are widely used in modern restorative dentistry for preserving sound tooth structure and replicating the natural tooth's optical and mechanical properties.[1] They support the principles of minimally invasive treatment through conservative cavity designs, durable adhesive strategies, and biomimetic concepts that aim to restore both function and esthetics.[2] In the anterior region, patients have high esthetic expectations, so color adjustment is critical for patient satisfaction. Among these esthetic considerations, achieving a harmonious color match between the resin composite

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(RC) and the surrounding tooth is essential for clinical success.[3] However, this is often challenging due to the limited range of available shades and the multifactorial nature of tooth color, which is influenced by factors such as tooth type, location, age, and the distinct optical properties of enamel and dentin.[4] The final perceived color results from complex light interactions, including diffuse reflectance from the underlying dentin through the translucent enamel layer, making accurate shade matching between RC and natural teeth a demanding aspect of restorative dentistry.[2,4]

To help overcome these challenges, various changes have been made to the formulation of resin composites in recent years.[1] One of the most notable developments is the introduction of pigment-free, one-shade composites.[5,6] These universal one-shade composites are designed to match a wide range of shades (from A1 to D4) using a single syringe , eliminating the need for multiple shades and simplifying the restorative procedure.

One-shade composites take advantage of the blending effect, where the restoration's optical properties interact with the surrounding tooth to create a smooth visual transition, making restoration margins natural.[2] This phenomenon is closely related to the concept of color adjustment potential, which describes the ability of a resin composite to harmonize with adjacent tooth tissues through light scattering, translucency, and internal reflection.[7]

Color adjustment potential (CAP) refers to the color-matching phenomenon of resin composites, which involves the mutual reflection and shift of optical properties between the RC restoration and the surrounding tooth structure. One-shade composites with their color adjustment feature make clinical procedures easier by reducing the effort needed for shade selection.[6] CAP is not only relevant for immediate shade matching but also plays a crucial role in maintaining long-term esthetic stability, as materials with higher blending ability are better able to tolerate minor color changes in both the composite and the surrounding tooth structure over time.[8] Their ability to adapt to different tooth colors lessens esthetic concerns and helps achieve satisfactory results in daily practice.[6,7]

Despite these advantages, achieving invisible margins remains a challenge, particularly in anterior teeth where esthetic demands are highest. In this context, cavity design plays a crucial role, and the placement of a cavosurface margin bevel has traditionally been recommended in literature for more effective retention, reducing microleakage, and improving esthetics, especially in anterior regions.[9-11] However, advancements in adhesive technology have made it possible to place adequate restorations without bevels, resulting in more conservative preparations.[12,13] With the focus on minimally invasive approaches and the improved optical properties of modern restorative materials, the need for bevel application in anterior restorations has become questionable.[12,14]

Previous studies have highlighted the role of beveling in enhancing the esthetic integration of anterior restorations, while recent research has focused on the color adjustment potential of one-shade composites with advanced optical properties.[9,15,16] However, there is limited evidence regarding the influence of beveling on the color adjustment potential of these new restorative materials.[5-7]

Therefore, the present study aimed to investigate whether (I) bevel design and (II) composite type influence the color adjustment potential of three one-shade and one conventional resin composites with color adjustment future. Two null hypothesis were evaluated:

$H0_1$: Bevel design (beveled vs non-beveled) does not significantly affect the color adjustment potential of tested resin composites.

$H0_2$: There are no significant differences in the color adjustment potential among the four tested resin composites

MATERIALS AND METHODS

This laboratory-based study included four commercial resin composites: Omnichroma (Tokuyama Dental, Japan), Vitra APS Unique (FGM Dental Group, Brazil), Charisma Topaz One (Kulzer, Germany), Estellite Sigma Quick (Tokuyama Dental, Japan) with a color adjustment potential future. The composition and manufacturer details for the materials employed in this study are listed in Table 1. Fig. 1 illustrates

Table 1. Materials used in the study

Product	Shade	Filler content-filler (wt%/ vol%)	Monomer Type	Manufacturer	Batch No.
Omnichroma	-	Spherical SiO2 -ZrO2 Particle size of 260 nm- (79%/68%)	UDMA, TEGDMA	Tokuyama Dental, Shibuya, Tokyo, Japan	2409
Vitra APS Unique	-	Zirconia filler (200 nm), Silica - (72-80%/50-60%)	UDMA, TEGDMA	FGM, Joinville, Brazil	040723
Estelite Sigma Quick	A2	Spherical SiO2 -ZrO2 Particle size of 100-300 nm - (82%/71%)	Bis-GMA, TEGDMA	Tokuyama Dental, Shibuya, Tokyo, Japan	E9024
Charisma Topaz One	-	Barium aluminum fluoride glass filler of 0.02–2 μm, 5 vol% pyrogenic silicon dioxide filler of 0.02–0.07 μm -(81%/64%)	UDMA, TCD-DIHEA, TEGDMA	Kulzer, Hanau, Germany	N010302

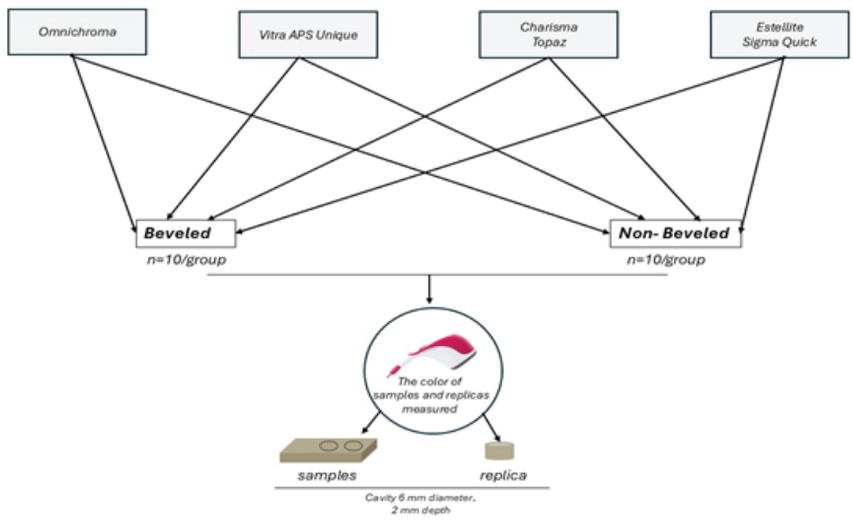

Fig 1. Flow chart of the experimental design

the study design, showing the flow of specimens through the various stages of the experiment. In order to create dual and replica samples, molds were designed and produced with a 3D printer (HP Jet Fusion, HP Inc., Germany) as follows; non-beveled and 2 mm beveled. The cavities in the molds were prepared with a diameter of 6 mm, a depth of 2 mm, and with or without 2 mm 45^0 beveling for dual samples The sample size was calculated using G*Power (version 3.1.9.7, Kiel University, Kiel, Germany) and the one-way analysis of variance (ANOVA) for four groups based on the findings of a previous study.[17] The effect size was effect size of d = 0.55, a sample size of 10 was sufficient to achieve 95% power at α =0.05.

Then, in order to ensure standardization, mold negatives get prepared with silicone impressions (Zetaplus, Zhermack, Germany), and then final molds to which the restorations will be applied were prepared with autopolymerizing acrylic (Dentalon plus, Heraus Kulzer, Germany), which is a temporary crown and bridge material in A2 shade. Samples with and without a 2 mm bevel were produced by resin composites of each group. For the dual sample measurements, designated measurement areas within the acrylic molds were utilized. The composites were placed into the cavity as a single increment, and the microscope slide and mylar strip were applied with slight pressure. All specimens were light-cured with a light-emitted diode unit

(D-Light Pro, GC Corporation, Japan) used in the standard mode (1400 mW/cm^2) for 20 s. Previously described silicone molds were used to obtain single specimens. To remove the mylar layer, the finishing/polishing procedure is applied to the composite surface with Sof-Lex Contouring and Polishing Disks (3M™ ESPE, USA) at medium, fine, and super-fine grit discs under water cooling at a speed of 10.000 rpm for 20s. Following the restorations, the specimens were kept in distilled water at room temperature for 24 hours.

All data collection was performed by a single operator in a controlled environment with standardized D65 illumination (6500K). Prior to the measurements, the spectrophotometer (VITA Easyshade V, VITA Zahnfabrik, Germany) was calibrated to ensure accuracy. The color parameters (L*, a*, b*) were obtained from the central area of each specimen against a white background and subsequently converted to CIEDE2000 values as follows:

In the ΔE formula, the terms ΔL, ΔC, and ΔH represent the differences in lightness, chroma (saturation), and hue, respectively. The R_T value accounts for the interaction between chroma and hue differences. The parametric factors Kl, Kc, and Kh are typically set to 1 under standard conditions.

The instrumental color adjustment potential (CAP-I) parameter was calculated using the CIEDE2000 equation with values of the sample as follows:

For each specimen group (2 mm beveled, non-beveled, single, and dual), ten samples were prepared (n=10). All measurements were performed by the same operator, repeated three times, and the mean values were calculated and recorded as the color values of each specimen.

In the evaluation of color adjustment potential (CAP), color differences were calculated using ΔE values. Specifically, ΔE_{SINGLE} refers to the color difference between a single composite specimen and the reference (unrestored acrylic space), while ΔE_{DUAL} represents the color difference between a composite-restored cavity (dual specimen) and the same unrestored acrylic space.

All statistical analyses were carried out using IBM SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA), with a significance level of $p<0.05$.
The Shapiro–Wilk test showed that the data were normally distributed ($p>0.05$). Independent samples t-tests were performed for each composite to compare beveled and non-beveled groups. Additionally, one-way ANOVA was used within each margin design group (beveled or non-beveled) to compare the four composite materials, followed by Tamhane's post-hoc test when variances were unequal.

RESULTS

The CAP-I values for each composite material under non-beveled and beveled conditions are summarized in Table 2. Welch independent samples t-tests demonstrated that bevel preparation produced a statistically significant increase in CAP-I only for Omnichroma ($p=0.003$), whereas no significant differences were observed between beveled and non-beveled groups for Vitra ($p=0.32$), Charisma Topaz One ($p=0.45$), or Estellite Sigma Quick ($p=0.27$). One-way ANOVA indicated that composite type significantly affected CAP-I in non-beveled restorations ($p = 0.009$), while no significant inter-material differences were detected in beveled restorations ($p=0.15$). These findings indicate that bevel preparation does not uniformly enhance the

Table 2. Mean color adjustment potential (CAP-I) values and standard deviations of tested composites with different cavity margin designs

	CAP-I		
Groups	Non-beveled	2- mm bevel	p-value (Beveled vs Non-Beveled
Omnichroma	$0.57 \pm 0.10^{a,A}$	0.87 ± 0.01^{B}	0.003
Vitra APS Unique	$0.80 \pm 0.09^{b,A}$	0.85 ± 0.09^{A}	0.120
Charisma Topaz	$0.82 \pm 0.17^{b,A}$	0.87 ± 0.07^{A}	0.400
Estellite	$0.86 \pm 0.14^{b,A}$	0.94 ± 0.04^{A}	0.05

*Different lowercase letters shown as superscripts on the column indicate a statistically significant difference by (Welch) t-test ($p<0.05$; two-sided)
**Different uppercase letters shown as a superscripts on the line indicate a statistically significant difference

color adjustment potential of tested composites and that material-dependent differences are more prominent in non-beveled cavities.

DISCUSSION

In esthetic dentistry, achieving imperceptible margins and harmonious color integration remains one of the greatest challenges, particularly in anterior restorations where patient expectations are high.[18] To address these demands, recent advances have focused both on developing one-shade resin composites with enhanced optical properties and on evaluating cavity preparation designs, such as beveling, that may improve the blending effect and esthetic outcome.[19] However, preparation design alone cannot ensure perfect integration, because the optical properties of the restorative material—such as translucency, opalescence, and especially its color adjustment potential (CAP)—play a decisive role.[20]

In this context, the concept of CAP has gained increasing attention, reflecting the ability of a composite to harmonize with surrounding tooth structures and enhance the blending effect.[7] CAP can be assessed by two main approaches: visual evaluation and instrumental analysis. While visual methods rely on subjective perception and can be influenced by individual variability, instrumental methods provide more objective and reproducible measurements.[21] In the present study, CAP was determined using instrumental analysis; therefore, a spectrophotometer (VITA Easyshade V) was employed for shade evaluation. Objective color-measurement devices such as spectrophotometers—particularly the VITA Easyshade V—have been shown to provide standardized and reproducible shade selection, reducing the subjectivity of visual assessment.[22] VITA Easyshade V demonstrates high reliability and accuracy and has been validated to produce the most precise, repeatable, and clinically acceptable results among available devices.[23]

The CIELAB color system has long been used to quantify tooth color differences; however, it shows limitations in accurately reflecting human visual perception, particularly for the subtle color variations critical in dental applications. To address these shortcomings, the International Commission on Illumination (CIE) introduced the CIEDE2000 formula, which incorporates corrections for hue, chroma, and lightness interactions, along with a weighting factor to improve perceptual uniformity.[4] With the increasing emphasis on precise color matching, CIEDE2000 has become the most widely accepted method for defining perceptibility and acceptability thresholds in dental research.[24] Although CIELAB calculations are still commonly used, CIEDE2000 was employed in our study to provide a more perceptually relevant assessment of color differences.

One-shade composites were developed to simplify shade selection in clinical practice while maintaining esthetically acceptable outcomes. These materials differ significantly from traditional multi-shade composites, as they exhibit wavelength-dependent optical behavior with distinct translucency and opalescence parameters.[18] “Smart monochromatic” composites represent a newer category based on smart chromatic technology, which captures the structural color of surrounding enamel through filler particle size-dependent light scattering, without added pigments. Omnichroma, first marketed in 2019, is a pigment-free one-shade composite that relies on the chameleon effect to achieve superior shade-matching ability.[20] Similarly, Vitra APS Unique (FGM) and Charisma Topaz One (Kulzer) are universal one-shade composites designed to simplify shade selection; Vitra incorporates zirconia and silica fillers, while Charisma Topaz utilizes a TCD-based monomer matrix to enhance physical and optical properties.[6,18] In contrast, Estelite Sigma Quick (Tokuyama) is a conventional submicron-filled composite, included in this study as a reference material due to its established esthetic track record.[5,17]

Translucency significantly influences the CAP of composite restorations. An optimal level of translucency facilitates the uptake of surrounding tooth color, enhancing the blending effect, whereas excessively opaque or overly translucent materials compromise this integration.[25] In their study comparing one-shade composites, Lucena *et al*.[18] reported that Omnichroma exhibited the highest translucency, which decreased with increasing material thickness. In the present study, Omnichroma showed the lowest CAP-I values in the non-bevel design, while in the 2 mm bevel design it demonstrated comparable CAP to other materials tested, suggesting that translucency at

this thickness was insufficient for ideal adaptation. One-shade composites such as Omnichroma can achieve clinically acceptable color matching, but performance depends on factors including cavity depth and surrounding shades.[5] Therefore, optimal CAP performance appears to rely on the interaction between translucency, restoration thickness, and application technique.

Among all groups and bevel designs, Estellite demonstrated the highest CAP. This superior performance may be attributed to the presence of pigments within its formulation, which enhances its ability to modulate color and harmonize with the surrounding tooth structure. The incorporation of pigments can improve the blending effect by promoting better light scattering and shade matching in composite resins.

Enamel beveling is a widely accepted procedure in adhesive dentistry to optimize the clinical performance of direct composite restorations.[10] In modern restorative dentistry, its purpose extends to esthetics, as beveling provides a gradual transition between restoration and tooth, improving integration.[9] Beveling removes the aprismatic, fluoride-rich enamel layer, creating a more favorable etching pattern and increasing surface wettability.[10] Exposure of enamel rod ends increases bonding area, promoting stronger micromechanical retention and smoother margins. Studies have demonstrated that beveling improves marginal sealing, reduces microleakage, and enhances the optical transition between composite and enamel.[9,10] Qadir *et al*.[11] also found that a 45° bevel provided better stress distribution and reduced marginal fractures compared with chamfer designs. Beveling therefore softens restoration margins and improves the natural appearance of anterior restorations.[26]

A significant bevel-related increase in CAP-I was observed only for Omnichroma, while Vitra, Charisma Topaz One, and Estellite were unaffected. Accordingly, $H0_1$—which stated that bevel preparation would not influence CAP-I—was rejected. This material-specific response may be linked to Omnichroma's structural-color mechanism, which relies on light-scattering phenomena that could be amplified at beveled enamel margins. In contrast, the remaining materials exhibited stable CAP-I values regardless of beveling, indicating that their blending behavior is largely governed by intrinsic optical properties rather than cavity design.

Moreover, inter-material differences were significant only in non-beveled restorations, whereas beveling diminished these differences, possibly by creating a smoother optical transition at the restoration margins. Therefore, $H0_2$ was also rejected, as significant material-dependent differences were demonstrated—particularly in non-beveled restorations—highlighting that intrinsic optical characteristics had a more decisive influence on chromatic blending than margin configuration. One-shade composites demonstrated variable CAP performance depending on material type, underscoring the importance of appropriate material selection and application strategy in anterior esthetic restorations. A primary limitation of this study is the use of acrylic resin molds, which, despite offering standardization, lack the complex optical gradients and histological structure of natural tooth tissues. Additionally, the assessment was confined to a single background shade (A2) and immediate optical integration, meaning the results may not fully extrapolate to the entire spectrum of tooth shades or long-term clinical scenarios involving aging and thermocycling. Finally, reliance solely on spectrophotometric analysis excludes the nuances of human visual perception, which remains essential for evaluating clinical esthetic success. Long-term clinical studies are warranted to confirm these findings and to further elucidate the interplay between cavity design and optical behavior in contemporary composites.

CONCLUSION

Within the limitations of this laboratory study, a significant bevel-related increase in CAP-I was observed only for Omnichroma, whereas Vitra APS Unique, Charisma Topaz One, and Estelite Sigma Quick demonstrated no bevel-dependent changes. This finding indicates that the optical behavior of tested composites with color adjustment feature is material-specific, and that beveling enhances blending performance only in selected formulations.

Furthermore, inter-material differences were evident in non-beveled restorations but diminished when a

bevel was present, suggesting that cavity design may partially mask material-dependent optical variability. Overall, the results indicate that intrinsic optical properties played a more decisive role than bevel preparation in achieving chromatic integration.

These findings suggest that acceptable esthetic outcomes may be achievable without bevel preparation when using contemporary resin composites systems with color adjustment feature, although material selection remains a critical factor. Further clinical investigations are warranted to validate these results under intraoral conditions and to assess the long-term color stability of these composites in functional environments.

CONFLICTS OF INTEREST STATEMENT

The authors report no conflicts of interest to declare.

Bizotaj Uygulamasının Tek Renk Kompozitlerde Renk Uyumu Potansiyeline Etkisi

ÖZET

Amaç: Bu çalışmanın amacı, anterior restorasyonlarda kullanılan üç tek renkli ve bir adet geleneksel rezin kompozitin renk uyumu potansiyeli (CAP) üzerine bizotaj preparasyonunun etkisini değerlendirmektir.

Gereç ve Yöntemler: Çalışmada üç tek renkli (Omnichroma, Vitra APS Unique, Charisma Topaz One ve bir adet geleneksel (Estellite Sigma Quick) incelendi. A2 renkli akrilik kalıplarda 6 mm çapında, 2 mm derinliğinde, bizotajsız veya 2 mm, 45° bizotaj uygulanmış kaviteler hazırlandı. Her grup 10 örnekten oluştu (n=10). Restorasyonlar tek tabaka halinde yerleştirildi, ışıkla polimerize edildi, polisajı yapıldı ve 24 saat distile suda bekletildi. Renk parametreleri (L*, a*, b*) spektrofotometre (VITA Easyshade V) ile ölçüldü; ΔE değerleri CIEDE2000 formülüne göre hesaplandı. Renk uyumu potansiyel indeksi (CAP-I)=1–(ΔEDUAL/ΔESINGLE) olarak belirlendi. Veriler ANOVA , t-Test ve Tamhane post-hoc testleri ile analiz edildi (α=0.05).

Bulgular: CAP-I değerleri bizotajsız gruplarda 0.57–0.86, bizotaj uygulanan gruplarda 0.85–0.94 arasında değişti. Bizotajlı tasarım ile bizotajsız kaviteler arasında anlamlı fark Omnichroma grupları dışında bulunmadı (p=0.003). Omnichroma bizotajsız grupta en düşük, Estellite ise genel olarak en yüksek CAP değerini gösterdi.

Sonuç: Bizotaj preparasyonu test edilen rezin kompozitlerin renk uyumu potansiyelini anlamlı şekilde etkilememiştir. Estetik entegrasyonda kavite tasarımından çok restoratif materyalin optik özellikleri belirleyici görünmektedir. Bu nedenle, uygun kompozit seçimi anterior_restorasyonlarda doğal görünüm elde edilmesi açısından kritik öneme sahiptir.

Anahtar Kelimeler: Diş kavite preparasyonu; Kompozit dental rezin; Renk

REFERENCES

1. Ferracane JL. Resin composite—State of the art. Dent Mater 2011;27:29–38.

2. Meyer-Lueckel H, Paris S, Ekstrand KR, Effenberger S. Caries management—Science and clinical practice. Stuttgart: Thieme; 2013.

3. Paravina RD, Westland S, Kimura M, Powers JM, Imai FH. Color interaction of dental materials: Blending effect of layered composites. Dent Mater 2006;22:903–8.

4. Khashayar G, Bain PA, Salari S, Dozic A, Kleverlaan CJ, Feilzer AJ. Perceptibility and acceptability thresholds for colour differences in dentistry. J Dent 2014;42:637–44.

5. Kobayashi S, Nakajima M, Furusawa K, Tichy A, Hosaka K, Tagami J. Color adjustment potential of single-shade resin composite to various-shade human teeth: Effect of structural color phenomenon. Dent Mater J 2021;40:1033–40.

6. Altınışık H, Özyurt E. Instrumental and visual evaluation of the color adjustment potential of different single-shade resin composites to human teeth of various shades. Clin Oral Investig 2023;27:889–96.

7. Ismail EH, Paravina RD. Color adjustment potential of resin composites: Optical illusion or physical reality? A comprehensive overview. J Esthet Restor Dent 2022;34:42–54.

8. Fazlıoğlu L, Oğlakçı B, Özduman ZC, Dalkılıç EE. The color change of a novel single-shade composite immersed in different beverages. Bezmialem Sci 2022;10:345–51.

9. Ramírez-Barrantes JC. Esthetic anterior resin restorations: To bevel enamel or not? Odovtos Int J Dent Sci 2021;23:13–7.

10. Rajagopal S, Sharma S. Comparative evaluation of marginal leakage of various bevel designs using direct composite restoration in fractured anterior teeth: An *in vitro* study. Cureus 2024;16:e56860.

11. Qadir HA, El-Wassefy NA, Abdullah AM, Hamama HH. Effect of different bevel designs on microleakage and shear bond strength of Class IV composite restoration: A laboratory study. Mansoura J Dent 2022;9:1–3.

12. Baratieri LN, Ritter AV, Swift EJ Jr. To bevel or not in anterior composites. J Esthet Restor Dent 2005;17:264–6.

13. Peumans M, De Munck J, Mine A, Van Meerbeek B. Clinical effectiveness of contemporary adhesives for the restoration of non-carious cervical lesions: A systematic review. Dent Mater 2014;30:1089–103.

14. Costa TRF, Loguercio AD, Reis A. Effect of enamel bevel on the clinical performance of resin composite restorations placed in non-carious cervical lesions. J Esthet Restor Dent 2013;25:346–56.

15. Apel Z, Vafaeian B, Apel DB, Hussain A. Occlusal stresses in beveled versus non-beveled tooth preparation. Biomed Eng Adv 2021;100010.

16. Poojary PK, Bhandary S, Srinivasan R, Nasreen F, Pramod J, Mahesh M. Influence of restorative technique, bevelling and aging on composite bonding to sectioned incisal edges: A comparative *in vitro* study. J Conserv Dent Endod 2013;16:28–31.

17. Durand LB, Ruiz-López J, Perez BG, Ionescu AM, Carrillo-Pérez F, Ghinea R, *et al*. Color, lightness, chroma, hue, and translucency adjustment potential of resin composites using CIEDE2000 color difference formula. J Esthet Restor Dent 2021;33:836–43.

18. Lucena C, Ruiz-López J, Pulgar R, Della Bona A, Pérez MM. Optical behavior of one-shaded resin-based composites. Dent Mater 2021;37:840–8.

19. Mohammadipour HS, Yazdi SS, Mashhad MJM, Babazadeh S, Shahri A. Color matching and translucency of single-shade resin composites: Effects of restoration thickness, background shade, and aging. BMC Oral Health 2025;25:616.

20. Prodan CM, Gasparik C, Ruiz-López J, Dudea D. Color and translucency variation of a one-shaded resin-based composite after repeated heating cycles and staining. Materials 2023;16:3793.

21. de Bragança RMF, Del Rio DL, Oliveira-Neto LA, Johnston WM. Assessing color mismatch in single-shade composite resins for enamel replacement. J Prosthet Dent 2024;132:613.e1–8.

22. Baghizadeh S, Tabari K, Abbasi K, Tabatabaei SF, Heshmat H. Assessing shade matching capability of Omnichroma, a single-shade composite in posterior restorations: An *in vitro* study. J Med Life 2024;17:776–82.

23. Knezović D, Zlatarić D, Illeš IŽ, Alajbeg M. *In vivo* and *in vitro* evaluations of repeatability and accuracy of VITA Easyshade® Advance 4.0 dental shade-matching device. Acta Stomatol Croat 2015;49:112

24. Luo MR, Cui G, Rigg B. The development of the CIE 2000 colour-difference formula: CIEDE2000. Color Res Appl 2001;26:340–50.

25. Özdemir B, Karadeniz BKK, Özdemir SB, Akbulut Ö. How the translucency and color stability of single-shade universal resin composites are affected by coffee? Curr Res Dent Sci 2024;34:270–5.

26. Aida A, Nakajima M, Seki N, Kano Y, Foxton RM, Tagami J. Effect of enamel margin configuration on color change of resin composite restoration. Dent Mater J 2016;35:675–83.

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Original Research Article

Comparison of Jaw Functional Limitations and Oral Health-Related Quality of Life in Masticatory Muscle Disorder and Disc Displacement Patients

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ABSTRACT

Aim: This study compared jaw functional limitations and oral health-related quality of life in patients with Masticatory Muscles Disorder (MMD) and Internal Derangement (DD) using the Jaw Functional Limitation Scale (JFLS-20) and the Oral Health Impact Profile-14 (OHIP-14). It also investigated the reliability of these scales within each patient group.

Materials and Methods: A total of 70 patients, 35 with MMD and 35 with DD, were included. Diagnoses were established based on the Research Diagnostic Criteria for Temporomandibular Disorders and clinical examination. JFLS-20 and OHIP-14 were administered to assess functional limitations and oral health-related quality of life. Statistical analyses were performed using independent t-tests and Pearson correlation.

Results: The DD group exhibited significantly higher JFLS-20 scores ($p<0.001$), indicating greater functional limitations. Similarly, OHIP-14 scores were significantly higher in DD patients ($p=0.003$), reflecting a greater impact on quality of life. JFLS-20 demonstrated higher reliability in the DD group ($\alpha=0.915$), whereas OHIP-14 showed higher reliability in the MMD group ($\alpha=0.862$). No significant correlation was found between JFLS-20 and OHIP-14 in either group.

Conclusions: DD patients experience more severe functional impairments and quality-of-life reductions than MMD patients. The differing reliability of JFLS-20 and OHIP-14 suggests that structural dysfunctions primarily impact function. On the other hand, myofascial pain is more closely associated with psychosocial distress. While the JFLS-20 may be more suitable for evaluating functional impairment in DD patients, the OHIP-14 may better capture the broader impact of MMD, emphasizing the importance of individualized treatment approaches.

Keywords: Disc displacement; Masticatory muscles; Myofascial pain dysfunction syndrome; Temporomandibular joint disorder; Quality of life; Surveys and questionnaires

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INTRODUCTION

Temporomandibular disorders (TMDs) are a collection of pathological conditions affecting the temporomandibular joint (TMJ) and masticatory muscles, often resulting in pain, functional impairments, and decreased quality of life.[1] Their etiology is multifactorial, involving mechanical, inflammatory, and psychosocial components.[2] The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I provides a standardized approach for diagnosing TMDs, classifying them into three main categories: myofascial pain, disc displacement, and arthralgia/degenerative joint disorders.[3,4] Among these, Masticatory Muscle Disorders (MMD) primarily involve muscular dysfunction, whereas Disc Displacement (DD) is characterized by structural abnormalities such as disc displacement, often resulting in restricted mandibular movement.[4]

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Evaluating the functional and psychosocial effects of TMDs necessitates the use of reliable and validated assessment tools. The Jaw Functional Limitation Scale (JFLS-20) is commonly employed to measure restrictions in chewing, jaw mobility, and communication abilities,[5,6] while the Oral Health Impact Profile-14 (OHIP-14) assesses the influence of oral health issues on the overall quality of life.[7] Both instruments have demonstrated strong reliability in previous research and are crucial for understanding the impact of TMDs on daily functioning.

Despite the widespread use of these assessment tools, limited studies have directly compared jaw function limitations and quality of life between MMD and DD patients using both JFLS-20 and OHIP-14.[8] Given the divergent pathophysiological mechanisms underlying these disorders, a comparative analysis is imperative to elucidate how structural versus muscular dysfunctions impact functional impairment and quality of life.[9,10] This study aims to quantitatively evaluate the differences in functional limitations and oral health-related quality of life between patients diagnosed with MMD and those with DD. By elucidating these distinctions, the research may contribute to the formulation of more targeted therapeutic strategies and improve our understanding of the clinical burden associated with various subtypes of temporomandibular disorders.

MATERIALS AND METHODS

This study was conducted on patients diagnosed with TMD at Hacettepe University, Faculty of Dentistry, Department of Oral and Maxillofacial Surgery in 2025. Ethical approval for the study was obtained from Hacettepe University Health Sciences Research Ethics Committee (Approval Number: 2025/05-53). Written informed consent was obtained from all participants before their inclusion in the study. The study included a total of 70 patients, comprising the first 35 consecutively diagnosed DD cases and the first 35 consecutively diagnosed MMD cases. The diagnoses were established based on the RDC/TMD and clinical examination findings for the MMD and DD groups.[3,4] Patients with systemic diseases affecting the temporomandibular joint, a history of maxillofacial trauma, prior TMJ surgery, or ongoing TMD treatment were excluded from the study. All participants completed the JFLS-20 and the OHIP-14 questionnaires to assess jaw function and oral health-related quality of life. The surveys were conducted face-to-face, and all patients were given an average of 10 minutes for each questionnaire. These validated instruments have been widely used to determine TMD-related functional impairment and psychosocial impact.[5,7,11,12] Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to present categorical variables as frequencies and percentages, while continuous variables were reported as means and standard deviations. According to the criteria for normal distribution, skewness and kurtosis values must be within the range of ±1.5.[13] The analysis revealed that the data followed a normal distribution. Based on these results, parametric tests were applied for comparative analyses. Independent sample t-tests were used to compare JFLS-20 and OHIP-14 scores between the two patient groups. Pearson correlation analysis was conducted to examine the relationship between functional limitation and oral health-related quality of life. A significance level of $p<0.05$ was considered statistically significant for all analyses. Reliability of the JFLS-20 and OHIP-14 questionnaires was assessed using Cronbach's alpha coefficients, calculated separately for the MMD and DD groups.

RESULTS

The study included 70 patients, 35 diagnosed with MMD and 35 with DD, ensuring an equal sample size for the two comparison groups.

Reliability analysis was conducted for both scales used in the study. The Cronbach's Alpha values indicated high internal consistency for both scales across both patient groups.[14] The JFLS-20 demonstrated the highest reliability in the DD group ($\alpha=0.915$), while the OHIP-14 showed the highest reliability in the MMD group ($\alpha=0.862$) (Table 1).

The total JFLS-20 score was significantly higher in the DD group (4.42 ± 1.79) compared to the MMD group (1.83 ± 0.59, $p = 0.001$) (Table 2). Similarly, all subdimensions of JFLS-20 exhibited significantly higher scores in the DD group, indicating more significant functional limitations. The mean chewing limitation score was 4.77 ± 2.16 in the DD group and 2.99 ± 1.16 in the MMD group ($p=0.001$). The movement limitation score was 5.67 ± 2.31 in the DD group and 2.73 ± 0.99 in the MMD group ($p=0.001$).

Table 1. Reliability Analysis of JFLS-20 and OHIP-14 in MMD and DD Groups

Scale and Subscales	MMD Group (Cronbach's Alpha)	DD Group (Cronbach's Alpha)
JFLS-20	0.780	0.915
OHIP-14	0.862	0.830

JFLS-20: Jaw Functional Limitation Scale 20, OHIP-14: Oral Health Impact Profile-14, MMD: Masticatory Muscle Disorders, DD: Disc Displacement

Table 2. Comparison of Jaw Functional Limitations and Oral Health-Related Quality of Life Between MMD and DD Patients

	MMD Group (Mean ± SD)	DD Group (Mean ± SD)	t-value†	p-value
Total JFLS-20 Score	1.83 ± 0.59	4.42 ± 1.79	-8.13	0.001**
Chewing Limitation	2.99 ± 1.16	4.77 ± 2.16	-4.30	0.001**
Movement Limitation	2.73 ± 0.99	5.67 ± 2.31	-6.92	0.001**
Verbal/Non-verbal Communication Limitation	0.77 ± 0.51	3.71 ± 2.00	-8.45	0.001**
Total OHIP-14 Score	30 ± 8.25	36.49 ± 9.1	-3.12	0.003**
Functional Limitation	2.49 ± 1.09	3.86 ± 2.02	-3.54	0.001**
Physical Pain	7 ± 1.31	7.83 ± 1.82	-2.19	0.033*
Psychological Distress	5 ± 2.01	5.57 ± 2.08	-1.17	0.247
Physical Disability	3.86 ± 1.56	4.86 ± 2.18	-2.21	0.031*
Psychological Disability	4.14 ± 1.94	5.49 ± 1.79	-3.01	0.004**
Social Disability	3.91 ± 2.02	4.86 ± 2.05	-1.94	0.057
Handicap	3.6 ± 1.54	4.03 ± 1.54	-1.16	0.249

SD: Standard deviation, JFLS-20: Jaw Functional Limitation Scale 20, OHIP-14: Oral Health Impact Profile-14, MMD: Masticatory Muscle Disorders, DD: Disc Displacement, *p<0.05, **p<0.001

†: "The results of Levene's test indicated a violation of the homogeneity of variances assumption (p<.05). Consequently, the Welch adjusted t-test statistic was used for group comparisons, and the p-values derived from this test are presented."

The verbal/nonverbal communication limitation score was also higher in the DD group (3.71 ± 2.00) compared to the MMD group (0.77 ± 0.51, p=0.001) (Table 2).

The total OHIP-14 score was significantly higher in the DD group (36.49 ± 9.1) compared to the MMD group (30 ± 8.25, p=0.003), indicating a more significant negative impact on oral health-related quality of life in the DD group (Table 2). Significant differences were found in multiple subdimensions. The functional limitation score was 3.86 ± 2.02 in the DD group and 2.49 ± 1.09 in the MMD group (p= 0.001). The physical pain score was 7.83 ± 1.82 in the DD group and 7 ± 1.31 in the MMD group (p= 0.033). The physical disability score was 4.86 ± 2.18 in the DD group and 3.86 ± 1.56 in the MMD group (p=0.031). The psychological disability score was higher in the DD group (5.49 ± 1.79) compared to the MMD group (4.14 ± 1.94, p=0.004). No significant differences were observed between the groups in psychological distress (p=0.247), social disability (p=0.057), and handicap (p=0.249) (Table 2).

The correlation analysis between JFLS-20 and OHIP-14 scores showed no significant association in the MMD group (p=0.946). In the DD group, a weak positive correlation was found (r=0.29), but it did not reach statistical significance (p=0.091).

An item-level analysis of JFLS-20 and OHIP-14 showed significant differences in multiple items between the two groups (Table 3). Patients in the DD group reported greater difficulty in jaw opening, chewing hard foods, and verbal/non-verbal expressions. In OHIP-14, significant differences were found in aspects related to eating difficulties, self-confidence, and discomfort (Table 3).

Table 3. Item-Level Comparison of JFLS-20 and OHIP-14 Scores Between MMD and DD Patients

	MMD Group (Mean ± SD)	DD Group (Mean ± SD)	t-value†	p-value
JFLS Questions				
Chewing tough foods	6.54 ± 1.9	7.8 ± 2.29	-2.50	0.015*
Chewing hard bread	5.66 ± 2.14	7.37 ± 2.79	-2.89	0.005**
Chewing chicken	3.06 ± 1.92	5.29 ± 3.01	-3.69	0.001**
Chewing crackers	2.26 ± 1.62	4.23 ± 3.15	-3.29	0.002**
Chewing soft foods	0.37 ± 0.84	2.49 ± 2.56	-4.64	0.001**
Eating soft non-chew foods	0.06 ± 0.24	1.46 ± 2.37	-3.48	0.001**
Open wide enough to bite from a whole apple	5.66 ± 1.97	8.6 ± 2.76	-5.14	0.001**
Open wide enough to bite into a sandwich	4.54 ± 1.85	7.49 ± 2.81	-5.17	0.001**
Open wide enough to talk	0.43 ± 0.85	3.29 ± 3.09	-5.27	0.001**
Open wide enough to drink from a cup	0.29 ± 0.71	3.31 ± 3.4	-5.16	0.001**
Swallowing	0.43 ± 1.01	2 ± 2.71	-3.21	0.002**
Yawning	5 ± 2.39	7.94 ± 2.5	-5.04	0.001**
Talk	0.6 ± 1.48	2.8 ± 2.62	-4.32	0.001**
Singing	0.43 ± 1.04	2.91 ± 2.75	-5.01	0.001**
Putting on a happy face	0.2 ± 0.58	2.94 ± 2.7	-5.87	0.001**
Putting on an angry face	0.03 ± 0.17	3.26 ± 3.24	-5.89	0.001**
Frowning	0.03 ± 0.17	2.77 ± 3.09	-5.25	0.001**
Kissing	0.09 ± 0.28	3.4 ± 3.39	-5.77	0.001**
Smiling	0.4 ± 0.85	3.26 ± 3.22	-5.08	0.001**
Laughing	0.49 ± 0.92	5.86 ± 3.19	-9.57	0.001**
OHIP-14 Questions				
Pronouncing words	1.29 ± 0.57	2.14 ± 1.24	-3.71	0.001**
Sense of taste worsened	1.2 ± 0.58	1.71 ± 1.13	-2.40	0.020*
Psinful aching	3.86 ± 0.81	3.91 ± 1.12	-0.24	0.808
Uncomfortable to eat any foods	3.14 ± 0.94	3.91 ± 1.17	-3.03	0.003**
Been self-conscious	1.77 ± 1.11	2.26 ± 1.22	-1.74	0.087
Felt tense	3.23 ± 1.29	3.31 ± 1.3	-0.28	0.782
Diet been unsatisfactory	1.83 ± 0.95	2.63 ± 1.42	-2.77	0.007**
Interrupt meals	2.03 ± 0.89	2.23 ± 1.14	-0.82	0.416
Difficult to relax	2.69 ± 1.3	3.43 ± 1.04	-2.64	0.01*
Feel a bit embarressed	1.46 ± 0.82	2.06 ± 1.16	-2.50	0.015*
Irritable with people	2.03 ± 1.1	2.54 ± 1.12	-1.94	0.057
Difficulty doing usual jobs	1.89 ± 1.11	2.31 ± 1.16	-1.58	0.118
Life in general less satisfying	2.46 ± 1.34	2.63 ± 1.29	-0.55	0.586
Totally unable to function	1.14 ± 0.43	1.4 ± 0.6	-2.05	0.044*

JFLS-20: Jaw Functional Limitation Scale 20, OHIP-14: Oral Health Impact Profile-14, MMD: Masticatory Muscle Disorders, DD: Disc Displacement, S.D.: standard deviation, t: independent sample t-test, *p<0.05 **: p<0.01

†: "The results of Levene's test indicated a violation of the homogeneity of variances assumption (p<.05). Consequently, the Welch adjusted t-test statistic was used for group comparisons, and the p-values derived from this test are presented."

DISCUSSION

This study conducted a comparative analysis of jaw function limitations and oral health-related quality of life among patients diagnosed with MMD versus those with DD of the TMJ. The findings indicate that patients with DD exhibit statistically significant functional impairments in jaw movements and mastication, accompanied by a markedly more significant detrimental effect on their oral health-related quality of life.[15] These results underscore the distinct pathophysiological mechanisms that differentiate these two types of TMDs and advocate for tailored therapeutic interventions to address the specific needs of each patient cohort.[16]

The findings indicate that the JFLS-20 exhibited enhanced reliability within the DD subgroup, while the OHIP-14 demonstrated superior reliability among patients with MMD. This disparity highlights fundamental differences in the pathophysiological mechanisms and clinical presentations associated with these TMDs. Disc disorders, characterized primarily as structural disorders, result in chronic mechanical impediments, rendering the JFLS-20 a more robust and consistent instrument for evaluating functional impairments related to jaw movement.[17] Given that restriction in jaw mobility associated with DD remains relatively stable over time, the resultant responses on the JFLS-20 reflect enhanced reliability in this population. In contrast, MMD is primarily characterized by muscle pain, which fluctuates due to factors such as stress, parafunctional habits, and psychological influences.[18] This variability may contribute to lower consistency in JFLS-20 responses. However, OHIP-14, which captures the psychosocial impact of oral health conditions, appears to be more reliable in MMD patients, likely due to the strong association between chronic myofascial pain and emotional distress.[19] Since psychological factors play a significant role in MMD, self-reported quality-of-life measures may provide more consistent results in this group.[2,20] These findings emphasize the importance of condition-specific assessment tools in TMD research and clinical practice. While JFLS-20 is more suitable for evaluating functional impairment in DD patients, OHIP-14 may better capture the broader impact of MMD on daily life.[21] This supports the need for an integrated approach that considers physical function and psychosocial well-being in managing TMDs.

The significantly higher JFLS-20 scores in the DD group suggest that the structural alterations associated with DD, such as reduction and condylar deformation, contribute to more severe functional impairments. This is in contrast to the primarily muscular dysfunction seen in MMD.[22] The more difficulty reported by DD patients in tasks requiring wide mouth opening (e.g., biting into an apple or yawning) aligns with previous findings indicating that structural constraints in DD restrict mandibular mobility. Conversely, MMD patients exhibited lower functional impairment, possibly due to the dynamic and fluctuating nature of muscular pain, which may allow periods of relative relief in jaw function.[23]

The OHIP-14 results further reinforce the functional disparity between these two groups, as DD patients reported a significantly more significant negative impact on their quality of life. The increased scores in functional limitation, physical disability, and psychological disability domains among DD patients suggest that the chronicity and mechanical nature of their dysfunction impose a more persistent and intrusive burden on daily activities. In contrast, the absence of significant differences in psychological distress and social disability between the groups suggests that both conditions can cause substantial emotional distress and social impairment despite their differing pathophysiological bases. This finding underscores the importance of addressing the psychosocial aspects of TMD management in both patient populations.[24,25]

Interestingly, correlation analysis between JFLS-20 and OHIP-14 scores did not reveal a statistically significant relationship, particularly in the MMD group. This suggests that functional impairment and perceived quality of life impact do not always align directly. One possible explanation is that patients with MMD who experience episodic pain may develop coping strategies that mitigate the perceived burden of their condition. Additionally, the OHIP-14 primarily captures subjective perceptions of oral health, whereas the JFLS-20 assesses objective functional limitations.[6,26] The weak correlation in the DD group ($r = 0.29$) is statistically non-significant. This suggests that while functional impairment contributes to a decline in oral health-related quality

of life, other factors may also play crucial roles. These factors include pain chronicity, psychological adaptation, and treatment history.

These findings carry important clinical implications. The more significant functional impairment observed in DD patients suggests that treatment strategies should prioritize restoring mandibular mobility and addressing structural limitations, potentially through physiotherapy, occlusal adjustments, or surgical interventions in severe cases.[26-28] On the other hand, MMD patients may benefit more from multimodal pain management approaches, including physical therapy, cognitive-behavioral therapy, and pharmacological interventions targeting muscular dysfunction.[29] Given the comparable levels of psychological distress in both groups, an integrated biopsychosocial approach remains essential in the management of TMDs.

Future research should further explore the interplay between functional impairment, pain perception, and quality of life in different TMD subtypes. Longitudinal studies investigating how these factors evolve over time and respond to different treatment modalities could provide valuable insights into optimizing patient outcomes. Moreover, developing more comprehensive assessment tools that integrate functional and psychosocial dimensions may enhance our ability to tailor interventions effectively.

Despite its valuable insights, this study has certain limitations that should be acknowledged. One major limitation is its cross-sectional design, which captures only a snapshot of the patients' functional impairments and quality of life. Given the fluctuating nature of myofascial pain and the progressive nature of internal derangement, a longitudinal approach would have provided a more comprehensive understanding of how these conditions evolve over time and how treatment interventions influence their trajectory.

Another limitation is the reliance on self-reported measures such as the OHIP-14. Despite being widely used, it may be influenced by individual pain tolerance, psychological resilience, and coping mechanisms. Patients with chronic conditions often undergo adaptive changes in their perception of disability, which may not always align with objective functional impairment. The weak correlation observed between functional limitation and quality of life scores in this study may, in part, be attributed to these subjective biases. Incorporating objective assessments, such as kinematic jaw tracking or electromyographic analysis of masticatory muscle activity, could enhance the validity of the findings. Additionally, the study did not account for potential confounding factors such as the duration of symptoms, prior treatments, or concurrent psychological conditions, all of which may significantly influence functional impairment and quality of life perceptions. Given the well-documented interplay between chronic pain and mental health, future research should integrate psychometric evaluations, such as anxiety and depression scales, to better delineate their role in TMD-related disability.

Lastly, while this study focused on two well-defined TMD subgroups, the heterogeneity of temporomandibular disorders remains challenging. Many patients present with overlapping features of myofascial pain and internal derangement, complicating strict diagnostic categorization. Therefore, this study's findings may not be generalizable to patients with mixed TMD presentations. Future studies employing more nuanced subgroup analyses or machine learning-based classification models may help refine diagnostic distinctions and improve treatment stratification.

Despite these limitations, the study provides important insights into the functional and psychosocial burdens of TMDs, highlighting the need for individualized, multidisciplinary treatment approaches. Addressing these limitations in future research could further enhance our understanding of TMD pathophysiology and optimize patient care strategies.

In conclusion, this study highlights the distinct functional and quality-of-life impairments in MMD and DD patients, emphasizing the importance of individualized management approaches. While DD patients experience more severe functional limitations, both groups exhibit significant psychological distress, warranting a holistic treatment strategy that addresses both the physical and emotional aspects of TMDs.

DECLARATIONS

Author contribution: GA conceptualization, methodology, measurement, writing—original draft, review and editing, visualization, supervision, project administration; SEM conceptualization, methodology, measurement, validation, analysis, writing—review and editing.

Both authors have viewed and agreed to the submission

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None.

DATA AVAILABILITY

Upon request via email, data will be shared in accordance with ethical considerations.

ETHICS APPROVAL

The Ethics Committee at Hacettepe University approved the design and procedures of this study (Hacettepe University Health Sciences Research Ethics Committee (Approval Number:2025/05-53).

Consent to participate: Informed consent was obtained from all participants included in the study.

COMPETING INTERESTS

The authors declare no competing interests.

Çiğneme Kaslarının Bozukluğu ve Disk Deplasmanlı Hastalarda Çene Fonksiyon Kısıtlılıkları ile Ağız Sağlığına Bağlı Yaşam Kalitesinin Karşılaştırılması

ÖZET

Amaç: Bu çalışmada, Çiğneme Kasları Bozukluğu (Masticatory Muscle Disorder, MMD) ve Disk Deplasmanı / İç Düzen Bozukluğu (Disc Displacement, DD) olan hastalarda çene fonksiyon kısıtlılıkları ve ağız sağlığına bağlı yaşam kalitesi, Çene Fonksiyonel Kısıtlılık Ölçeği-20 (Jaw Functional Limitation Scale-20, JFLS-20) ve Ağız Sağlığı Etki Profili-14 (Oral Health Impact Profile-14, OHIP-14) kullanılarak karşılaştırılmıştır. Ayrıca bu ölçeklerin her bir hasta grubundaki güvenirliği incelenmiştir.

Gereç ve Yöntem: Çalışmaya 35'i MMD, 35'i DD olmak üzere toplam 70 hasta dahil edilmiştir. Tanılar, Temporomandibular Bozukluklar için Araştırma Tanı Kriterleri ve klinik muayene bulgularına göre konulmuştur. Fonksiyonel kısıtlılıkları ve ağız sağlığına bağlı yaşam kalitesini değerlendirmek için JFLS-20 ve OHIP-14 ölçekleri uygulanmıştır. İstatistiksel analizler bağımsız örneklem t-testi ve Pearson korelasyon analizi ile gerçekleştirilmiştir.

Bulgular: DD grubunda JFLS-20 skorları anlamlı düzeyde yüksek bulunmuştur ($p<0.001$) ve bu durum daha fazla fonksiyonel kısıtlılığa işaret etmektedir. Benzer şekilde, OHIP-14 skorları da DD hastalarında anlamlı derecede yüksek saptanmıştır ($p=0.003$). JFLS-20, DD grubunda ($\alpha=0.915$), OHIP-14 ise MMD grubunda daha yüksek iç güvenirlik göstermiştir ($\alpha=0.862$). Her iki grupta da JFLS-20 ve OHIP-14 skorları arasında anlamlı bir korelasyon saptanmamıştır.

Sonuçlar: DD hastaları, MMD hastalarına kıyasla daha şiddetli fonksiyonel kısıtlılıklar ve daha belirgin yaşam kalitesi kayıpları yaşamaktadır. JFLS-20 ve OHIP-14'ün farklı güvenirlik düzeyleri, yapısal disfonksiyonların öncelikle fonksiyonel parametreleri etkilediğini, miyofasiyal ağrının ise daha çok psikososyal sıkıntı ile ilişkili olduğunu düşündürmektedir. JFLS-20, DD hastalarında fonksiyonel bozuklukların değerlendirilmesi için daha uygun görünürken, OHIP-14 MMD'nin daha geniş kapsamlı etkilerini yakalamada daha duyarlı olabilir ve bireyselleştirilmiş tedavi yaklaşımlarının önemini vurgulamaktadır.

Anahtar Kelimeler: Anketler ve ölçekler; Çiğneme kasları; Disk deplasmanı; Miyofasiyal ağrı disfonksiyon sendromu; Temporomandibular eklem bozukluğu; Yaşam kalitesi

REFERENCES

1. Di Francesco F, Lanza A, Di Blasio M, Vaienti B, Cafferata EA, Cervino G, *et al*. Application of botulinum toxin in temporomandibular disorders: a systematic review of randomized controlled trials (RCTs). Applied Sciences 2022;12:12409.

2. Menéndez-Torre Á, Martin-Pintado-Zugasti A, Paris-Alemany A, Bocos-Corredor E, Molina-Alvares M, Arribas-Romano A, *et al*. Pain sensitization and pain-related psychological factors in patients with temporomandibular disorders: an observational cross-sectional study. Clin Oral Investig 2024;28:594.

3. Schiffman EL, Truelove EL, Ohrbach R, Anderson GC, John MT, List T, *et al*. The Research Diagnostic Criteria for Temporomandibular Disorders. I: overview and methodology for assessment of validity. J Orofac Pain 2010;24:7-24.

4. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, *et al*. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache 2014;28:6-27.

5. Ohrbach R, Larsson P, List T. The jaw functional limitation scale: development, reliability, and validity of 8-item and 20-item versions. J Orofac Pain 2008;22:219-30.

6. Yıldız NT, Kocaman H, Bingöl H. Validity and reliability of the Turkish version of the 20-item jaw functional limitation scale. Physiother Theory and Pract 2025;41:377-89.

7. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997;25:284-90.

8. Xu L, He Y, Fan S, Cai B, Fang Z, Dai K. Validation of a Chinese version of the Jaw Functional Limitation Scale in relation to the diagnostic subgroup of temporomandibular disorders. J Oral Rehabil 2020;47:1-8.

9. Şener S, Guler Ö. Self-reported data on sleep quality and psychologic characteristics in patients with myofascial pain and disc displacement versus asymptomatic controls. Int J Prosthodont 2012;25:348-52.

10. Kurtoglu C, Gur OH, Kurkcu M, Sertdemir Y, Guler-Uysal F, Uysal H. Effect of botulinum toxin-A in myofascial pain patients with or without functional disc displacement. J Oral Maxillofacial Surg 2008;66:1644-51.

11. Fang Z-Y, Yang Y, Yao Y, Liu SS, Liu LK, Lu SJ, *et al*. Oral behaviors and anxiety are significant predictors of jaw function limitation in patients with anterior disc displacement without reduction. Arch Oral Biol 2024;166:106033.

12. Figueiró C, Knorst JK, Fensterseifer CK, Folchini S, Milanesi JDM, Silva TB, *et al*. Changes in oral health-related quality of life after self-care treatment in patients with myofascial pain. Cranio 2024;42:199-205.

13. Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics. vol 5. pearson Boston, MA; 2007. p. 5.

14. Pallant J. SPSS survival manual: A step by step guide to data analysis using IBM SPSS. Routledge 2020.

15. Ekici Ö, Dündar Ü, Gökay GD, Büyükbosna M. Evaluation of the efficiency of different treatment modalities in individuals with painful temporomandibular joint disc displacement with reduction: a randomised controlled clinical trial. Br J Oral Maxillofac Surg 2022;60:350-6.

16. Cairns BE. Pathophysiology of TMD pain–basic mechanisms and their implications for pharmacotherapy. J Oral Rehabil 2010;37:391-410.

17. Minervini G, D'Amico C, Cicciù M, Fiorillo L. Temporomandibular joint disk displacement: etiology, diagnosis, imaging, and therapeutic approaches. J Craniofac Surg 2023;34:1115-21.

18. Kalladka M, Young A, Khan J. Myofascial pain in temporomandibular disorders: Updates on etiopathogenesis and management. J Bodyw Mov Ther 2021;28:104-13.

19. Schierz O, Baba K, Fueki K. Functional oral health-related quality of life impact: A systematic review in populations with tooth loss. J Oral Rehabil 2021;48:256-70.

20. Yang Y, Xu LL, Liu SS, Lu SJ, Liu LK, Zeng H, *et al*. Analysis of risk factors and interactions for pain in temporomandibular disorder: a cross-sectional study. J Oral Rehabil 2024;51:1113-22.

21. Marciniak T, Kruk-Majtyka W, Bobowik P, Marszałek S. The relationship between kinesiophobia, emotional state, functional state and chronic pain in subjects with/without temporomandibular disorders. J Clin Med 2024;13:848.

22. Moncada G, Cortés D, Millas R, Marholz C. Relationship between disk position and degenerative bone changes in temporomandibular joints of young subjects with TMD. An MRI study. J Clin Pediatr Dent 2014;38:269-76.

23. Reiter S, Goldsmith C, Emodi-Perlman A, Friedman-Rubin P, Winocur E. Masticatory muscle disorders diagnostic criteria: the American Academy of Orofacial Pain versus the research diagnostic criteria/temporomandibular disorders (RDC/TMD). J Oral Rehabil 2012;39:941-7.

24. Sójka A, Stelcer B, Roy M, Mojs E, Pryliński M. Is there a relationship between psychological factors and TMD? Brain Behav 2019;9:e01360.

25. Yap A, Chua E, Hoe J. Clinical TMD, pain-related disability and psychological status of TMD patients. J Oral Rehabil 2002;29:374-80.

26. Esteve M, Rosales-Leal JI. Analysis of Temporomandibular Disorders, Bruxism and Well-Being in Patients With Fibromyalgia Syndrome: A Case–Control Study. J Oral Rehabil 2025;52:350-6.

27. Asquini G, Pitance L, Michelotti A, Falla D. Effectiveness of manual therapy applied to craniomandibular structures in temporomandibular disorders: A systematic review. J Oral Rehabil 2022;49:442-55.

28. Liu Z, Yin J, Cao W, Deng L, Song Z, Zhang Y, *et al*. Evaluation of clinical impact of two types of Temporomandibular joint disc reduction and fixation. J Stomatol Oral Maxillofac Surg 2024;125:101956.

29. Ballesteros-Frutos J, Fernandez-Matias R, Gallardo-Zamora P, Pecos-Martín D. Critical appraisal of clinical trials evaluating physical therapy treatments for temporomandibular disorders: A scoping review. J Oral Rehabil 2024;51:2683-95.

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Original Research Article

Assessing Pediatric Dentists' Communication Skills Regarding Oral Health Literacy: A Cross-Sectional Study

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ABSTRACT

Aim: This study aimed to assess the communication-based oral health literacy (OHL) skills of pediatric dentists in Türkiye and to identify individual and institutional factors influencing these skills.

Materials and Methods: A cross-sectional survey was conducted between July 1, 2024, and January 10, 2025, with 127 pediatric dentists who had completed postgraduate training and were actively practicing. Participants completed a 20-item structured online questionnaire designed to assess demographic features and communication competencies related to OHL. Statistical analyses included Mann–Whitney U, Kruskal–Wallis, Spearman correlation, and linear regression tests, with statistical significance set at $p < 0.05$.

Results: No statistically significant difference was found between genders in communication scores ($p = 0.62$). Age was positively correlated with communication-based oral health literacy skills ($\rho = 0.36$, $p < 0.001$). There was no statistically significant difference in communication scores between pediatric dentists with and without prior communication training ($p = 0.16$). Linear regression revealed that age was a significant predictor of communication scores ($\beta = 0.074$, $p < 0.001$), whereas training status did not emerge as a statistically significant predictor ($\beta = -0.76$, $p = 0.06$). The model accounted for 15.1% of the variance in communication scores.

Conclusion: Communication-based oral health literacy skills among pediatric dentists in Türkiye are primarily influenced by age, experience, and institutional factors. The results emphasize the need for applied communication training, curricular enhancements, and institutional arrangements that allocate time for effective patient-dentist interaction. These efforts can strengthen clinical communication and contribute to the promotion of oral health literacy at the community level.

Keywords: Dental health education; Health literacy; Oral health; Pediatric dentistry

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INTRODUCTION

The concept of health literacy (HL) was first introduced in 1974 during a conference in which S.K. Simons's book Health Education as Social Policy discussed health education from a socio-political perspective.[1] Although its use remained limited until the 1990s, the term has since evolved into a comprehensive construct encompassing individuals' cognitive and behavioral abilities to comprehend, evaluate, and apply health-related information.[2] According to the Turkish Ministry of Health, HL is defined as the possession of knowledge, skills, and self-confidence necessary for individuals to improve both their own health and that of society.[3]

The World Health Organization's 2003 report emphasized that oral health is an integral component of general health. Common oral diseases such as

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dental caries are associated with chronic systemic conditions including obesity, diabetes, cardiovascular disease, and stroke.[4] Due to their high prevalence and economic burden, oral health problems have become a major public health concern globally.

In this context, dentists play a critical role in implementing oral health literacy (OHL) practices. Dental practice is not limited to technical competence but also relies heavily on effective communication and accurate transmission of information. OHL encompasses numerous communication-based components such as history-taking, the informed consent process, presentation of treatment plans, and facilitating patient involvement in decision-making.[5]

Research has shown that low levels of OHL are associated with a lack of knowledge, reduced dental visits, poor adherence to treatment, and an increased prevalence of dental caries.[6-8] The American Academy of Pediatrics has also emphasized the need to adapt adult HL strategies for children and families and has developed relevant guidance accordingly.[9]

In recent years, the concept of HL in children has gained increasing importance, highlighting the need to address existing knowledge gaps in this area.[10] Considering that health behaviors adopted in childhood tend to persist throughout life, it is essential to initiate HL education at an early age, supported by effective, communication-based strategies.[11,12]

In this regard, pediatric dentists are not only in direct contact with children but also with their caregivers, placing them in a strategic position to improve OHL at the community level. However, no prior studies were found in the Turkish literature assessing pediatric dentists' communication-based oral health literacy skills. Addressing this gap, this study aimed to evaluate pediatric dentists' communication practices in the context of oral health literacy, to identify strengths and areas for improvement in clinical interactions with patients and caregivers.

MATERIALS AND METHODS

Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Bozok University (Decision No: 2024-GOKAEK-246_2024.07.10_83, Date: 10.07.2024). All participants provided informed consent prior to participation, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

This cross-sectional study was conducted between July 1, 2024, and January 10, 2025, targeting pediatric dentists actively practicing across various regions of Türkiye. A total of 127 pediatric dentists who had completed their specialty or doctoral training in pedodontics, were currently involved in clinical practice, and voluntarily agreed to participate were included in the study. The questionnaire link was distributed via a widely used social media platform (WhatsApp™, Mountain View, CA). The survey remained accessible for a predetermined period, and responses were collected through Google Forms. Prior to commencing the questionnaire, participants were presented with an introductory page outlining the study's purpose, an invitation to participate, an informed consent statement, and a notice ensuring confidentiality of the collected data. Participation was entirely voluntary.

The data collection tool was a structured questionnaire consisting of 20 items developed by the research team. The questionnaire comprised two main sections: the first gathered demographic information (e.g., age, gender, years of experience, type of institution, previous communication training), while the second section evaluated participants' communication skills related to oral health literacy. The development of the questionnaire was informed by a review of the relevant literature and expert consultation. Initially, a pool of 28 items was generated based on existing communication and OHL frameworks. After expert evaluation for clarity and content validity, 20 items with the highest relevance and comprehensibility were retained. Example items included "I use simple, non-technical language when explaining treatment procedures to parents" and "I check whether the child or caregiver has understood the information I provided." The items did not cluster into separate subdimensions, as the aim was to obtain a unidimensional assessment of overall communication competence. Internal consistency reliability of the scale was assessed using Cronbach's alpha, which yielded a coefficient of 0.87, indicating high internal consistency.

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the variables: categorical variables were presented as frequencies and percentages, while continuous variables were summarized as means ± standard deviation.

The normality of distribution for continuous variables was evaluated, and the statistical significance threshold was set at $p < 0.05$ for all analyses. In addition, a post-hoc power analysis was performed using G*Power (version 3.1.9.7) to evaluate the achieved statistical power of the regression model. Between-group comparisons were conducted using the Chi-square test for categorical variables (i.e., proportions), Mann–Whitney U test for comparisons of means between two independent groups, and Kruskal–Wallis test for comparisons of means involving more than two groups. Correlations between continuous variables were assessed using Spearman's rank correlation analysis. Additionally, linear regression analysis was performed to determine the predictive variables associated with communication skill scores. The statistical significance threshold was set at $p < 0.05$ for all analyses.

RESULTS

According to the results of the Mann-Whitney U test comparing communication scores by gender, no statistically significant difference was found between female ($\bar{X}$ = 10.84 ± 1.97) and male ($\bar{X}$ = 10.55 ± 1.90) pediatric dentists (U = 12.0, p = 0.62) (Table 1). Although female participants had slightly higher mean scores, the difference was not statistically significant. This finding suggests that communication skills among pediatric dentists are similar regardless of gender. It may also indicate that factors such as clinical experience, education, and institutional context might be more influential than gender in shaping communication abilities.

Table 1. Comparison of Total Communication Scores by Gender

Gender	n	Mean ± SD	Min-Max
Female	104	10.84 ± 1.97	7-16
Male	22	10.55 ± 1.90	7-15
p > 0.05 Not statistically significant			

Test: Mann-Whitney U Test, U value: 1221.0

A Spearman correlation analysis revealed a statistically significant, moderate positive association between age and communication score ($\rho = 0.36$, $p = 0.015$), indicating that communication scores tend to increase with age. This result suggests that communication skills improve with age, likely due to increased professional experience and time in clinical practice. More experienced pediatric dentists may have better-developed strategies for engaging with patients and caregivers.

The Kruskal-Wallis test showed statistically significant differences in communication scores across different practice settings ($H = 12.29$, $p = 0.015$) (Table 2). The highest communication scores were reported among pediatric dentists working in private dental outpatient clinics (mean ± SD: 12.11 ± 1.10; median: 12.0), followed by private centers (mean ± SD: 11.25 ± 1.20; median: 11.0), private clinics (mean ± SD: 11.22 ± 2.25; median: 11.0), public health centers (mean ± SD: 10.55 ± 2.30; median: 10.0), and university hospitals (mean ± SD: 10.46 ± 1.90; median: 10.0). Post-hoc pairwise comparisons using the Dunn–Bonferroni procedure demonstrated a statistically significant difference in communication scores between pediatric dentists working in private dental outpatient clinics and those working in university hospitals, as well as between private dental outpatient clinics and public health centers, with higher scores observed in the private outpatient clinic setting ($p = 0.009$ and $p = 0.021$, respectively. These findings may reflect the greater emphasis on patient satisfaction and communication in the private sector, while university settings may have limited time or structural support for patient interaction.

Although the mean communication scores of pediatric dentists who had received communication training were higher than those who had not, the difference was not statistically significant ($U = 1569.5$, $p = 0.16$) (Table 3). This suggests that while communication training may have a positive effect, the sample size may be insufficient to detect a significant difference. Additionally, the nature and structure of the training may influence its effectiveness in improving communication behavior.

Table 2. Comparison of Communication Scores According to Type of Institution

Type of Institution	n	Mean ± SD	Median	Post Hoc
University (1)	84	10.46 ± 1.90	10	5>1
Public Oral and Dental Health Center (2)	11	10.55 ± 2.30	10	5>2
Private Practice (3)	9	11.22 ± 2.25	11	
Private Oral and Dental Health Center (4)	5	11.25 ± 1.20	11	
Private Oral and Dental Health Outpatient Clinics (5)	18	12.11 ± 1.10	12	
$p < 0.05$ Statistically significant difference.				

Kruskal-Wallis H = 12.3

Table 3. Comparison of Communication Scores Based on Training Status

Group	n	Mean ± SD	Median
Trained	57	11.44 ± 2.30	11
Untrained	70	10.62 ± 2.40	11
$p > 0.05$ Not statistically significant			

U value: 1569.5 Statistical test: Mann-Whitney U Test.

A linear regression model was used to identify factors predicting communication skills. The model explained 15.1% of the total variance (R^2=0.151) (Table 4). A stepwise linear regression approach was used to construct a statistically significant model by selecting variables that contributed meaningfully to the explanation of communication scores. Within this model, age emerged as a significant positive predictor of communication scores (β=0.074, p< 0.001). The coefficient for communication training was negative (β=–0.76), which reflects the coding scheme used in the analysis (1 = received training; 0 = no training), but this trend did not reach statistical significance (p = 0.06). Neither gender nor type of institution had a significant effect on communication scores. The overall regression model was statistically significant (F = 4.32, p = 0.003), indicating that the included predictors collectively explained a meaningful proportion of variance in communication scores. Additional model diagnostics were performed. Residual analyses confirmed that assumptions of linearity, homoscedasticity, and normality were satisfied, and VIF values indicated no multicollinearity. These analyses support the validity and stability of the regression model.

Table 4. Regression Coefficients

Independent Variable	Coefficient (β)	St. Coefficient	t	P value	Interpretation
Age	+0.074	0.31	14.86	0.0002	Communication score increases with age
Gender (Female = 1)	+0.48	0.11	1.24	0.2682	Female participants scored higher
Institution Type (coded)	-0.033	-0.03	0.07	0.7960	Weak negative association with institution type
Received Training	-0.76	0.07	3.57	0.0614	Trained participants scored lower
Intercept	8.46				Model intercept (baseline value)
R^2	0.151				Model explains 15.1% of the variance
	F	**p**			
Model Significance	4.320	0.003			

Intercept: 8.457, R^2: 0.151. Statistical test: Linear regression analysis. Age is a significant positive predictor of communication scores ($p < 0.001$). Gender, institution type, and training are not statistically significant predictors ($p > 0.05$).

DISCUSSION

This study evaluated the communication-based oral health literacy skills of pediatric dentists practicing in Türkiye and discussed the findings in comparison with existing literature. The results revealed that both individual and institutional factors significantly influence communication skills.

The limited effect of gender on communication abilities aligns with the study by Stowers *et al*.[13], which found no significant difference between male and female pediatric dentists in terms of communication-based oral health literacy skills. Their findings emphasized that professional experience and education play a more prominent role in shaping communication skills. Similarly, studies conducted by Coleman *et al*.[14] among healthcare professionals indicated that gender alone is not a determining factor; rather, organizational context and professional maturity have a more pronounced influence on communication. In this regard, the current study supports the idea that experience, education, and contextual factors, rather than gender, are the primary determinants of communication competence.

Age and professional experience were positively associated with improved communication skills. Nutbeam's model of health literacy emphasizes the importance of empathetic dialogue and individualized information delivery, both of which develop through experience.[15] In line with this model, the present findings showed that more experienced pediatric dentists engaged more effectively with both patients and their parents. Moreover, effective communication with pediatric patients plays a crucial role not only in enhancing oral health literacy but also in reducing dental anxiety. Previous research conducted in Türkiye has highlighted the impact of communication-based approaches on managing dental anxiety in children within clinical settings. This underscores that communication skills are critical in pediatric dental practice for both health education and psychological support.[16] Berkman *et al*.[7] also highlighted in their review that communication strategies diversify with experience and that a patient-centered approach becomes more dominant. Jacobs *et al*.[11] further demonstrated that more experienced professionals utilize digital tools more efficiently, which enhances patient satisfaction.Therefore, age and experience contribute not only to increased knowledge but also to the maturation of communication style.

Institutional differences also yielded important findings. Pediatric dentists working in the private sector demonstrated higher communication scores compared to their counterparts in university hospitals. Batista *et al*.[8] reported that the extended time allocated to each patient in private clinics and a patient satisfaction-focused service approach positively affect communication.Studies specific to Türkiye have shown that heavy academic workloads and high patient volumes in university clinics often limit time for effective communication, thereby negatively impacting communication skills.[17] Additionally, research from Cumhuriyet Dental Journal emphasized the importance of technical knowledge alongside communication skills in pediatric dental practice, supporting the notion that both competencies must be developed concurrently to improve patient care quality.[18] While the private sector may encourage communication competencies due to competitive pressures, structural limitations in public and academic institutions may hinder the quality of communication.

Although pediatric dentists who had received communication training scored higher on average, the difference was not statistically significant. As emphasized by Baskaradoss, the effectiveness of communication training depends on its content, duration, and inclusion of practical components.[6] Training limited to theoretical knowledge may not adequately reflect in clinical practice. Therefore, programs that incorporate active learning methods such as role-playing, simulations, and direct feedback are likely to have a more substantial impact on communication skills.

The persistent positive effect of age in the linear regression analysis further confirms the role of experience. Coleman *et al*.[14] interpreted this not only as an increase in technical knowledge but also as a refinement in empathic communication, delivery of effective feedback, and use of plain language.On the other hand, the negative association with having received training may suggest that the current format of communication training is disconnected from practical application and does not translate into behavioral change. As Nutbeam has stated, effective HL programs must address not only the

transfer of knowledge but also the promotion of behavioral transformation.[15] This underscores the need to restructure communication training in Turkish pediatric dentistry curricula in terms of both content and practical implementation.

The methodological limitations of this study must also be acknowledged. The use of an online questionnaire introduces the possibility of social desirability bias and inaccurate responses. Moreover, self-reported data may not fully reflect actual communication behavior in clinical practice. Future studies should incorporate observational methods to enhance data accuracy. Additionally, the relatively small sample size highlights the need for further studies with larger and more representative samples. Although the study employed an adequate sample size, a post-hoc power analysis conducted using G*Power (version 3.1.9.7) indicated an achieved power of 0.997 based on the observed effect size (R^2 = 0.151; f^2 = 0.178). This demonstrates that the study was sufficiently powered to detect the observed associations; therefore, the non-significant findings cannot be attributed to insufficient statistical power. However, because the survey link was distributed digitally via WhatsApp™, the exact number of individuals who received the invitation could not be tracked, making it impossible to calculate a precise response rate, although the number of completed responses was known (n = 127). In addition, while internal consistency reliability of the 20-item questionnaire was established, more detailed reporting of its content or construct validity would have strengthened the methodological rigor. Finally, the possibility of social desirability bias and self-reported inaccuracies should also be acknowledged, as participants' answers might not fully reflect their actual attitudes or behaviors. These factors may have partially influenced the generalizability of the results.

In recent years, there has been a growing awareness of HL among children.[10] Since the foundation of healthy lifestyle habits is laid in childhood, health education provided during this period can have a lifelong impact. Pediatric dentists, due to their direct access to both child patients and their caregivers, hold a strategic position in promoting oral health literacy. To the best of our knowledge, no prior study has comprehensively focused on pediatric dentists in Türkiye in this context, emphasizing the originality and pioneering nature of this research.

In conclusion, the findings indicate that pediatric dentists' communication-based oral health literacy skills are influenced by variables such as age, experience, and institutional factors. To improve clinical communication, the expansion of applied communication training, enhancement of educational curricula, and structural changes that allocate sufficient time for dentist-patient interaction at the institutional level are necessary. Advanced quantitative and qualitative research in this field will provide valuable insights to strengthen pediatric clinical communication practices in Türkiye.

CONCLUSION

This study highlights the important role of pediatric dentists' communication skills in enhancing oral health literacy (OHL) among children and their caregivers in Türkiye. The findings demonstrate that communication abilities are significantly influenced by age, clinical experience, and the type of institution, whereas gender and previous communication training showed limited effects. The higher communication scores observed in private practice settings suggest that institutional factors and workload may impact the quality of dentist-patient interactions. The lack of significant impact from current communication training programs indicates a need to redesign and implement more practical, skill-based educational approaches. To promote effective oral health communication and literacy, pediatric dental education and institutional policies should prioritize applied communication training and create environments that facilitate patient-centered care. Future research using larger samples and observational methodologies is warranted to further explore these dynamics and support the development of best practices in pediatric dental communication.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Pedodontistlerin Ağız ve Diş Sağlığı Okuryazarlığına Yönelik İletişim Becerilerinin Değerlendirilmesi: Kesitsel Bir Çalışma

ÖZET

Amaç: Bu çalışma, Türkiye'de görev yapan çocuk diş hekimlerinin iletişim temelli ağız ve diş sağlığı okuryazarlığı (ADSOY) becerilerini değerlendirmeyi ve bu becerileri etkileyen bireysel ve kurumsal faktörleri belirlemeyi amaçlamıştır.

Gereç ve Yöntem: Kesitsel tipteki bu çalışma, 1 Temmuz 2024 – 10 Ocak 2025 tarihleri arasında, mezuniyet sonrası uzmanlık eğitimini tamamlamış ve aktif olarak çalışan 127 çocuk diş hekimi ile gerçekleştirilmiştir. Katılımcılar, demografik bilgileri ve ADSOY ile ilişkili iletişim yeterliliklerini değerlendiren 20 maddelik yapılandırılmış çevrimiçi anketi yanıtlamıştır. Veriler Mann–Whitney U, Kruskal–Wallis, Spearman korelasyon ve doğrusal regresyon testleri ile analiz edilmiş, anlamlılık düzeyi $p < 0.05$ olarak kabul edilmiştir.

Bulgular: İletişim puanları açısından cinsiyetler arasında istatistiksel olarak anlamlı fark bulunmamıştır ($p = 0.618$). Ancak, yaş ile iletişim becerileri arasında pozitif yönde anlamlı bir ilişki saptanmıştır ($\rho = 0.358$, $p < 0.001$). Kurum türlerine göre iletişim puanları arasında anlamlı fark gözlenmiş ($p = 0.015$) ve en yüksek ortalama puan özel ADSM'lerde çalışan hekimlerde bulunmuştur. İletişim eğitimi almış katılımcıların ortalama puanları daha yüksek olsa da bu fark anlamlı bulunmamıştır ($p = 0.160$). Doğrusal regresyon analizinde yalnızca yaş değişkeni anlamlı bir yordayıcı olarak bulunmuştur ($\beta = 0.074$, $p < 0.001$); eğitim değişkeni ise sınırda anlamlı negatif etkiye sahipti ($\beta = -0.756$, $p = 0.0614$). Model, toplam varyansın %15.1'ini açıklamaktadır.

Sonuç: Türkiye'deki çocuk diş hekimlerinin iletişim temelli ADSOY becerileri; yaş, deneyim ve kurum türü gibi faktörlerden etkilenmektedir. Klinik iletişimin güçlendirilmesi amacıyla uygulamalı iletişim eğitimlerinin yaygınlaştırılması, müfredatların geliştirilmesi ve hasta-hekim etkileşimine zaman ayrılmasını sağlayacak kurumsal düzenlemelerin yapılması önemlidir. Bu yönde yapılacak ileri çalışmalar, Türkiye'de çocuk diş hekimliği klinik iletişimin gelişimine katkı sağlayacaktır.

Anahtar Kelimeler: Çocuk diş hekimliği; Ağız sağlığı; Diş sağlığı eğitimi; Sağlık okuryazarlığı.

REFERENCES

1. Ratzan SC. Health literacy: communication for the public good. Health Promot Int 2001;16:207-14.

2. Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, *et al*. Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health 2012;12:80.

3. Zaralı F, Düzgün Z. Sağlık Bakanlığı Temel Sağlık Hizmetleri Genel Müdürlüğü, Sağlığın Teşviki ve Geliştirilmesi Sözlüğü. Ankara; 2011.

4. World Health Organization. The World Oral Health Report 2003. Cenevre: World Health Organization; 2003.

5. Centore L. Dental health literacy and California's clarion call. J Calif Dent Assoc 2012;40:352-9.

6. Baskaradoss JK. The association between oral health literacy and missed dental appointments. J Am Dent Assoc 2016;147:867-74.

7. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. Ann Intern Med 2011;155:97-107.

8. Batista MJ, Lawrence HP, Sousa MLR. Oral health literacy and oral health outcomes in an adult population in Brazil. BMC Public Health 2017;18:60.

9. Chang FC, Chiu CH, Chen PH, Miao NF, Lee CM, Chiang JT, *et al*. Relationship between parental and adolescent eHealth literacy and online health information seeking in Taiwan. Cyberpsychol Behav Soc Netw 2015;18:618-24.

10. Hsu W, Chiang C, Yang S. The effect of individual factors on health behaviors among college students: the mediating effects of eHealth literacy. J Med Internet Res 2014;16:e287.

11. Jacobs RJ, Lou JQ, Ownby RL, Caballero J. A systematic review of eHealth interventions to improve health literacy. Health Inform J 2016;22:81-98.

12. Jimenez-Marroquin MC, Deber R, Jadad AR. Information and communication technology (ICT) and eHealth policy in Latin America and the Caribbean: a review of national policies and assessment of socioeconomic context. Rev Panam Salud Publica 2014;35:329.

13. Stowers ME, Lee JY, Majewski RF, Estrella MRP, Taylor GW, Boynton JR. Oral health literacy: awareness and practices among pediatric dentists. Pediatr Dent 2013;35:430-4.

14. Coleman CA, Hudson S, Maine LL. Health literacy practices and educational competencies for health professionals: a consensus study. J Health Commun 2013;18:82-102.

15. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. Health Promot Int 2000;15:259-67.

16. Gökçe N, Yıldız G, Ünal M. Çocuk hastalarda dental anksiyete: retrospektif bir değerlendirme. Cumhuriyet Dent J 2020;23:343-8.

17. Karamüftüoğlu N, Atabek D. Sağlık okuryazarlığında yeni bir alan: ağız ve diş sağlığı okuryazarlığı. Türkiye Sağlık Okuryazarlığı Derg 2020;1:130-48.

18. Buldur B, Oznurhan F, Kayabasi M, Sahin F. Shear bond strength of two calcium silicate-based cements to compomer. Cumhuriyet Dent J 2018;21:18-23.

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Original Research Article

In Vitro Assessment of pH and Surface Contact Angle of Triton as a Novel All-In-One Disinfectant

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ABSTRACT

Introduction: This study compared the pH levels and surface wettability of conventional endodontic irrigants with Triton, a novel all-in-one solution. Sodium hypochlorite (NaOCl), ethylenediaminetetraacetic acid (EDTA), chlorhexidine (CHX), and Triton were tested.

Materials and Methods: Each irrigant (10 mL) was stored in glass tubes (n=10). pH was measured with an electronic pH meter on days 1, 2, 5, 7, and 14, with three repeated measurements at each time point. For contact angle analysis, 26 extracted anterior teeth were sectioned, standardized, and exposed to the irrigants. Angles were measured using a goniometer device (SEO Phonix Contact Angle, Republic of Korea). Data were analyzed using repeated-measures ANOVA followed by Bonferroni-adjusted pairwise comparisons ($p<0.05$).

Results: Significant differences were found among irrigants for both pH and contact angle ($p<0.05$). All solutions showed lower pH values at day 14 compared to day 1 ($p<0.05$). In the Triton group, values at days 1, 2, and 5 were not significantly different, whereas decreases were observed at days 7 and 14 ($p<0.05$). CHX (14.73°) and NaOCl (15.82°) demonstrated the lowest contact angles, Triton an intermediate value (19.35°), and EDTA the highest (21.46°).

Conclusion: Triton maintained stable pH values during the first week and provided satisfactory dentin wettability, superior to EDTA but lower than CHX and NaOCl. These properties support its potential as a next-generation irrigant that combines multiple functions in a single solution.

Keywords: Conservative treatment; Dentin; Endodontics; Hydrogen-ion concentration; Surface properties; Wettability

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INTRODUCTION

The aim of endodontic treatment is the comprehensive removal of both vital and necrotic tissues, as well as microorganisms, from the root canal system.[1] The smear layer is composed of debris and bacterial residues generated during the shaping of root canals and cavity preparation, consisting of both organic and inorganic components.[2] Studies have demonstrated that the removal of the smear layer allows for enhanced penetration and improved sealing, as the sealants are able to establish a mechanical connection within the dentinal tubules.[3,4] Complete removal of the smear layer is essential for the success of root canal treatment.[5] Achieving this initial objective requires the combined use of mechanical instrumentation and irrigation, along with ensuring proper coronal restoration to prevent bacterial leakage.[6,7]

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Ideally, the physical properties and chemical composition of dentin should remain unaffected following the use of irrigating solutions in the root canal and dentinal tubules. However, studies have demonstrated that irrigating solutions, despite their beneficial effects, cause alterations in both the organic and inorganic components of dentin.[8-10] These structural changes may result in reduced bond strength, alterations in micro and nano-hardness, and increased surface roughness.[11] The acidic or alkaline pH of root canal irrigants, along with their direct contact with periapical and coronal tissues, can significantly impact both the treatment prognosis and the dentin surface within the cavity.[12] Sodium hypochlorite (NaOCl) is regarded as the gold standard irrigant in endodontic treatment.[13,14] Although the average pH of sodium hypochlorite is approximately 8.5, high concentrations of hypochlorous acid promote protein degradation and enhance reactivity with amines. To maintain the stability of sodium hypochlorite, the pH should not drop below 9.[15] Furthermore, it is recommended that the pH range be maintained between 11 and 12, as the toxicity of hypochlorous acid increases with its concentration, and it becomes cytotoxic within this pH range.[16]

Chlorhexidine (CHX) is commonly used as an irrigation solution at a 2% concentration, and its effect persists for a duration ranging from 72 hours to 12 weeks. The antibacterial efficacy of CHX is optimal within a pH range of 5.5 to 7. At lower concentrations, CHX exhibits a bacteriostatic effect, while at higher concentrations, it exerts bactericidal properties. However, its efficacy is significantly diminished in the presence of organic tissue due to its pH dependency. Despite its bactericidal action, CHX lacks the ability to eliminate biofilms and other organic debris effectively. A key factor contributing to the widespread use of CHX is its ability to adhere to hard tissues, thereby maintaining its antibacterial activity. However, the primary limitation of CHX is its insolubility in tissue. Additionally, CHX functions as a matrix metalloproteinase (MMP) inhibitor, exhibiting broad-spectrum anti-collagenolytic activity.[17]

Ethylenediaminetetraacetic acid (EDTA) is the most commonly used for removing the inorganic component of the smear layer, functioning as an effective chelating agent. An initial application of a 15% EDTA solution with a pH of 7.3 is recommended. The interaction of dentin calcium ions with the solution leads to the formation of calcium chelates. Although EDTA effectively removes the smear layer formed during root canal preparation, several studies have reported its potential adverse effects on the radicular dentin beneath the smear layer. Specifically, the application of 17% EDTA in root canals for durations exceeding one minute may cause dentin erosion in the root canal and coronal cavity.[18,19]

The wettability of a liquid on a solid surface is determined by the relative surface free energy of the solid, which can be evaluated through the contact angle formed by the liquid. A lower contact angle indicates higher surface free energy. In endodontics, the contact angle between an irrigant and the dentin surface plays a critical role.[20]

The contact angle of irrigating solutions indicates their ability to establish contact with and spread across dentin surfaces. A lower contact angle reflects improved wettability, allowing the solution to spread more effectively over the dentin substrate. This enhanced spreading capacity facilitates deeper penetration into dentinal tubules and irregularities, thereby improving the overall cleaning and disinfection potential of the irrigant within the root canal system.[21]

Triton (Brasseler, Savannah, USA) is a mixture composed of two solutions, recently developed for use as a cavity and canal irrigant. A limited number of studies have assessed the efficacy of Triton on dentin tissue.[22-25] This study aims to compare the pH values and contact angle of Triton, an all-in-one formulation, with those of commonly used root canal irrigants in endodontics.

The null hypotheses were defined as follows: (1) Triton would not exhibit stable pH values over the specified time period and (2) there would be no significant differences in contact angle values between Triton and the other irrigants.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of Ankara Medipol University on 29 August 2025, in accordance with the Declaration of Helsinki (Reference number: E-85859696-604.01.01-7331).

The research was conducted in full compliance with the ethical principles set out in the Declaration of Helsinki, and informed consent was obtained from all participants.

Irrigant solutions and pH measurements

Four irrigants were tested in this study: NaOCl, EDTA, CHX and Triton (a novel all-in-one solution). Information regarding the composition of these solutions is presented in Table 1. For pH measurements, each solution was distributed into 10 glass tubes (10 mL each), with a total of 40 tubes prepared (n = 10 per group). Outside of measurement periods, the tubes were stored in an incubator set at 25 °C.

pH measurements were performed on days 1, 2, 5, 7, and 14 using an electronic pH meter (OHAUS, Aquasearcher, USA) in accordance with the manufacturer's instructions. At each time point, three repeated measurements were obtained per tube, and the mean values along with standard deviations were recorded. During measurement, the indicator probe was immersed in the solution, and the sample was gently agitated for 30 seconds without the electrode tip contacting the glass surface. The pH value was documented once it was stable. To ensure accuracy, the probe tip was rinsed between each measurement. During storage, all samples were kept in tightly sealed, capped glass tubes to prevent evaporation. The solution volumes were visually inspected before and after storage, and no measurable volumetric loss was observed.

Contact angle measurements

For contact angle analysis, 26 extracted human anterior teeth with intact roots and free of caries, cracks, or previous endodontic treatment were selected. The teeth were stored in 0.1% thymol solution until use, then rinsed thoroughly with distilled water. A standardized notch was prepared at the cemento-enamel junction, and each tooth was sectioned buccolingually using a diamond disc under water cooling, yielding two halves per tooth. This procedure provided a total of 52 dentin surfaces for analysis.

The dentin surfaces were flattened and standardized using 600-grit silicon carbide abrasive paper under water irrigation to produce a uniform smear layer. After preparation, surfaces were rinsed with distilled water and gently air-dried. For each specimen, a droplet of irrigant solution (NaOCl, EDTA, CHX, or Triton) was applied to the dentin surface using a micro-syringe. Contact angles were immediately measured using a goniometer device (SEO Phonix Contact Angle Analyzer, Suwon, Republic of Korea) equipped with high-resolution imaging and analysis software. All measurements were conducted under controlled laboratory conditions (room temperature and humidity) to minimize variability.

The contact-angle measurements were based on the single processed output values generated by the device software for each droplet. Because the software provided only a single processed value per droplet and raw replicate outputs were not retained, standard deviations could not be calculated; therefore, only mean contact-angle values are reported.

Statistical analysis

Sample size calculation was performed using GPower 3.1 software (Heinrich Heine University, Düsseldorf, Germany). Because no study

Table 1. Irrigation solutions, product name, and contents

Irrigation Soluiton	Product Name	Content
NaOCl	Wizard (Istanbul,Turkey)	%5.25 NaOCl
EDTA	Microvem (Sakarya,Turkey)	%5 EDTA
CHX	Microvem (Sakarya,Turkey)	%2 CHX
ALL-IN-ONE	Triton (Brasseler, USA)	Part-A: 1,2,4-Butanetricarboxylic acid, 2-phosphono- Citric acid, Sodium dodecylbenzenesulfonate, Alcohols, C9-11, ethoxylated, liquids, Polyethylene glycol 4-(tert-octylphenyl) ether, liquid, Sodium lauryl sulfate, 2-Ethylhexyl sodium sulfate, Sodium cumenesulphonate, Sodium hydroxide Part-B: Sodium hypochlorite, Sodium hydroxide

with analytical parameters directly comparable to those of the present research was identified in the literature, the effect size could not be derived from a fully matched model. Therefore, we referred to the closest available study evaluating similar contact angle related surface characteristics to guide the estimation.[21] Based on the variability reported in that study, an effect size within the moderate to large range (approximately f = 0.40) was considered a reasonable approximation for planning the analysis. Using α = 0.05 and a power of 0.80, the sample-size calculation indicated that at least 13 surfaces per group were required; therefore, 26 teeth were included to obtain 52 dentin surfaces.

The pH data were analyzed using IBM SPSS Statistics software (version 20.0, Chicago, IL, USA). Normality was assessed with the Shapiro–Wilk test. Levene's test was used to assess the homogeneity of variances, and the results confirmed that this assumption was satisfied, supporting the use of ANOVA for both outcomes. As the outcome variable, pH values over time were analyzed with repeated-measures ANOVA and Bonferroni correction, while post hoc Tukey multiple comparison tests were applied when appropriate. Contact angle values among the four irrigants were compared using one-way ANOVA with Bonferroni-adjusted post hoc tests. Statistical significance was set at p<0.05.

RESULTS

The changes in pH values are presented in Table 2. All four irrigants showed a statistically significant decrease in pH between day 1 and day 14 (p< 0.05). The smallest absolute changes over this period were observed in CHX and EDTA, while NaOCl and Triton exhibited slightly larger reductions. In the Triton group, no significant differences were observed between days 1, 2, and 5; however, significant decreases occurred on days 7 and 14 (p<0.05). Additionally, no significant differences were found between the measurements on days 2, 5, and 7 (p>0.05).

The mean contact angles obtained from 26 extracted anterior teeth, based on the processed output values of the measurement software, are presented in Table 3. Statistical analysis revealed a significant difference among the groups (p<0.05). Pairwise comparisons revealed that CHX and NaOCl had significantly lower contact angles than both Triton and EDTA (p<0.05). In addition, Triton exhibited a significantly lower contact angle compared with EDTA (p<0.05). These findings indicate superior wettability for CHX and NaOCl, intermediate wettability for Triton, and the lowest wettability for EDTA. Contact angles of irrigation solutions are illustrated in Figure 1.

Table 2. pH changes of solutions

Irrigation Solution	Day 1	Day 2	Day 5	Day 7	Day 14
EDTA^{A}	10.71(±0.16)^{Aa}	10.47(±0.09)^{Ab}	10.41(±0.06)^{Ab}	10.32(±0.06)^{Ac}	10.34(±0.07)^{Ac}
NaOCl^{B}	12.21(±0.16)^{Ba}	12.06(±0.03)^{Bab}	11.97(±0.13)^{Bb}	11.80(±0.28)^{Bb}	11.62(±0.58)^{Bb}
TRITON^{C}	9.90 (±0.79)^{Ca}	9.55(±0.47)^{Cab}	9.32(±0.30)^{Cac}	9.22(±0.17)^{Cbc}	9.14(±0.04)^{Cc}
CHX^{D}	7.61 (±0.30)^{Da}	7.39(±0.03)^{Dab}	7.29(±0.11)^{Db}	7.27(±0.15)^{Db}	7.25(±0.15)^{Db}

The p-value was calculated using the one-way ANOVA test

** Indicates significance at p<0.05.

a,b,c Superscript differences in the same row indicate significant (p<0.05) differences between groups. Capital letters demonstrate irrigant pH values. The post hoc test was conducted using Tukey's HSD test.

Table 3. Mean contact angle values of the tested irrigation solution

Irrigation Solution	Mean Contact Angle (°)
CHX	14.73^{a}
NaOCl	15.82^{b}
TRITON	19.35^{c}
EDTA	21.46^{d}

Values represent the mean contact angle (°) measured on dentin surfaces. Lower values indicate greater wettability.
Different superscript lowercase letters indicate statistically significant differences between groups (p<0.05).

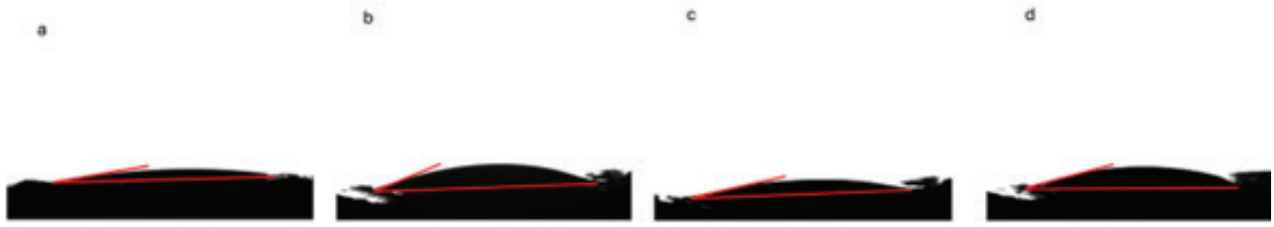

Figure 1. The contact angle of irrigation solutions reflects the wettability of the surface. A lower contact angle indicates higher surface wettability, whereas an increased contact angle corresponds to reduced wettability and higher surface energy. a) demonstrates a contact angle of CHX of 14.73°. b) demonstrates a contact angle of EDTA of 21.46°. c) demonstrates a contact angle of NaOCl of 15.82°. d) demonstrates a contact angle of Triton of 19.35°.

DISCUSSION

In this study, the pH values and surface contact angles of commonly used irrigation solutions and the all-in-one solution Triton were compared and analyzed. The efficacy of irrigants is influenced by factors such as root canal length, penetration depth of the substance, duration of application, dentin hardness, as well as the concentration and pH value of the solutions.[26-28] Based on the findings of this study, the first null hypothesis—stating that Triton would not exhibit a stable pH the specified time period—was confirmed. However, the second null hypothesis—predicting no significant differences in contact angle values among the irrigants—was rejected.

The most widely used method for measuring pH values is pH measuring electrodes. These electrodes consist of an electrochemical sensor comprising a measuring electrode and a reference electrode. Compared to alternative methods, pH electrodes provide the highest sensitivity and the broadest measurement range for pH determination. Consequently, in this study, pH measurements were conducted using a pH electrode. To ensure standardization in this study, Eppendorf tubes were used, as different pH values can be measured in various regions of the root of extracted teeth.[29] In addition to pH evaluation, contact angle analysis was employed to assess the wettability of irrigants on dentin surfaces, since this parameter reflects the ability of a solution to spread and penetrate into dentinal tubules. The combination of pH stability and favorable contact angle is therefore critical for predicting the overall disinfection potential and clinical effectiveness of new all-in-one irrigants such as Triton.

In this study, a newly developed irrigation solution was used in addition to the conventional irrigants. According to the manufacturer, unlike traditional irrigants or other advanced 2:1 formulations, Triton functions in a completely different mechanism. The NaOCl-free components in Triton enable a lower concentration of NaOCl to effectively dissolve residual organic debris with minimal buffering. The synergistic and simultaneous dissolution of organic and inorganic debris enables clinicians to use smaller volumes of irrigation solution while achieving optimal clinical efficiency.

Containing a lower concentration of NaOCl, a surfactant, and a combination of chelating agents, Triton is the first irrigation solution to offer the combined benefits of NaOCl, EDTA, and CHX in a single-step application.[22] Our comprehensive literature review revealed no studies evaluating the pH value of the Triton solution, suggesting that the results of this study may address this gap in the literature.

Previous studies have reported that the pH of 5.25% NaOCl ranges between 10.8 and 13.2. In the present study, the pH value was measured at 12.21 on day 1 and 11.80 on day 5. The average pH range of the EDTA solution has been documented as being between 7 and 9.[30]

As there are no existing studies or information regarding the pH range and changes in the Triton solution in the literature or on the manufacturer's website, a direct comparison could not be made.[22] The pH value, resulting from the mixture of various chemicals in Triton's part A and part B solutions using an injector, indicates that this solution may become one of the commonly used options in routine practice. Furthermore, the combination of an organic tissue-dissolving agent like NaOCl with an inorganic

tissue-dissolving irrigation solution, such as citric acid, within the root canal offers not only ease of use and cost-effectiveness but also the potential to reduce environmental waste due to the decreased use of syringes. However, further clinical studies are necessary to evaluate the antibacterial efficacy and determine whether this new all-in-one solution can effectively replace the irrigation solutions currently used in routine practice.

If the contact angle is less than 90°, the liquid (sealer) is considered to wet the substrate, whereas a value greater than 90° indicates non-wettability. A contact angle of 0° represents complete wetting. Therefore, the contact angle provides an inverse measure of wettability, meaning that the lower the contact angle, the greater the wettability. Contact angle measurement is a useful indicator of the wetting behavior of any tested liquid. This angle is formed by a liquid at the three-phase boundary where the liquid, gas, and solid intersect.

The clinical effectiveness of an irrigating solution is not determined by a single property but rather by the interplay of its physicochemical characteristics. For instance, a solution with a high pH may exert strong antimicrobial activity; however, if its surface wettability is poor, its ability to adequately spread over the canal walls and penetrate into dentinal tubules is compromised, thereby limiting its disinfection potential. Conversely, a solution with excellent wettability but low pH and limited dentin-dissolving capacity may also demonstrate restricted effectiveness. Thus, both pH and wettability can be regarded as fundamental determinants of the clinical performance of irrigants. These parameters are particularly critical when evaluating newly developed all-in-one solutions such as Triton, BioPure MTAD, or QMix, as they provide essential benchmarks for assessing their potential efficacy prior to clinical application.

Within the limitations of this study, experimental conditions do not fully simulate the clinical environment, which could influence the behavior of irrigants *in vivo*. Only two parameters (pH stability and contact angle of irrigation solution) were assessed in this study; other crucial factors, such as antibacterial activity and dentin–sealer interactions, were not evaluated. These could be considered for future research. The observation period was limited to 14 days, and measurements were taken from standardized tooth sections, which might not represent clinical variations. Additionally, long-term and clinical studies are necessary to validate these findings.

CONCLUSION

Considering the limitations of this *in vitro* study, it can be concluded that Triton exhibited relative pH stability during the initial 7 days and demonstrated intermediate contact angle values that indicate satisfactory wettability on dentin surfaces. These combined properties suggest that Triton possesses favorable physicochemical characteristics for clinical application as an irrigant. Although its wettability was not superior to CHX and NaOCl, Triton performed better than EDTA, highlighting its potential as a balanced all-in-one solution. Future studies are required to further investigate the long-term effects of Triton, particularly in relation to dentinal tubule penetration, smear layer removal, and its influence on the adhesion of root canal sealers.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

Yeni Nesil Bir Dezenfektan Olan Triton'un Yüzey Temas Açısı ve pH Değerinin *İn Vitro* Olarak Değerlendirilmesi

ÖZET

Giriş: Bu çalışmada, geleneksel endodontik irrigasyon solüsyonlarının pH seviyeleri ve yüzey ıslanabilirliği, yeni bir hepsi bir arada solüsyon olan Triton ile karşılaştırılmıştır. Sodyum hipoklorit (NaOCl), etilendiamintetraasetik asit (EDTA), klorheksidin (CHX) ve Triton test edilmiştir.

Gereç ve Yöntemler: Her irrigasyon solüsyonu (10 mL) cam tüplerde saklanmıştır (n=10). pH, 1., 2., 5., 7. ve 14. günlerde elektronik bir pH metre ile ölçülmüştür ve her zaman noktasında üç tekrarlı ölçüm yapılmıştır. Temas açısı analizi için 26 adet çekilmiş ön diş kesitlere ayrılmış, standardize edilmiş ve irrigasyon solüsyonlarına maruz bırakılmıştır. Açılar bir gonyometre cihazı (SEO Phonix Contact Angle, Kore Cumhuriyeti) kullanılarak ölçülmüştür. Veriler, tekrarlı ölçümler ANOVA ve Tukey post-hoc testleri ile analiz edilmiştir ($p<0.05$).

Bulgular: Hem pH hem de temas açısı açısından irrigasyon solüsyonları arasında anlamlı farklılıklar bulundu ($p<0.05$). Tüm solüsyonlar, 14. günde 1. güne kıyasla daha düşük pH değerleri gösterdi ($p<0.05$). Triton grubunda, 1., 2. ve 5. günlerdeki değerler anlamlı bir farklılık göstermezken, 7. ve 14. günlerde düşüşler gözlendi ($p<0.05$). CHX (14.73°) ve NaOCl (15.82°) en düşük temas açılarını gösterirken, Triton orta düzeyde bir değer (19.35°) ve EDTA en yüksek değeri (21.46°) gösterdi.

Sonuç: Triton ilk hafta boyunca stabil pH değerlerini korumuş ve dentin yüzeyinde tatmin edici ıslanabilirlik sağlamıştır. Bu özellikleri ile EDTA'dan üstün, ancak CHX ve NaOCl'den daha düşük performans göstermiştir. Bulgular, Triton'un birden fazla işlevi tek bir solüsyonda birleştiren yeni nesil bir irrigasyon ajanı olma potansiyelini desteklemektedir.

Anahtar Kelimeler: Dentin; Endodonti; Hidrojen iyonu konsantrasyonu; Islanabilirlik; Konservatif tedavi; Yüzey özellikleri

REFERENCES

1. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod 1990;16:498-504.

2. Pashley DH, Michelich V, Kehl T. Dentin permeability: effects of smear layer removal. J Prosthet Dent 1981;46:531-7.

3. White RR, Goldman M, Lin PS. The influence of the smeared layer upon dentinal tubule penetration by plastic filling materials. J Endod 1984;10:558-62.

4. Sen BH, Pişkin B, Baran N. The effect of tubular penetration of root canal sealers on dye microleakage. Int Endod J 1996;29:23-8.

5. Shahravan A, Haghdoost AA, Adl A, Rahimi H, Shadifar F. Effect of smear layer on sealing ability of canal obturation: a systematic review and meta-analysis. J Endod 2007;33:96-105.

6. Prada I, Micó-Muñoz P, Giner-Lluesma T, Micó-Martínez P, Muwaquet-Rodríguez S, Albero-Monteagudo A. Update of the therapeutic planning of irrigation and intracanal medication in root canal treatment. A literature review. Endod 1990;16:498-504.

7. Azim AA, Griggs JA, Huang GT. The Tennessee study: factors affecting treatment outcome and healing time following nonsurgical root canal treatment. Int Endod J 2016;49:6-16.

8. Qian W, Shen Y, Haapasalo M. Quantitative analysis of the effect of irrigant solution sequences on dentin erosion. J Endod 2011;37:1437-41.

9. Hennequin M, Pajot J, Avignant D. Effects of different pH values of citric acid solutions on the calcium and phosphorus contents of human root dentin. J Endod 1994;20:551-4.

10. Zhang K, Kim YK, Cadenaro M, Bryan TE, Sidow SJ, Loushine RJ, *et al*. Effects of different exposure times and concentrations of sodium hypochlorite/ethylenediaminetetraacetic acid on the structural integrity of mineralized dentin. J Endod 2010;36:105-9.

11. Eldeniz AU, Erdemir A, Belli S. Effect of EDTA and citric acid solutions on the microhardness and the roughness of human root canal dentin. J Endod 2005;31:107-10.

12. Macedo RG, Herrero NP, Wesselink P, Versluis M, van der Sluis L. Influence of the dentinal wall on the pH of sodium hypochlorite during root canal irrigation. J Endod 2014;40:1005-8.

13. Haapasalo M, Shen Y, Wang Z, Gao Y. Irrigation in endodontics. Br Dent J 2014;216:299-303.

14. Satti P, Kakarla P, Jogendra Avula SS, Muppa R, Kiran Rompicharla SV, Biswas S. Indigenous irrigants as potent antimicrobials in endodontic treatment: An *in vitro* study. J Indian Soc Pedod Prev Dent 2019;37:275-81.

15. Estrela C, Estrela CR, Barbin EL, Spanó JC, Marchesan MA, Pécora JD. Mechanism of action of sodium hypochlorite. Braz Dent J 2002;13:113-7.

16. Byström A, Sundqvist G. Bacteriologic evaluation of the effect of 0.5 percent sodium hypochlorite in endodontic therapy. Oral Surg Oral Med Oral Pathol 1983;55:307-12.

17. Siqueira JF, Jr., Paiva SS, Rôças IN. Reduction in the cultivable bacterial populations in infected root canals by a chlorhexidine-based antimicrobial protocol. J Endod 2007;33:541-7.

18. Calt S, Serper A. Time-dependent effects of EDTA on dentin structures. J Endod 2002;28:17-9.

19. Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB, Bozhilov K, *et al*. A new solution for the removal of the smear layer. J Endod 2003;29:170-5.

20. de Assis DF, do Prado M, Simão RA. Evaluation of the interaction between endodontic sealers and dentin treated with different irrigant solutions. Journal of endodontics 2011;37:1550-2.

21. Tammineedi S, Kakollu S, Thota MM, Basam LC, Basam RC, Chinthamreddy S. Comparison of the effect of sodium hypochlorite, EDTA, and etidronic acid on wettability of root canal sealers using contact angle goniometer: An *in vitro* study. Journal of Dr YSR University of Health Sciences 2020;9:178-82.

22. Wakas Oraim H, Al-Zaka IM. Effectiveness of Triton Irrigation Solution in Smear Layer Removal: An in-vitro Study. Eur Endod J 2024;9:139-45.

23. Castagnola R, Martini C, Colangeli M, Pellicciotta I, Marigo L, Grande NM, *et al*. In Vitro Evaluation of Smear Layer and Debris Removal and Antimicrobial Activity of Different Irrigating Solutions. Eur Endod J 2024;9:81-8.

24. Deepa VL, Vanga HR, Kadali N, Divve S, Sravya V, Kapa RS. Effect of prewarming and continuous warming on tissue dissolving ability of Triton™ versus Twin Kleen™: An *in vitro* study. J Conserv Dent Endod 2024;27:100-4.

25. Hackbarth M, Montoya M, Noblett WC, Lima BP, Dietz M, Staley C, *et al*. An In Vitro Evaluation of the Antimicrobial Efficacy of a Novel Irrigant Using Next-Generation Sequencing. J Endod 2024;50:1314-20.e1.

26. Orstavik D, Haapasalo M. Disinfection by endodontic irrigants and dressings of experimentally infected dentinal tubules. Endod Dent Traumatol 1990;6:142-9.

27. Yang SE, Cha JH, Kim ES, Kum KY, Lee CY, Jung IY. Effect of smear layer and chlorhexidine treatment on the adhesion of Enterococcus faecalis to bovine dentin. J Endod 2006;32:663-7.

28. Marques JA, Falacho RI, Santos JM, Ramos JC, Palma PJ. Effects of endodontic irrigation solutions on structural, chemical, and mechanical properties of coronal dentin: A scoping review. J Esthet Restor Dent 2024;36:606-19.

29. Vivan RR, Zapata RO, Zeferino MA, Bramante CM, Bernardineli N, Garcia RB, *et al*. Evaluation of the physical and chemical properties of two commercial and three experimental root-end filling materials. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:250-6.

30. Baruwa AO, Martins JNR, Maravic T, Mazzitelli C, Mazzoni A, Ginjeira A. Effect of Endodontic Irrigating Solutions on Radicular Dentine Structure and Matrix Metalloproteinases-A Comprehensive Review. Dent J (Basel) 2022;10

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Original Research Article

A Psychological Perspective on Temporomandibular Disorders: Evaluating Anxiety and Depression Symptoms

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ABSTRACT

Objective: Temporomandibular disorders (TMD) are multifactorial conditions affected by both physical and psychological factors. The present study aimed to compare the levels of anxiety and depression in individuals with TMD with those in healthy controls, as well as to examine the associations of these psychological parameters with demographic variables.

Materials and Methods: A total of 62 participants, including 31 patients with TMD and 31 healthy individuals aged between 18 and 40 years, were included in the study. Clinical and demographic data were collected, and psychological assessments were conducted using the Beck Depression Inventory (BDI) and the State-Trait Anxiety Inventory (STAI-I and STAI-II).

Results: State anxiety levels were found to be significantly higher in the TMD group as compared to the control group (p=0.007) by Student's t-test. No statistically significant differences were observed between the groups in terms of trait anxiety levels (p>0.05). Similarly, BDI scores did not differ significantly between the groups (p>0.05). No significant associations were found between psychological parameters and age, sex, or educational level (p>0.05).

Conclusion: Within the limitations of this study, individuals with TMD exhibited higher levels of state anxiety compared with healthy controls. Based on this finding, we conclude that psychological assessments may constitute an integral part of the management of patients with TMD, and the treatment should address not only the TMD condition itself but also the accompanying psychological factors.

Keywords: Anxiety; Depression; Psychology; Temporomandibular joint disorders

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INTRODUCTION

Temporomandibular disorders (TMD) are complex musculoskeletal conditions characterized by pain and/or dysfunction involving masticatory muscles, temporomandibular joints (TMJ), and associated structures. Clinical manifestations of TMD encompass a wide range of symptoms, including tenderness in masticatory muscles, TMJ dysfunction, pain during mandibular movements, joint sounds, jaw locking or dislocation, and limited mandibular mobility.[1,2] Although the etiology of TMD remains unclear, numerous studies support its multifactorial and biopsychosocial nature, encompassing both physical and psychological components including the interplay of psychological, physiological, structural, postural, and genetic factors.[3–7] Therefore, TMD may be considered not merely as a physiological disorder, but as a multidimensional clinical condition encompassing also psychological and social aspects.

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Psychological effects of TMD on patients can be evaluated using various psychometric tools. Among these, the most widely used ones are the Beck Depression Inventory (BDI) and the State-Trait Anxiety Inventory (STAI). The BDI is a 21-item self-report instrument designed to evaluate severity of depressive symptoms. Each item consists of four statements arranged in increasing order of severity, and respondents are asked to select the one that best describes their condition over the past two weeks, including the day of assessment. The total score in the BDI ranges from 0 to 63, with higher scores indicating greater severity of depressive symptoms.[8,9] The STAI is a 40-item self-report tool that measures the frequency of anxiety responses. Items are rated on a four-point Likert scale, with subscale scores ranging from 20 to 80. The STAI-I is the State Anxiety Inventory, whereas the STAI-II is the Trait Anxiety Inventory. Higher scores reflect more severe levels of anxiety.[10] The Turkish adaptation of the BDI, introduced by Hisli, was reported to have high levels of reliability and validity for the scale.[11] The STAI-I and STAI-II were adapted into Turkish by Öner and Le Compte.[12]

Available evidence supports the association between TMD and psychological conditions. Sadrzadeh Afshar *et al*. reported that soldiers exposed to chronic stress were more likely to develop TMD when exhibiting higher levels of depression.[14] Similarly, in a Turkish sample, Ekici demonstrated that patients with bruxism had significantly higher STAI and BDI scores, which correlated with increased bruxism frequency.[13] Despite these findings, studies investigating the psychological dimensions of TMD within the Turkish population remain scarce, the need for further research in this area. The hypothesis of this study is that, considering the multifactorial nature of TMD, individuals with TMD would exhibit higher levels of anxiety and depression compared to healthy controls. In this context, the present study aims to evaluate the levels of anxiety and depression in individuals diagnosed with TMD, as well as to investigate potential associations of these psychological conditions with various demographic variables.

MATERIALS AND METHODS

This study was conducted at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, with patients who presented for routine dental examinations. The research protocol fully complied with the ethical principles of the Declaration of Helsinki, and written informed consent was obtained from all participants. Ethical approval was also granted by the Non-Interventional Clinical Research Ethics Committee (Approval Date: 29.01.2025, protocol no: 2025.01.28).

The participants were divided into two groups: Group 1 (study group) consisted of individuals diagnosed with TMD, while Group 2 (control group) included individuals without any active symptoms or pathology in the oral and maxillofacial region, who presented solely for routine check-ups. Individuals of both sexes aged between 18 and 40 years were included in the study.

Exclusion criteria were as follows: (1) the presence of systemic diseases, (2) regular use of medication, (3) history of previous TMD treatment, or (4) a diagnosed psychological disorder. No medical intervention or treatment was administered to the participants within the scope of the study.

Demographic data, including age, sex, educational level, and occupation, were recorded for all participants. All patients underwent a standardized clinical examination performed by an oral and maxillofacial surgeon with at least 5 years of clinical experience. The diagnosis of temporomandibular disorders was established in accordance with the Diagnostic Criteria for Temporomandibular Disorders Axis I (DC/TMD). The DC/TMD protocol was applied through a standardized clinical examination, which included assessment of mandibular range of motion, joint sounds, deviation or deflection during opening, and palpation of the temporomandibular joint and masticatory muscles (masseter, temporalis, medial and lateral pterygoids) to identify pain or tenderness. Internal derangements identified during this process were further classified according to the Wilkes staging system (Stages I–V) for descriptive analysis.

In the study group, the impact of TMD on quality of life was evaluated using a Visual Analog Scale (VAS), scored from 0 (“no impact”) to 10 (“severe impact”). The VAS was used exclusively within the TMD group to quantify the perceived impact of the disorder on quality of life; it was not intended

for direct comparison with the control group. For psychological evaluation, all participants completed the BDI, the STAI-I, and the STAI-II. The instruments were administered in a paper-and-pencil format under researcher supervision and were completed individually. The data collected were then used for both within-group and between-group statistical analyses.

Sample Size Estimation

The sample size of the study was determined a priori using the GPower 3.1.9.7 software for an independent samples t-test, based on an expected medium effect size derived from Reissmann *et al*. [15] According to this effect size, significance level of 5% and a statistical power of 80%, approximately 30 participants per group were deemed sufficient.

Statistical Analyses

The distribution of numerical variables was evaluated using the Kolmogorov–Smirnov test. For the variables showing a normal distribution, descriptive statistics were presented as mean ± standard deviation (Mean ± SD). To compare differences between means/medians of two independent groups, the independent samples t-test was used when parametric assumptions were met; otherwise, the Mann–Whitney U test was performed. The Chi-square test was employed to evaluate differences between categorical variables. To examine relationships between numerical variables, Pearson correlation coefficients were computed for the data in normal distribution, while Spearman's rank correlation coefficient was calculated for data that did not meet normality assumptions. A p-value of less than 0.05 was considered to be statistically significant in all analyses.

RESULTS

The study was conducted with a total of 62 participants (mean age 27.4 ± 6.3 years). Among the participants, 34 (54.8%) were female and 28 (45.2%) were male. As summarized in Table 1, there were no statistically significant differences between the groups in terms of age, gender distribution, or educational level, indicating that both groups were comparable demographically.

STAI-I scores were significantly higher in Group 1 (45.2±5.3) as compared to the control group (38.3 ± 3.8; p = 0.007) No statistically significant associations were found between STAI-I scores and age, gender, or educational level (p=0.25, p=0.25, and p=0.66, respectively). STAI-II scores were 43.2±9.6 in Group 1 and 39.65±6.79 in the control group; however, the difference was not statistically significant (p=0.18). Similarly, STAI-II scores did not show significant associations with age, gender, or educational level (p=0.50, p=0.63, and p=0.24, respectively). The mean BDI score was 10.9±7.3 in Group 1 and 9.2±7.6 in the control group, with no statistically significant difference (p=0.32) (Table 2; Figure 1). Likewise, no significant associations were found between BDI scores and gender or education level (p=0.98 and p=0.09, respectively), while a statistically significant correlation was observed with age (p=0.02).

Additionally, the weak positive correlation noted between STAI-I and STAI-II scores (r = 0.13, p = 0.33) was not statistically significant. Another weak negative correlation observed between STAI-I and BDI scores (r = –0.11, p = 0.4) also was not statistically significant. In contrast, a moderate positive correlation was found between STAI-II and

Table 1. Distribution of Demographic Characteristics

Variable	Total (n = 62)	Group 1 (n = 31)	Group 2 (Control)	P
Age (Mean±SD)	27.3±6.3	27.5±6.3	27.1±6.4	0.72
Gender, n (%)				0.20
- Female	34 (54.8%)	11 (35.4%)	17 (54.8%)	
- Male	28 (45.1%)	20 (64.5%)	14 (45.1%)	
Education Level, n (%)				0.84
- High School	18 (29.3%)	10 (32.2%)	8 (25.8%)	
- Bachelor's Degree	38 (61.2%)	18 (58.0%)	20 (64.5%)	
- Master's Degree	6 (9.6%)	3 (9.6%)	3 (9.6%)	

Table 2. Distribution of Inventory Scores

Variable	Group 1 (n = 31)	Group 2 (n = 31)	Total (n = 62)	P
STAI-I (Mean±SD)	45.2±5.3	38.2±3.8	41.7±5.8	0.007*
STAI-II (Mean±SD)	43.2±9.5	39.6±6.7	41.4±8.5	0.18
Beck Depression Score (Mean±SD)	10.8±7.3	9.1±7.5	10.0±7.4	0.31
VAS	4.7±1.4	-	-	-

*STAI-I: State Anxiety Inventory, **STAI-II and the Trait Anxiety Inventory; p>0.05

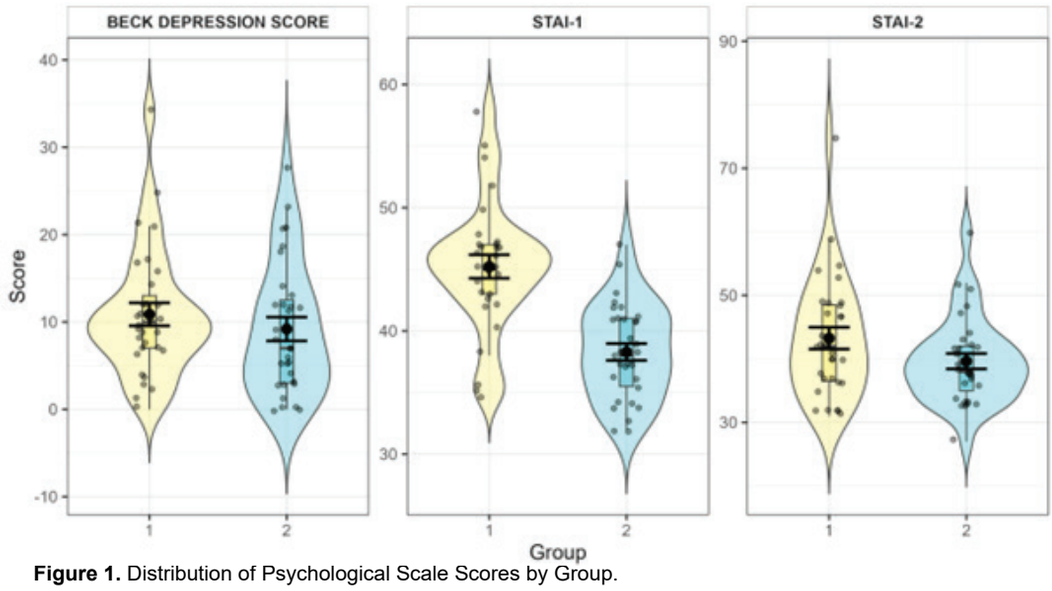

Figure 1. Distribution of Psychological Scale Scores by Group.
Distribution of Beck Depression Inventory (BDI), State Anxiety Inventory Form-I (STAI-1), and Form-II (STAI-2) scores across study groups. Each dot represents an individual participant; black circles and error bars indicate mean ± SE. Group 1: TMD; Group 2: Controls.

BDI scores (r=0.31, p=0.01), which was a statistically significant relationship.

The mean VAS score among Group 1 participants was 4.74±1.4. No statistically significant associations were found between VAS scores and age (p=0.88), gender (p=0.11), Wilkes staging (p=0.13), BDI (p=0.30), or STAI-I scores (p=0.60). However, weak negative correlations were observed between VAS scores and educational level (ρ = –0.33, p=0.06) and between VAS and STAI-II scores (ρ = –0.34, p=0.06).

According to the RDC/TMD Axis I classification, 7 participants were diagnosed with muscle disorders (Group I), 15 with internal derangements (Group II), and 9 presented with both categories simultaneously. BDI scores were significantly higher in individuals with muscular disorders as compared to those with internal TMJ derangements alone (p=0.01). BDI scores were significantly higher in individuals with muscular disorders as compared to those with only internal TMJ derangements (p=0.01). Additionally, a statistically significant positive correlation was found between the presence of muscle disorders and BDI scores (r=0.39, p=0.03).

However, no statistically significant associations were found between muscular disorders and STAI-I or STAI-II scores (p>0.05). Similarly, among participants with internal TMJ derangements, there were no significant differences or correlations with BDI, STAI-I, or STAI-II scores (p>0.05). Among the 24 patients with internal derangements, 17 were classified as Wilkes Stage I and 7 as Stage II. No significant correlations were found between Wilkes stages and BDI, STAI-I, or STAI-II scores (p>0.05).

DISCUSSION

TMD are multifactorial conditions resulting from the interaction of physical and psychological factors. Their pathophysiology involves complex biomechanical, neuromuscular, and biological mechanisms, with psychological components playing a critical role in both onset and persistence.[1,16,17] Consistent with previous findings, individuals with TMD in the present study exhibited significantly higher state anxiety levels compared to healthy controls, suggesting that pain and function al limitation may exacerbate situational anxiety.

Although anxiety is commonly reported among TMD patients, previous studies such as those by Fernandes Azevedo *et al*. found no significant association between TMD and anxiety.[18] Similarly, our study revealed no difference in trait anxiety levels between groups. This may indicate that anxiety in TMD is more reactive to current symptoms rather than a stable personality trait. An increase in depression levels may be positively associated with the prevalence of TMD. Individuals under chronic stress were previously found to have significantly higher rates of TMD as compared to their non-stressed peers.[14] However, in the present study, we found no statistically significant difference between the groups in terms of BDI scores. This outcome can be attributed to individual variations in pain sensitivity and duration of symptoms in TMD patients.

Participants with muscular TMD demonstrated significantly higher BDI scores compared to those with internal TMJ derangements. This is consistent with previous studies reporting that myofascial pain tends to cause more persistent and diffuse discomfort, thereby imposing greater psychological burden.[19,20,21] Accordingly, TMD subtypes may require targeted psychosocial assessment and intervention.

TMD are most commonly observed in individuals aged 20–40 years old and particularly in women of reproductive age.[22,23] For instance, Giannakopoulos *et al*. reported that depressive symptoms are more frequent in women with TMD-related pain, whereas men with similar conditions may exhibit more severe depressive symptoms.[24] These findings suggest that TMD are closely associated with psychological effects regardless of gender. However, in the present study, no significant relationship was found between age or gender and the levels of anxiety or depression.

Furthermore, socioeconomic variables such as educational level are thought to significantly influence pain perception and expression. Martins *et al*. reported that individuals with lower educational levels experience more intense pain as compared to those with higher levels of education. However, in the present study, there was no statistically significant relationship between educational level and anxiety or depression scores.[25]

The present study has several limitations. These include a relatively small sample size, the cross-sectional design that precludes causal inference, reliance solely on self-reported inventories to evaluate anxiety and depression, and the absence of clinical psychiatric diagnoses. These limitations warrant using larger sample sizes and multidimensional assessment tools in further research.

TMD can adversely affect quality of life, particularly in chronic cases.[26] In the present study, individuals with TMD exhibited significantly higher state anxiety levels compared to healthy controls, indicating that situational psychological distress is common among these patients. However, trait anxiety and depression scores did not differ significantly between the groups. From a clinical perspective, the observed increase in state anxiety suggests the need for interdisciplinary management approaches that include psychological assessment as an integral component of TMD care. Psychological evaluation and individualized interventions may be particularly beneficial for patients presenting with muscular forms of TMD.

CONCLUSION

Within the limitations of the present study, TMD should be regarded not merely as physiological conditions, but as multifactorial disorders encompassing significant psychological components. Accurate diagnosis and effective management of TMD therefore require acknowledging the close interaction between physical and psychological factors. A comprehensive, multidisciplinary approach including a psychological evaluation may assist with individualized treatment planning for TMD patients.

Temporomandibular Bozukluklara Psikolojik Bir Bakış: Anksiyete ve Depresyon Belirtilerinin Değerlendirilmesi

ÖZET

Amaç: Temporomandibular bozukluklar, hem fiziksel hem de psikolojik faktörlerden etkilenen multifaktöriyel yapıya sahip durumlardır. Bu çalışmanın amacı, temporomandibular bozukluğu olan bireylerde anksiyete ve depresyon düzeylerini sağlıklı bireylerle karşılaştırmak ve bu psikolojik parametrelerin demografik değişkenlerle ilişkilerini incelemektir.

Gereç ve Yöntemler: Çalışmaya yaşları 18–40 arasında değişen, 31 temporomandibular bozukluğu olan hasta ve 31 sağlıklı birey olmak üzere toplam 62 katılımcı dahil edilmiştir. Klinik ve demografik veriler toplanmış; psikolojik değerlendirmeler için Beck Depresyon Envanteri (BDE) ile Durumluk ve Sürekli Kaygı Envanteri (STAI-I ve STAI-II) uygulanmıştır.

Bulgular: Temporomandibular bozukluğu olan grupta durumluk kaygı düzeyleri kontrol grubuna kıyasla anlamlı derecede yüksek bulunmuştur (p=0.007). Sürekli kaygı düzeyleri açısından gruplar arasında istatistiksel olarak anlamlı fark saptanmamıştır (p>0.05). Benzer şekilde, Beck Depresyon Envanteri puanları da gruplar arasında anlamlı farklılık göstermemiştir (p>0.05). Yaş, cinsiyet ve eğitim düzeyi ile psikolojik parametreler arasında istatistiksel olarak anlamlı bir ilişki bulunmamıştır (p>0.05).

Sonuç: Çalışma bulguları, temporomandibular bozukluğu olan bireylerde durumluk kaygı düzeyleri sağlıklı bireylere kıyasla daha yüksek olabildiğini göstermiştir. Bu bulguya dayanarak, psikolojik değerlendirmeler temporomandibular bozukluğu olan hastaların tedavisinde ayrılmaz bir parça oluşturabilir ve tedavi sadece temporomandibular durumun kendisini değil, aynı zamanda buna eşlik eden psikolojik faktörleri de ele almalıdır.

Anahtar Kelimeler: Anksiyete; Depresyon; Psikoloji; Temporomandibular eklem bozuklukları

REFERENCES

1. Aiken A, Bouloux G, Hudgins P. MR imaging of the temporomandibular joint. Magn Reson Imaging Clin N Am 2012;20:397-412.

2. Mohlin B, Axelsson S, Paulin G, Pietilä T, Bondemark L, Brattström V, *et al*. TMD in relation to malocclusion and orthodontic treatment. Angle Orthod 2007;77:542-8.

3. Chisnoiu AM, Picos AM, Popa S, Chisnoiu PD, Lascu L, Picos A, *et al*. Factors involved in the etiology of temporomandibular disorders - a literature review. Clujul Med 2015;88:473-8.

4. Resende CMBM, Rocha LGDDS, Paiva RP, Cavalcanti CDS, Almeida EO, Roncalli AG, *et al*. Relationship between anxiety, quality of life, and sociodemographic characteristics and temporomandibular disorder. Oral Surg Oral Med Oral Pathol Oral Radiol 2020;129:125-32.

5. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. Pain 1992;50:133-49.

6. Ismail F, Eisenburger M, Lange K, Schneller T, Schwabe L, Strempel J, *et al*. Identification of psychological comorbidity in TMD-patients. Cranio 2016;34:182-7.

7. List T, Jensen RH. Temporomandibular disorders: Old ideas and new concepts. Cephalalgia 2017;37:692-704.

8. Beck AT, Steer RA, Carbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. Clin Psychol Rev 1988;8:77-100.

9. Beck At, Ward Ch, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561-71.

10. Gaudry E, Vagg P, Spielberger CD. Validation of the State-Trait Distinction in Anxiety Research. Multivariate Behav Res. 1975;10:331-41.

11. Hisli N. Beck Depresyon Envanteri'nin üniversite öğrencileri için geçerliği, güvenirliği. Psikol Derg 1989;7:3-13.

12. Öner N, Le Compte A. Durumluk Sürekli Kaygı Envanteri El Kitabı. İstanbul: Boğaziçi Üniversitesi Yayınları; 1983. s.1-26.

13. Ekici Öner. Bruksizmli veya Bruksizmsiz Temporomandibular Eklem Disfonksiyonu Olan Hastaların Psikolojik Profili ve Uyku Kalitesi. J Turk Sleep Med. 2021;5:13.

14. Sadrzadeh Afshar M, Salari B, Nejad SV. Investigating the effect of depression on clinical symptoms of temporomandibular disorder in young stressful men. Clin Exp Dent Res 2024;10:909.

15. Reissmann DR, John MT, Seedorf H, Doering S, Schierz O. Temporomandibular Disorder Pain Is Related to the General Disposition to be Anxious. J Oral Facial Pain Headache 2014;28:322-30.

16. Slade GD, Ohrbach R, Greenspan JD, Fillingim RB, Bair E, Sanders AE, Painful Temporomandibular Disorder: Decade of Discovery from OPPERA Studies. J Dent Res 2016;95:1084-92.

17. Simoen L, Van den Berghe L, Jacquet W, Marks L. Depression and anxiety levels in patients with temporomandibular disorders: comparison with the general population. Clin Oral Investig 2020;24:3939-45.

18. Fernandes Azevedo AB, Câmara-Souza MB, Dantas I de S, de Resende CMBM, Barbosa GAS. Relationship between anxiety and temporomandibular disorders in dental students. Cranio 2018;36:300-3.

19. Kılıçoğlu A, Pekkan G. Diş Kliniğine Başvuran Hastalarda Bruksizmi Olan ve Olmayanların Depresyon ve Anksiyete Açısından Karşılaştırılması. Klinik Psikiyatri Dergisi 2009;12:68-71.

20. Benoliel R, Sela G, Teich S, Sharav Y. Painful temporomandibular disorders and headaches in 359 dental and medical students. Quintessence Int 2011;42:73-8.

21. Reis PHF, Laxe LAC, Lacerda-Santos R, Münchow EA. Distribution of anxiety and depression among different subtypes of temporomandibular disorder: A systematic review and meta-analysis. J Oral Rehabil 2022;49:754-67.

22. Conceição HN dos S, Azevêdo TC, Santos AC de J dos, Xavier MRSR. Comorbidities associated with temporomandibular joint disorders and the role of central sensitization: literature review. BrJP 2022;5:56-60.

23. Minervini G, Franco R, Marrapodi MM, Fiorillo L, Cervino G, Cicciù M. Prevalence of temporomandibular disorders in children and adolescents evaluated with Diagnostic Criteria for Temporomandibular Disorders: A systematic review with meta-analysis. J Oral Rehabil 2023;50:522-30.

24. Giannakopoulos NN, Keller L, Rammelsberg P, Kronmüller KT, Schmitter M. Anxietyand depression in patients with chronic temporomandibular pain and in controls. J Dent 2010;38:369-76.

25. Martins RJ, Garcia AR, Garbin CAS, Sundefeld MLMM. The relation between socio-economic class and demographic factors in the occurrence of temporomandibular joint dysfunction. Cien Saude Colet 2008;13:2089-96.

26. Bitiniene D, Zamaliauskiene R, Kubilius R, Leketas M, Gailius T, Smirnovaite K. Quality of life in patients with temporomandibular disorders. A systematic review. Stomatologija 2018;20:3-9.

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Original Research Article

Evaluation of Surface Roughness Produced By Orthophosphoric Acid And Er:Yag Laser

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ABSTRACT

Aim: The aim of this study was to comparatively evaluate the changes in surface roughness of primary and permanent teeth following acid and laser application.

Materials and Methods: A total of 80 teeth—40 permanent molars and 40 primary molars—were used in this study. The dentin surfaces were exposed using a separating disc. Primary teeth (Group I, Group II) and permanent teeth (Group III, Group IV) were each divided into two subgroups. Ortho-phosphoric acid was applied to Groups II and IV, while Er:YAG laser was applied to Groups I and III. The initial (Ra0) and post-treatment (Ra1) surface roughness values of each specimen were measured using a profilometer.

Results: The Ra1 values of all groups (Group I: 7.63 ± 2.01 [7.31]; Group II: 3.17 ± 1.81 [2.89]; Group III: 6.37 ± 1.24 [6.14]; Group IV: 3.52 ± 1.98 [3.08]) were higher than their respective Ra0 values (Group I: 1.57 ± 1.16 [1.23]; Group II: 1.77 ± 1.24 [1.52]; Group III: 2.49 ± 2.14 [1.50]; Group IV: 2.01 ± 1.44 [1.40]). The change in surface roughness was greater in Group I (6.06 ± 1.91 [5.70]) compared to Group II (1.40 ± 1.47 [0.81]), and greater in Group III (3.88 ± 1.70 [4.11]) compared to Group IV (1.52 ± 1.52 [0.96]).

Conclusion: In both primary and permanent teeth, laser application resulted in greater changes in surface roughness compared with acid application.

Keywords: Permanent Dentition; Er:YAG Laser; Phosphoric Acid; Primary Dentition

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INTRODUCTION

To successfully perform restorative treatments in dentistry, it is imperative to enhance the physical and aesthetic properties of the materials used while concomitantly augmenting their bonding strength to dental hard tissues. In the context of dentistry, adhesion describes the force of attraction between different molecules or the connection between two different surfaces, while cohesion describes the bond between the same molecules.[1] Mechanical adhesion is a type of adhesion that occurs by locking the adhesive to the recessed and protruding areas on the adherent. Surface roughness is an important factor in ensuring adhesion because it affects the flow of the adhesive material towards the recesses and protrusions and the adhesive's bonding by shrinking.

It is widely accepted that the removal, modification, or dissolution of the smear layer is necessary for optimal adhesion.[2] The objective of acid application is threefold: first to remove the smear layer, second to open the dentin tubules, and third to expose collagen fibrils by demineralisation. The result of these processes is the creation of a hybrid layer for the primer and bonding agent to be later applied.[3] Pre-treatment with different concentrations of phosphoric acid is a conventional method for creating micro-porosities, which facilitate the adhesion of various restorative materials.[4]

Phosphoric acid, at a concentration of 30–40%, has been shown to demineralise dentin tissue to a depth of several micrometres, thus exposing the collagen-rich hydroxyapatite structure. Consequently, collagen fibres that are susceptible to infiltration by hydrophilic monomers, become exposed.[5] However, due to the technical sensitivity and isolation problems associated with acid roughening, alternative methods, such as air-abrasion and laser applications, have been the focus of recent research to roughen dental hard tissues.

In the field of dentistry, lasers operating at low energy levels have been the focus of numerous studies as part of adhesive systems, serving as a substitute for conventional acid roughening techniques for the preparation of enamel and dentin surfaces.[6] It has been reported that Er:YAG lasers can be used safely in dental hard tissues without causing damage to the surrounding tissues.[7] Erbium lasers are particularly well suited to minimally invasive dentistry applications due to their effectiveness in preparing enamel and dentin, which is because they are highly water and hydroxyapatite-absorbable.[8] Er:YAG laser has a wavelength of 2940 nm and is used in various hard tissue applications. A notable advantage of the Er:YAG laser is that it does not cause thermal damage during its use in the cavity. The laser creates superficial micro roughness without forming a smear layer on the applied tooth surface and the dentinal tubule mouths remain open.[9] The fact that laser surface roughening is an essentially painless process, does not generate vibration or heat, and most importantly, does not require isolation, renders it a routine procedure.

Although various studies have investigated the use of lasers, research directly comparing Er:YAG laser and phosphoric acid etching on both primary and permanent dentin remains limited. Structural differences between the dentin of primary and permanent teeth are well documented. In a study comparing the tubule density and diameters of coronal dentin in primary and permanent teeth using SEM, the dentin of primary teeth was reported to have a significantly higher tubule density than that of permanent teeth.[10] A micro-CT study evaluating the mineral density of the enamel and dentin of primary and permanent teeth also reported that permanent teeth exhibit higher mineral density.[11] Additionally, another investigation comparing structural parameters such as dentinal tubule orientation, the presence of interglobular dentin, and incremental lines between primary and permanent molars demonstrated clear biological differences between the two dentin types.[12] Due to these structural variations, the dentin of primary and permanent teeth does not respond in the same way to laser or acid conditioning. For this reason, in the present study, both Er:YAG laser and phosphoric acid were applied to primary and permanent dentin. The aim of this study was to evaluate the changes in dentin surface roughness caused by acid and laser application in primary and permanent teeth.

The null hypothesis tested in this study was that there would be no statistically significant difference in the surface roughness values of dentin from primary and permanent teeth following surface preparation with 37% phosphoric acid or Er:YAG laser. It was assumed that the change in surface roughness would be similar regardless of the surface preparation method applied.

MATERIALS AND METHODS

In this study, a total of 80 teeth (40 permanent molars and 40 primary molars) that were extracted due to orthodontic, traumatic, periodontal problems, or infection at the Zonguldak Bülent Ecevit University Faculty of Dentistry were used. The teeth were randomly divided into four groups, each consisting of 20 samples. (Table 1). A review of the literature shows that the application times used for dentin surface preparation with Er:YAG lasers vary widely.

Table 1. Distribution of samples in the study groups

Group	Number of samples	Tooth type	Method used	Application parameter
Group I	20	Primary molar	Er:YAG laser	20 sec/100 mJ
Group II	20	Primary molar	Orthophosphoric acid	15 sec/37%
Group III	20	Permanent molar	Er:YAG laser	20 sec/100 mJ
Group IV	20	Permanent molar	Orthophosphoric acid	15 sec/37%

While some studies have employed short durations such as 10 seconds, both clinical and experimental research has reported application times ranging from 15–30 seconds and even up to 60 seconds. When considered alongside variations in laser parameters (energy, frequency, water/air ratio, and application mode), this indicates that no standardized protocol exists regarding exposure time. Therefore, the 20-second / 100-mJ combination used in our study falls within the range of durations reported in the literature and is meaningful in terms of evaluating this existing heterogeneity. [13-17]

Group 1 included 20 primary molars treated with Er:YAG laser for 20 seconds at 100 mJ energy. Group 2 consisted of 20 primary molars etched with 37% orthophosphoric acid for 15 seconds. Group 3 comprised 20 permanent molars treated with Er:YAG laser under the same parameters as Group 1 (20 seconds, 100 mJ). Group 4 included 20 permanent molars treated with 37% orthophosphoric acid for 15 seconds. Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Zonguldak Bülent Ecevit University (approved by decision number 2024/10, decision date 29/05/2024).

Soft tissue residues and debris on all teeth were removed with the aid of a cretin. The extracted teeth were then stored in a sterile saline solution until the start of the study. The teeth were washed under running water after which they were embedded in blocks up to the enamel–cementum boundary. The roots were embedded in autopolymerising acrylic resin. For the experiment, a low-speed diamond separator (Isomet Low-Speed, Buehler, Düsseldorf, Germany) was used to meticulously separate the occlusal third of the teeth perpendicular to their long axes, while being cooled underwater, to expose the dentin surfaces. The exposed dentin surfaces were then prepared with polishing discs (Sof Lex, 3M ESPE, St Paul, MN, USA) from burgundy to yellow colour in all teeth, in accordance with the manufacturer's recommendations. To minimize variability caused by disc wear during the cutting procedure, a new disc was used for each tooth. Primary and permanent teeth were randomly assigned into two groups of 20 specimens per group. To minimize measurement bias, the samples were assigned to groups using a randomly prepared sealed-envelope method. All surface roughness measurements were performed by a blinded investigator who was unaware of the group allocation of the specimens.The roughness value of each specimen was measured from three different areas on the exposed dentin surface with a profilometer (TIME 3221,TESKON, Bursa, Turkey) and calculated by averaging the obtained values (Ra0). In the Group I, a 100 mJ Er:YAG laser was applied to the primary teeth for 20 seconds. The roughness values of the samples were measured from three distinct regions on the surface using a profilometer. The values were averaged to calculate the roughness parameters, denoted as Ra1. Group III followed the same protocol, but with permanent teeth. For Group II, 37% orthophosphoric acid was added to the primary teeth for 15 seconds after which the teeth were thoroughly rinsed with water for a further 15 seconds and then allowed to dry in ambient atmosphere for 10 seconds. Subsequently, measurements were taken from three distinct regions on the surface of the teeth using a profilometer device and the mean values were then calculated (Ra1). Group IV followed the same acid protocol, but with permanent teeth. The mean roughness and changes in these values were recorded.

Data analysis

Statistical analyses were performed with IBM SPSS 25 software and the significance level was set at $p<0.05$. The normality assumption was assessed by the Shapiro–Wilk test. The non-parametric Mann–Whitney U test was used to compare two independent groups as the data were not in normal distribution.

RESULTS

It was observed that the Ra1 values of all groups (Group I: 7.63 ± 2.01 [7.31]; Group II: 3.17 ± 1.81 [2.89]; Group III: 6.37 ± 1.24 [6.14]; Group IV: 3.52 ± 1.98 [3.08]) were higher than their corresponding Ra0 values (Group I: 1.57 ± 1.16 [1.23]; Group II: 1.77 ± 1.24 [1.52]; Group III: 2.49 ± 2.14 [1.50]; Group IV: 2.01 ± 1.44 [1.40]) (Table 2). A statistically significant difference was found between the surface roughness changes of Group I and Group II ($p<0.05$). The surface roughness change in Group I (6.06 ± 1.91 [5.70]) was significantly greater than that of Group II (1.40 ± 1.47 [0.81]). A statistically significant difference was also found between the surface

Table 2. Roughness values of samples according to tooth type and treatment

	Ra0 (min–max)	Ra1 (min–max)	Ra0 (mean±SD [median])	Ra1 (mean±SD [median])
Group I (primary tooth laser group)	0.40 – 4.90	4.64–13.01	1.57±1.16 [1.23]	7.63±2.01 [7.31]
Group II (primary tooth acid group)	0.47–5.57	1.02–6.63	1.77±1.24 [1.52]	3.17±1.81 [2.89]
Group III (permanent tooth laser group)	0.33–7.12	4.88–9.61	2.49±2.14 [1.50]	6.37±1.24 [6.14]
Group IV (permanent tooth acid group)	0.47–5.34	1.08–7.74	2.01±1.44 [1.40]	3.52±1.98 [3.08]

Table 3: Surface roughness change values of samples according to tooth types and treatments applied

	Ra1–Ra0 (min–max)	Ra1–Ra0 (mean±SD [median])	Test statistic	P value
Group I (primary tooth laser group)	3.15–11.82	6.06±1.91 [5.70]	–3.95	<0.001*
Group II (primary tooth acid group)	0.17–5.08	1.40±1.47 [0.81]	–	–
Group III (permanent tooth laser group)	0.87–6.73	3.88±1.70 [4.11]	–3.95	<0.001*
Group IV (permanent tooth acid group)	0.13–5.60	1.52±1.52 [0.96]	–	–

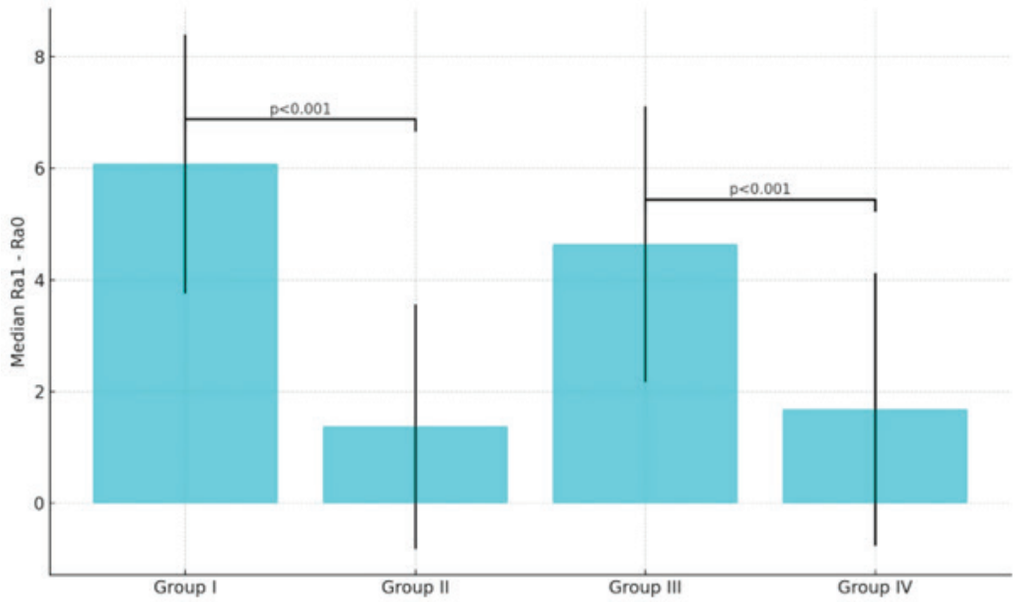

Figure 1. Amounts of surface roughness change according to tooth types and treatments applied

roughness changes of Group III and Group IV ($p < 0.05$). The surface roughness change in Group III (3.88 ± 1.70 [4.11]) was significantly greater than that of Group IV (1.52 ± 1.52 [0.96]) (Table 3, Figure 1).

DISCUSSION

The null hypothesis tested in this study stated that there would be no statistically significant difference in the surface roughness values of dentin from primary and permanent teeth following surface

preparation with 37% phosphoric acid or Er:YAG laser. However, the findings demonstrated that the surface preparation method had significant effects on surface roughness, leading to the rejection of the null hypothesis.

To optimise the adhesion of restorative materials to the dentin surface, it is essential to prepare the surface before the procedure. The objective of this preparation is to enhance the surface energy of dentin. The efficacy of bonding can be influenced by various surface preparation techniques and the adhesive system used.[18] It has been documented that the process of acid roughening is subject to variation in relation to the type of acid used (phosphoric acid, hydrochloric acid, or ethylenediaminetetraacetic acid). This variation arises from a range of factors, including the concentration of the acid, the duration of its application, its physical state (ie, gel, semi-gel, or liquid), the manner of washing and rinsing, the time allotted for these processes, the instrument used for application (eg, cotton pellet, brush, special applicator, or syringe), and the chemical structure of the dentin. Acids, such as citric, phosphoric, hydrochloric, and pyruvic acid have been trialled in laboratory conditions. The findings of these studies have led to the conclusion that the use of phosphoric acid is the most favoured, accepted, and standardised method for the roughening process.[19] Despite the existence of a plethora of procedures recommended for the pickling process, the most common method involves the application of phosphoric acid in semi-gel form at a concentration of 37%. The recommended roughening time is subject to variation according to the studies, but is typically in the range of 15–30 seconds.[20,21] The 37% orthophosphoric acid used in this study was in gel form and was applied to the dentin surface for 15 seconds, followed by a wash for 15 seconds and a drying period of 10 seconds according to the manufacturer's instructions.

Among the various laser technologies used for surface preparation, Nd:YAG, CO_2, and Er:YAG lasers are particularly favoured. The Er:YAG laser, with a wavelength of 2940 nm, exhibits a significantly higher level of absorption of OH groups in water and hydroxyapatite structures by water molecules when compared with the CO_2 laser (10 times) and the Nd:YAG laser (20,000 times). To achieve the same level of effectiveness as Er:YAG lasers in hard tissues, it is necessary to use CO_2 and Nd:YAG lasers at high energy levels.[22] For this study, the Er:YAG laser was selected due to its advantageous properties, which include its minimal adverse effects on tissue compared with alternative laser types and its high rate of absorption by dental hard tissues.

This study demonstrates that laser application produces a higher level of surface roughness in both primary and permanent teeth compared with acid etching. This finding can be explained by the micro-explosions, thermal effects, and mineral–matrix separation caused by laser irradiation on the dentin surface. Due to its higher organic content, dentin absorbs laser energy to a greater extent, resulting in a more irregular surface morphology in both primary and permanent teeth compared with acid treatment.

In contrast, phosphoric acid primarily induces selective dissolution of the mineral phase. Acid etching removes the smear layer, partially demineralizes the peritubular dentin, and exposes the collagen fibrils, creating a more homogeneous and controlled micro-retentive surface.[23] Although acid treatment increases surface roughness, it does not produce the same degree of topographic alteration as the irregular ablative effect of laser irradiation; in fact, several studies have reported that Ra values of acid-etched surfaces remain lower than those of laser-prepared ones.[24-27]

Hossain *et al*.[28] compared surface roughness of enamel and dentin after Er:YAG laser and acid treatment and reported that the laser was more effective in creating the desired roughness. Moshonov *et al*.[29] reported that both roughening methods produced similarly successful outcomes in their study using the Er:YAG laser and concluded that laser roughening could be an alternative to acid etching. Conversely, another study comparing micro-shear bond strength values of dentin reported that the highest bond strength was obtained in the acid-etched group.[30]

Firat *et al*.,[31] attribute this result to the effect of the Er:YAG laser on the tissue being predominantly ablative and that prolonged pulse durations cause thermal damage even under water cooling, which has a negative effect on the bonding process.

The findings of this study demonstrate that phosphoric acid application produces similar levels of surface roughness on primary and permanent dentin. This outcome can be explained by the direct demineralization effect of acid on the mineral components of dentin, which occurs in a comparable manner regardless of tooth type.[32,33] Although acid etching creates a similar effect on both primary and permanent teeth, laser application resulted in a greater impact on primary teeth compared with permanent teeth.

Lizarelli *et al*.[34] examined the micromorphological alterations in the dentin of primary and permanent teeth following Er:YAG laser application and reported that, due to differences in mineralization, primary teeth exhibited a rougher surface, whereas permanent teeth showed a smoother surface. This finding can be attributed to the histological and structural differences described in the literature. The dentinal tubule density of primary teeth has been reported to be 2–5 times higher than that of permanent teeth. Additionally, primary dentin contains lower levels of calcium and phosphorus but higher levels of organic material and water compared with permanent dentin.[35,36]

The higher organic matrix content, lower degree of mineralization, and wider and more densely packed dentinal tubules of primary dentin result in greater absorption of laser energy by primary dentin, leading to more pronounced ablation, disruption of collagen structure, and an increase in surface roughness.[37]

In this study, the differing degrees of roughness increase observed between primary and permanent dentin after laser application are consistent with variations in energy absorption linked to the microstructural characteristics of the dentin. Previous studies have reported that due to its higher water content, wider tubules, and lower mineralization, primary dentin is more sensitive to Er:YAG laser energy, resulting in faster ablation and the formation of more pronounced micro-retentive patterns on the surface.[38-40] In contrast, permanent dentin, with its denser mineral matrix and lower organic content, distributes energy differently and exhibits lower ablation efficiency.

The higher roughness values observed in primary dentin in our findings align with these biophysical characteristics. Therefore, the results should be interpreted not merely as superficial morphological differences but as reflections of how the unique structural properties of dentin influence laser–tissue interaction. A limitation of the study is that only surface roughness is considered. Although surface roughness is a concept that affects adhesion, further research is required to evaluate the micro-mechanical structure, exposed collagens, and the hybrid layer in greater detail.

CONCLUSION

The findings of this study indicate that both phosphoric acid and Er:YAG laser applications increase dentin surface roughness in primary and permanent teeth. The Er:YAG laser produced particularly higher roughness values in primary teeth. This difference is consistent with the lower degree of mineralization, higher organic and water content, and greater dentinal tubule density characteristic of primary dentin. The results demonstrate that laser application creates a significant morphological alteration on the dentin surface and provides an effect on surface roughness that is comparable to that of conventional acid etching.

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CONFLICT OF INTEREST

The authors report no competing interests.

Ortofosforik Asit ve Er:Yag Lazerle Oluşturulan Yüzey Pürüzlülüklerinin Değerlendirilmesi

ÖZET

Amaç: Bu çalışmanın amacı asit ve lazer uygulamasının süt ve daimi dişlerde oluşturduğu yüzey pürüzlülüğündeki değişimlerin karşılaştırmalı olarak değerlendirilmesidir.

Gereç ve Yöntem: Çalışmaya 40 adet daimi molar, 40 adet süt molar olmak üzere toplamda 80 adet diş kullanılmıştır. Dişler bir

separe yardımıyla dentin yüzeyi ortaya çıkarılmıştır. Süt dişleri (Grup I, Grup II) ve daimi dişler (Grup III, Grup IV) kendi içlerinde ikiye ayrılmıştır. Kendi içerisinde ikiye ayrılan süt dişleri ve daimi dişlere ortofosforik asit (Grup II, Grup IV) ve Er:YAG lazer (Grup I, Grup III) uygulanmıştır. Her bir örneğin başlangıç (Ra0) ve işlem gördükten sonra (Ra1) pürüzlülük değeri profilometre cihazı ile ölçülmüştür.

Bulgular: Tüm grupların Ra1 değerlerinin (Grup I: 7.63±2.01 [7.31]; Grup II: 3.17±1.81 [2.89]; Grup III: 6.37±1.24 [6.14]; Grup IV: 3.52±1.98 [3.08]) Ra0 değerlerinden (Grup I:1.57±1.16 [1.23]; Grup II:1.77±1.24 [1.52]; Grup III:2.49±2.14 [1.50]; Grup IV: 2.01±1.44 [1.40]) daha yüksek olduğu görülmüştür. Grup I'in yüzey pürüzlülük değişim miktarının (6.06±1.91 [5.70]) Grup II'den (1.40±1.47 [0.81]), Grup III'ün yüzey pürüzlülük değişim miktarının (3.88±1.70 [4.11]) Grup IV'ten (1.52±1.52 [0.96]) daha yüksek olduğu bulunmuştur.

Sonuç: Süt ve daimi dişlerde lazer uygulamasının yüzey pürüzlülüğünde oluşturduğu değişim, asit uygulamasından daha fazladır.

Anahtar Kelimeler: Daimi Dişlenme; Er: YAG Lazer; Fosforik Asit; Süt Dişlenme

REFERENCES

1. Kidd E, Frencken J, Nyvad B, Splieth C, Opdam N. Classical restorative or the minimally invasive concept. In: Dental Caries: The Disease and its Clinical Management. 2015. p. 335–73.

2. Oliveira SS, Pugach MK, Hilton JF, Watanabe LG, Marshall SJ, Marshall GW Jr. The influence of the dentin smear layer on adhesion: a self-etching primer vs a total-etch system. Dent Mater 2003;19:758–67.

3. Silveira de Araújo C, Incerti da Silva T, Ogliari F, Meireles S, Piva E, Demarco F. Microleakage of seven adhesive systems in enamel and dentin. J Contemp Dent Pract 2006;7:26–33.

4. Peutzfeldt A, Nielsen LA. Bond strength of a sealant to primary and permanent enamel: phosphoric acid versus self-etching adhesive. Pediatr Dent 2004;26:240–4.

5. Da Rosa WLDO, Piva E, da Silva AF. Bond strength of universal adhesives: a systematic review and meta-analysis. J Dent 2015;43:765–76.

6. Akkaya B, Şener Y. The effects of different surface preparation techniques on enamel surface properties and bond strength. Eur Res Dent 2024;8:14-25.

7. Lee B-S, Lin P-Y, Chen M-H, Hsieh T-T, Lin C-P, Lai J-Y, *et al*. Tensile bond strength of Er,Cr:YSGG laser-irradiated human dentin and analysis of dentin–resin interface. Dent Mater 2007;23:570–8.

8. Sung E, Chenard T, Caputo AA, Amadeo M, Chung EM, Rizoiu IM. Composite resin bond strength to primary dentin prepared with Er,Cr:YSGG laser. J Clin Pediatr Dent 2005;30:45–50.

9. Uysal AGDD, Guler C. Laser in dentistry: a literature review. Atatürk Univ Dent Fac J 2012;2012:1–6.

10. Lenzi TL, Guglielmi CAM de A, Arana-Chavez VE, Raggio DP. Tubule density and diameter in coronal dentin from primary and permanent human teeth. Microsc Microanal 2013;19:1445–9.

11. Hayashi-Sakai S, Sakamoto M, Hayashi T, Sakai J, Shimomura-Kuroki J, Nashida T. Evaluation of permanent and primary enamel and dentin mineral density using micro-computed tomography. Oral Radiol 2019;35:29–34.

12. Chowdhary N, Subba Reddy VV. Dentin comparison in primary and permanent molars under transmitted and polarised light microscopy: an *in vitro* study. J Indian Soc Pedod Prev Dent 2010;28:167–72.

13. Wang JH, Yang K, Zhang BZ, Zhou ZF, Wang ZR, Ge X, *et al*. Effects of Er:YAG laser pre-treatment on dentin structure and bonding strength of primary teeth: an *in vitro* study. BMC Oral Health 2020;20:316.

14. Villalobos-Tinoco J, Andretti F, Conner C, Rojas-Rueda S, Fischer NG, Pagan-Banchs M, *et al*. A narrative review and clinical study on Er:YAG laser debonding of ceramic and composite veneers. Biomimetics (Basel) 2025;10:295.

15. Fornaini C, Brulat N, Milia G, Rockl A, Rocca JP. The use of sub-ablative Er:YAG laser irradiation in prevention of dental caries during orthodontic treatment. Laser Ther 2014;23:173–81.

16. Fornaini C. Er:YAG laser for the aesthetic treatment of developmental enamel defects in frontal teeth: a case report. Laser Ther 2019;28:199–202.

17. Lin W, Shi T, Wang Y, Chen X, Zhao Y, Zhou L, *et al*. Effect of Er:YAG laser dentin pretreatment on composite bonding: a systematic review and meta-analysis. J Prosthodont Res. 2025;(prepublished-early access). PMID: 41114916.

18. Sattabanasuk V, Vachiramon V, Qian F, Armstrong SR. Resin–dentin bond strength as related to different surface preparation methods. J Dent 2007;35:467–75.

19. Cinnamon B. Investigation of adaptation and bond strength of bonding agents to dentin surface treated with Nd:YAG and Er,Cr:YSGG lasers. [Thesis]. İstanbul: Marmara University; 2005.

20. Cardenas AM, Siqueira F, Rocha J, Szesz AL, Anwar M, El-Askary F, *et al*. Influence of conditioning time of universal adhesives on adhesive properties and enamel-etching pattern. Oper Dent 2016;41:481–90.

21. Kakar S, Kanase A. Dentin bonding agents I: complete classification—a review. World J Dent 2013;2:367–70.

22. Wanderley RL, Monghini EM, Pecora JD, Palma-Dibb RG, Borsatto MC. Shear bond strength to enamel of primary teeth irradiated with varying Er:YAG energies and SEM of surface morphology. Photomed Laser Ther 2005;23:260–7.

23. Martínez-Insua A, Da Silva Domínguez L, Rivera FG, Santana-Penín UA. Differences in bonding to acid-etched or Er:YAG-laser-treated enamel and dentin surfaces. J Prosthet Dent 2000;84:280–8.

24. Wang JH, Yang K, Zhang BZ, Zhou ZF, Wang ZR, Ge X, *et al.* Effects of Er:YAG laser pre-treatment on dentin structure and

bonding strength of primary teeth: an *in vitro* study. BMC Oral Health. 2020;20:316.

25. Vermelho PM, Freitas PM, Reis AF, Giannini M. Influence of Er:YAG laser irradiation settings on dentin-adhesive interfacial ultramorphology and dentin bond strength. Microsc Res Tech 2022;85:2943–52.

26. Ersahan S, Sabuncuoğlu F. Effect of surface treatment on enamel surface roughness. J Istanbul Univ Fac Dent 2016;50:1–8.

27. Liu M, Xu X, Liu Q, Zhang K, Xin P. Effect of various Er:YAG laser conditioning energies on dentin surface: micromorphological investigation and dentin-resin shear bond strength test. Lasers Med Sci 2023;38:1–11.

28. Hossain M, Nakamura Y, Yamada Y, Murakami Y, Matsumoto K. Microleakage of composite restorations in Er,Cr:YSGG laser- and bur-prepared primary teeth. J Clin Pediatr Dent 2002;26:263–8.

29. Moshonov J, Stabholz A, Zyskind D, Sharlin E, Peretz B. Acid-etched and Er:YAG laser-treated enamel for fissure sealants: a comparison of microleakage. Int J Paediatr Dent 2005;15:205–9.

30. Al-Habdan AH, Al-Rabiah R, Al-Busayes R. Shear bond strength of acid- and laser-conditioned enamel and dentine to composite resin restorations: an *in vitro* study. Clin Exp Dent Res 2021;7:331–7.

31. Firat E, Gurgan S, Gutknecht N. Microtensile bond strength of an etch-and-rinse adhesive after Er:YAG laser pretreatment with different pulse durations. Lasers Med Sci 2012;27:15–21.

32. Perdigão J. New developments in dental adhesive systems. Compend Contin Educ Dent 2010;31:12–9.

33. Erickson RL, Barkmeier WW, Latta MA. Bonding to tooth structure: a review. J Esthet Restor Dent 2009;21:341–52.

34. Lizarelli RdF, Moriyama LT, Jorge J, Bagnato VS. Comparative ablation rate of Er:YAG laser on enamel and dentin of primary and permanent teeth. Laser Phys 2006;16:849–58.

35. Osorio R, Aguilera FS, Otero PR, Romero M, Osorio E, García-Godoy F, *et al*. Primary dentin etching time, bond strength and ultrastructure of dentin surfaces. J Dent 2010;38:222–31.

36. Esteves-Oliveira M, de Guglielmi CA, Ramalho KM, Arana-Chavez VE, de Eduardo CP. Comparison of root dentin permeability and morphology after Nd:YAG, Er:YAG, and diode lasers. Lasers Med Sci 2010;25:755–60.

37. Ten Cate AR, Nanci A. Ten Cate's Oral Histology: Development, Structure, and Function. 9th ed. St. Louis: Elsevier; 2020.

38. Uzun A, Aykut-Yetkiner A. Effects of Er:YAG laser on mineral content of sound dentin in primary teeth. J Dent Sci 2014;9:313–8.

39. Eduardo CdeP, de Freitas PM, Esteves-Oliveira M. Mechanisms of Er:YAG laser ablation on dental hard tissues. Photomed Laser Surg 2010;28:S7–S13.

40. Wang X, Wang Y, Liu Y, *et al*. Dentin microstructure differences between primary and permanent teeth. Int J Paediatr Dent 2012;22:223–30.

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Original Research Article

Comparison of Canal Shaping and Transportation Between the Protaper Next and Protaper Ultimate in Simulated Double-curved Canals

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ABSTRACT

Aim: To compare the canal shaping and transportation caused by the Protaper Next (PTN) and Protaper Ultimate (PTU) file systems in artificially created double-curved canals.

Material and Method: Thirty double-curved canals in clear resin blocks were prepared up to an apical size of #25 using PTN and PTU instruments. Resin blocks were filled with ink and photographed before and after instrumentation to develop composite images by superimposition. Shaping ability and transportation of the canals were evaluated. Student's t-test and Mann Whitney U test was used ($p<0.05$).

Results: Compared with the PTU system, PTN demonstrated significantly greater shaping at the 7–10 mm levels, corresponding to the coronal third of the canals ($p<0.05$). At the 4 mm level, representing the apical curvature, transportation was significantly higher in the PTU group ($p=0.006$). No statistically significant differences were observed at the other levels ($p>0.05$).

Conclusion: The PTU group, compared to the PTN group, demonstrated more conservative shaping in the coronal and middle thirds, preserving pericervical dentin more effectively. The PTU group may lead to transportation in the apical curvature.

Keywords: Root canal preparation; Root canal therapy; Root canal transportation

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INTRODUCTION

Root canal morphology is complex and significantly influences the success of endodontic treatment. Effective root canal treatment depends on preserving the tooth structure while maintaining the original canal shape during instrumentation, cleaning, shaping, and hermetic sealing.[1] However, complex root canal anatomy can cause difficulties in shaping the canal. Root canal shaping should preserve the original structure of the apical foramen and avoid root canal transportation.[2] The amount of root canal transportation depends both on the anatomy of the root canal and the cross-sectional design, taper, and flexibility of the files. Thanks to the improved mechanical properties of nickel-titanium (Ni-Ti) instruments, the shaping process can be performed more effectively and with fewer errors, especially in curved root canals.[3,4] Ni-Ti rotary file systems were developed to reduce iatrogenic errors by increasing flexibility through different alloys, tapers, cross-sectional designs, and heat treatments. Heat-treated Ni-Ti alloys contain the more ductile R-phase or martensitic phase, while conventional Ni-Ti alloys consist primarily of austenite. This provides heat-treated Ni-Ti files with higher flexibility and cyclic fatigue resistance than traditional Ni-Ti files.[5] Meanwhile, efforts have been made to improve the preservation of remaining pericervical dentin, which contributes to the fracture resistance of teeth and directly impacts long-term prognosis.[6] This has led to the continual evolution of innovative filing systems whose aim is to protect the tooth structure. Protaper Next (PTN; Dentsply, Maillefer, Ballaigues, Switzerland) is among the file systems developed for this purpose.[7]

PTN is an M-Wire file system composed of heat-treated Ni-Ti alloy, containing austenite, martensitic, and R-phases for improved cyclic fatigue resistance and flexibility.[7,8] The PTN has an off-center rectangular design and progressive tapers. Through the inclusion of both ascending and descending tapered designs on a single file, it minimizes the contact between dentin and file, reducing the unwanted screw effect.[9] In the PTN file system, only two points of the rectangular cross-section contact the canal wall at any one time.[10]

The ProTaper Ultimate (PTU; Dentsply Maillefer, Baillagues, Switzerland) is a multi-file system comprising shaping and finishing files with different crystallographic structures; the different mechanical properties of the files complement each other.[11] The newest generation of the Protaper group, this file group has a parallelogram cross-section with pronounced acute angles, partially off-center, and a maximum groove diameter of 1.0 mm. This allows for the conservative removal of dentin in important areas such as the cementoenamel junction, while at the same time offering larger apical dimensions for preparation. The finisher files of the PTU system include varied tip sizes and tapers (#20/0.07, #25/0.08, and #30/0.09), which allow for more effective shaping in the apical triangular region.[11,12]

The main advantage of this system is the separate shaper files, for working on the coronal two-thirds of the canal, and finisher files, for increasing the taper of the apical third without unnecessary widening of the coronal portion. The five main files of the set represent the most commonly used types: a slider to identify the canals, a shaper to prepare the coronal and middle thirds of the canal, and three different sizes of finisher files.[13] As with the PTN, heat treatment technology increases flexibility and resistance to cyclic fatigue, and optimizes performance. The PTU set consists of three different heat-treated alloys: including M-Wire for the slider, Gold-Wire for shapers and finishers, and Blue-Wire for finishers.[13] This study aimed to compare the shaping ability and amount of transport of the PTN and PTU file systems in artificial double-curved canals. The null hypothesis of this study was that there would be no significant differences between the PTN and PTU systems in terms of canal shaping ability (the ability of the file system to enlarge and shape the canal while maintaining its original curvature) and transportation in simulated double-curved canals.

MATERIALS AND METHODS

This study was conducted at Health Science University, Faculty of Hamidiye Dentistry, Department of Endodontics. Simulated double-curved resin blocks were used to compare the shaping efficiency of different Ni-Ti file systems in difficult canals and measure the amount of transportation. G*Power software (version 3.1.9.7; Heinrich Heine Universitat, Dusseldorf, Germany) was used to determine the required sample size. A priori analysis of variance (ANOVA; fixed effects, omnibus, one-way) was selected from the F-test family. The effect size was set at 0.6 based on data from a previous study.[14] The calculations were performed by setting the alpha error at 0.05 and the power (β value) at 0.85. A total of 30 resin blocks (Endo Training-Bloc-S, 0.02 Taper; Dentsply Maillefer, Ballaigues, Switzerland) with double-curvature canals were used, with n=15 per group.

Sample Preparation: Simulated canals in the resin blocks were prepared with a taper of 0.02, an apical diameter of 0.15 mm, a length of 18 mm, an apical curvature of 20° (3.5 mm radius), and a coronal curvature of 30° (5 mm radius). These blocks were randomly divided into two groups according to the file system used, PTN (n=15) and PTU (n=15).

Canal Shaping Procedures: The resin blocks were numbered from 1 to 30 and randomly divided into two groups according to the Ni-Ti file system used. Before instrumentation, all canals were injected with black ink (Pelikan 4000, Germany). To ensure the homogeneity of the photographs for each sample, a specialized setup was used to consistently position the transparent resin blocks. The setup was maintained with the same position and settings, and photographs were taken using a microscope-calibrated camera (Nikon D3500, Nikon, Japan).

Canal patency was confirmed using an ISO standard size #10K file (Dentsply Maillefer, Ballaigues, Switzerland). Root canal shaping was performed using the Ai-Endomotor (Woodpecker, China), with torque and speed at the manufacturer's recommended settings. All procedures were carried

out by a second-year endodontic resident. Each file was used for a single canal only. The working length was set to 18 mm, and a glide path was established using a #15K file. Distilled water was used instead of clinical irrigation solutions to prevent chemical interactions with the transparent blocks.

Following instrumentation, red ink (Pelikan 4001, Germany) was injected into the canal to enhance the color contrast of the photographs, and the images were captured again under the same conditions as before. To minimize the margin of error, all photographs were taken by the same individual.

Analysis of Transportation and Shaping Efficiency

The images obtained before and after instrumentation were transferred to Adobe Photoshop CC 2023 (Adobe Systems, San Jose, CA, USA) for further analysis. The photographed surfaces were optimally aligned by superimposing the created openings (Figure 1).

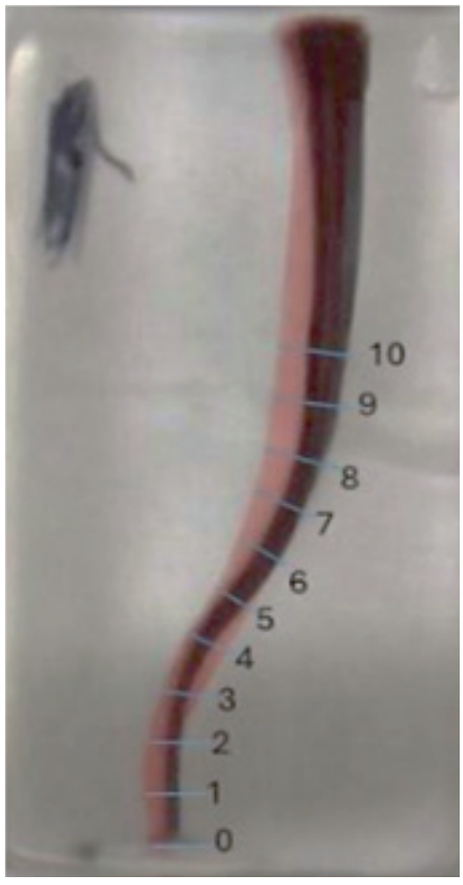

Figure 1. The images obtained before and after instrumentation were transferred to Adobe Photoshop CC 2023 (Adobe Systems, San Jose, CA, USA) and aligned using the overlay method.

To evaluate the shaping efficiency of the Ni-Ti rotary file systems used in this study, changes in the original shape of the canal were determined based on the following criteria:

a – Amount of enlargement on the outer side of the curvature (O)
b – Amount of enlargement on the inner side of the curvature (I)
c – Total amount of enlargement (S): O + I
d – Direction and amount of transportation (T): I - O

The difference between the amount of material removed from the outer side of the curvature and the amount removed from the inner side determines the transportation value (T). According to this formula:

T = 0 indicates that no transportation has occurred in the canal.
T > 0 signifies that the transportation direction is inward.
T < 0 signifies that the transportation direction is outward.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics v.22. Student's t-test was used for comparisons between the two groups for normally distributed parameters, and the Mann-Whitney U test was used for comparisons between the two groups when the normality assumption was not met. The p value < 0.05 was considered statistically significant.

RESULTS

Evaluation of Canal Shaping Amount: Table 1 presents the root canal shaping measurements for each group. No statistically significant differences were found between the groups at the 1 mm, 2 mm, 3 mm, 4 mm, 5 mm, and 6 mm levels, corresponding to the apical and middle thirds of the canal ($p>0.05$). However, the extent of root canal shaping at the 7 mm, 8 mm, 9 mm, and 10 mm levels, representing the coronal third of the canal, was significantly higher in the PTN group compared to the PTU group ($p<0.05$). Furthermore, the shaping measurements increased progressively from 1 mm to 10 mm within both file systems (Figure 2).

Table 1. The amounts of root canal shaping of Protaper Next and Protaper Ultimate groups

	Protaper Next	Protaper Ultimate	
Amounts of root canal shaping	**Mean±SD**	**Mean±SD**	**p**
1 mm	0.27±0.07	0.25±0.05	0.380
2 mm	0.28±0.10	0.25±0.07	0.533
3 mm	0.30±0.09	0.27±0.07	0.437
4 mm	0.40±0.09	0.34±0.08	0.141
5 mm	0.41±0.09	0.35±0.09	0.192
6 mm	0.42±0.11	0.41±0.12	0.891
7 mm	0.56±0.05	0.43±0.06	0.001*
8 mm	0.52±0.07	0.41±0.06	0.001*
9 mm	0.54±0.12	0.44±0.07	0.046*
10 mm	0.61±0.09	0.48±0.08	0.002*

Student's t-test *p<0.05

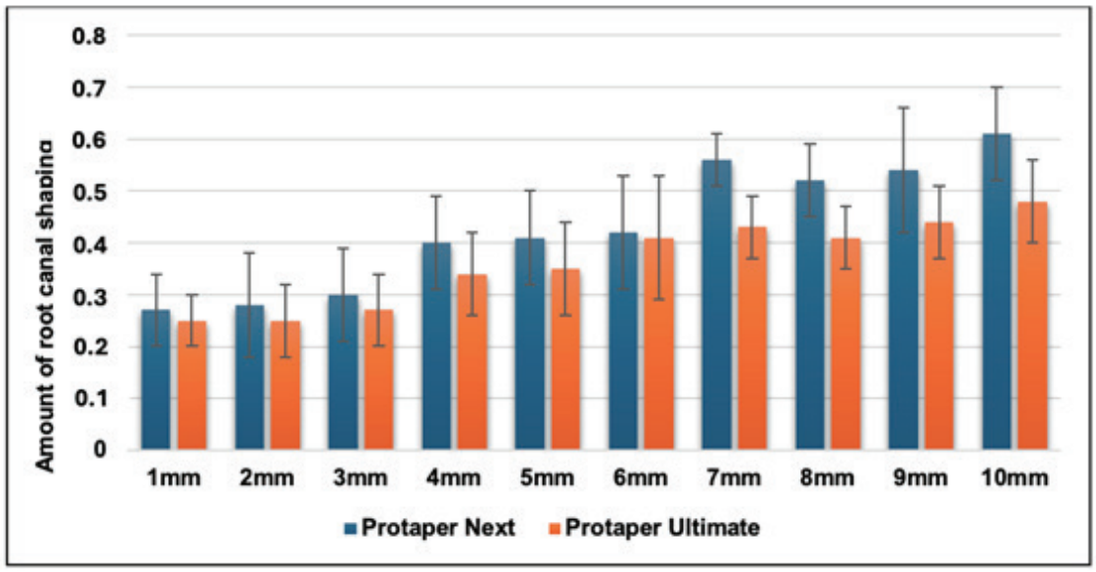

Figure 2. The amount of root canal shaping of Protaper Next and Protaper Ultimate

Table 2. The amounts of root canal transportation of Protaper Next and Protaper Ultimate groups

	Protaper Next	Protaper Ultimate	
Amounts of root canal transportation	**Mean±SD**	**Mean±SD**	**p**
1 mm	0.09±0.04 (0.08)	0.06±0.03 (0.06)	0.057
2 mm	0.14±0.08 (0.13)	0.11±0.10 (0.08)	0.269
3 mm	0.12±0.11 (0.09)	0.20±0.14 (0.15)	0.223
4 mm	0.05±0.03 (0.04)	0.16±0.13 (0.10)	0.006*
5 mm	0.16±0.04 (0.16)	0.14±0.06 (0.15)	0.704
6 mm	0.15±0.06 (0.19)	0.13±0.10 (0.11)	0.411
7 mm	0.12±0.09 (0.10)	0.11±0.08 (0.08)	0.731
8 mm	0.04±0.03 (0.04)	0.07±0.05 (0.07)	0.359
9 mm	0.08±0.04 (0.08)	0.07±0.03 (0.08)	0.939
10 mm	0.09±0.03 (0.09)	0.07±0.04 (0.07)	0.137

Student's t-test *p<0.05

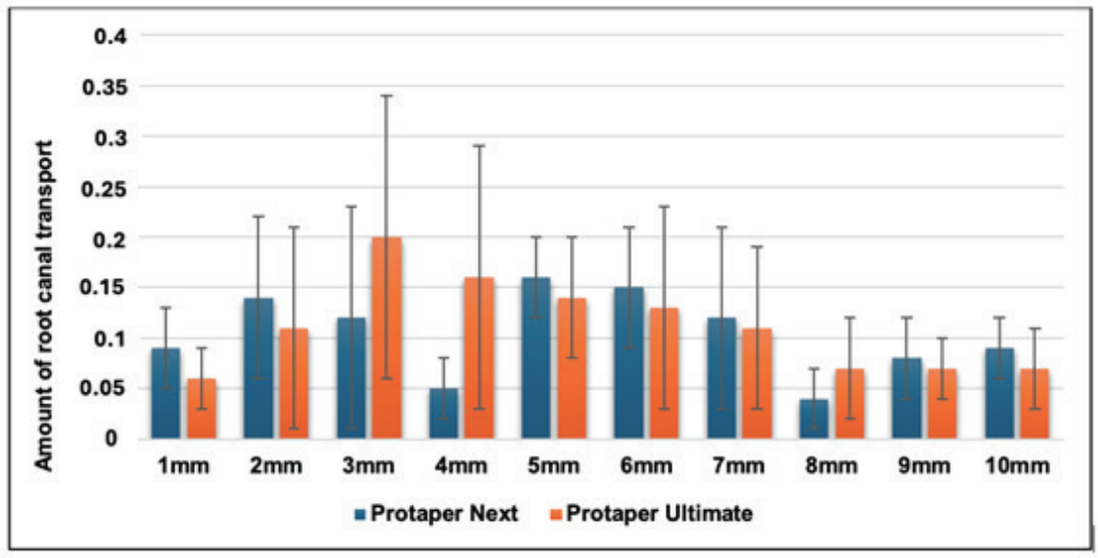

Figure 3. The amount of root canal transportation of Protaper Next and Protaper Ultimate

Evaluation of Root Canal Transportation: The extent of root canal transportation at the 4 mm level was found to be significantly higher in the PTU group compared to the PTN group (p=0.006).

However, no statistically significant differences were observed between the groups at 1 mm, 2 mm, 3 mm, 5 mm, 6 mm, 7 mm, 8 mm, 9 mm, and 10 mm (p>0.05) (Table 2). A significant difference between the two groups was detected only at the 4 mm level, corresponding to the apical curvature of the canal (Figure 3).

DISCUSSION

Regardless of the instrumentation technique used, cleaning and shaping procedures inevitably result in the removal of a certain amount of dentin from the canal walls. If dentin is not removed uniformly in all directions along the main axis of the tooth, but instead excessively in a single direction, it leads to a phenomenon known as canal transportation.[15,16] According to Goldberg *et al*.[17], apical transportation occurring during root canal treatment increases the risk of treatment failure.

Root canal transportation up to 0.15 mm is considered an acceptable amount; transportation exceeding 0.30 mm can impede apical sealing after canal obturation, potentially leading to failed treatment.[2] Older file systems were generally indicated for shaping straight or slightly curved canals. However, with ongoing advances in modern file systems, instruments with a higher martensitic phase have been developed. These newer instruments offer greater flexibility and shape memory control, making them more suitable for use in severely curved or double-curvature root canals.[18,19]

Consistent with our results, a previous study comparing the shaping efficiency of different Ni-Ti files in double-curvature root canals concluded that files with a lower taper more effectively preserved the original canal shape. In other words, as the taper angle decreases, the amount of transportation is also reduced.[20] When comparing the shaping ability of canal instruments, the instruments must have a similar apical diameter.[21] It was stated that an apical diameter of at least #35 size is necessary for optimal root canal cleaning.[22] However, Akhlaghi *et al*.[23] reported that, in terms of the ability to reduce bacterial load, an apical size of #25 was not significantly different from larger diameters. Additionally, as the apical size increases, the flexibility of the file decreases, leading to a higher risk of transportation.[23] Similarly, López *et al*.[24] reported an increased tendency for canal transportation as the file diameter increases. In the present study, the PTN system caused less transportation than the PTU files. This is believed to be due to the smaller taper angle of the PTN. Consistent with this, Shenoi *et al*.[25] previously reported that PTN did not cause significant transportation in the apical region. Although both PTU and PTN files were

used according to the manufacturers' instructions, differences in torque and continuous rotation settings may have influenced the results. Variations in these parameters can affect cutting efficiency, flexibility, and the tendency for canal transportation, particularly in curved canals. Therefore, while the present findings provide valuable insights into the shaping behavior of these systems, the potential influence of mechanical settings should be considered when interpreting and applying the results clinically.

In this study, PTN demonstrated significantly greater dentin removal in the coronal third (7–10 mm levels), whereas PTU caused more transportation in the apical third (4 mm level). These outcomes can be attributed to differences in taper and cross-sectional design. The progressive and variable taper of the PTN system likely enhanced flexibility in the apical region, thereby reducing transportation. In contrast, the larger taper of the PTU files may have increased stiffness within the apical curvature, resulting in higher transportation values.

Clinically, these findings suggest that PTN may be preferable in curved canals to minimize apical transportation, while PTU may be more suitable for preserving pericervical dentin in straighter canals. Based on our results, the null hypothesis stating that there would be no significant difference between the PTN and PTU systems was rejected.

Wu *et al*.[26] compared the PTU, WaveOne, and PTN systems and found that PTN caused the least apical transportation in severely curved canals, while also providing better shaping efficiency. This outcome was attributed to the PTN's progressive taper design, providing more flexibility in the apical section, and to the microstructure of its Ni-Ti alloy, which consists predominantly of the flexible martensitic phase.[26]

In a study comparing PTU with WaveOne Gold (Dentsply-Maillefer, Tulsa, OK) files, PTU demonstrated superior performance in preserving pericervical dentin.[27] Several studies have examined the resistance to cyclic fatigue of PTN and PTU files.[28-31] In one study comparing cyclic fatigue resistance, PTN demonstrated significantly better results than PTU.[30]

A larger taper in the file design has been shown to increase canal transportation. Kunert *et al*.[32] suggest that the taper is a primary factor responsible for canal transportation. In our study, when comparing the amount of transportation between groups, a statistically significant difference was observed only at the 4 mm level (p=0.006). This may be attributed to the fact that in the double-curvature resin blocks, the apical curvature transition occurs at 4 mm, leading to a higher degree of transportation at this specific level.

Many studies conducted on simulated resin blocks have suggested that differences in hardness between extracted tooth dentin and resin blocks may influence clinical outcomes.[33] However, Khalilak *et al*.[34] have argued that the amount of apical transportation observed in extracted teeth and high-hardness resin blocks is similar, and that results obtained from resin blocks can be considered valid if interpreted carefully. In our study, the use of simulated canals in resin blocks ensured standardization in factors such as canal size, curvature, and taper angle, eliminating parameters that vary according to root canal anatomy. This approach provided a controlled environment for a more reliable comparison of shaping and transportation effects. Additionally, the transparency of the simulated canals in resin blocks allowed for a direct comparison of pre- and post-instrumentation images, enabling a more precise evaluation of the shaping and transportation.

This study has several limitations. Although resin blocks provided standardization, they do not fully replicate the mechanical and histological properties of natural dentin. Micro-computed tomography (micro-CT), considered the gold standard for assessing canal shaping and transportation, was not employed; instead, two-dimensional image superimposition was used, which may not adequately represent three-dimensional changes. Distilled water was used for irrigation to ensure standardization, but this does not simulate the chemical and biological interactions occurring with clinical irrigants. Additionally, instrumentation time, file fatigue, and debris extrusion were not evaluated, limiting the clinical applicability of the findings. Finally, inter- and intra-observer reliability was not assessed, which may have introduced measurement bias. It is recommended that these limitations be excluded in future studies.

CONCLUSION

The PTU group, compared to the PTN group, demonstrated more conservative shaping in the coronal and middle thirds, preserving pericervical dentin more effectively. However, it was also found that PTU may lead to more extensive transportation in the apical curvature. Therefore, the use of PTU file systems is recommended in teeth without curvature and in those with weakened pericervical dentin.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

ETHICAL APPROVAL

Not applicable

INFORMED CONSENT

Not applicable

Simüle Edilmiş Çift Kurvatürlü Kanallarda Protaper Next ve Protaper Ultimate Eğeleri Arasındaki Kanal Şekillendirme ve Transportasyonunun Karşılaştırması

ÖZET

Amaç: Yapay olarak oluşturulan çift kurvatürlü kanallarda Protaper Next (PTN) ve Protaper Ultimate (PTU) eğe sistemlerinin neden olduğu kanal şekillendirme ve transportasyonu karşılaştırmak.

Gereç ve Yöntem: Şeffaf rezin bloklarda otuz adet çift kurvatürlü kanal, PTN ve PTU eğeleri kullanılarak #25 apikal boyuta kadar hazırlandı. Rezin bloklar mürekkeple dolduruldu ve preparasyon öncesi ve sonra fotoğraflanarak görüntüler çakıştırıldı. Kanalların şekillendirme ve transportasyon miktarları değerlendirildi. Student t testi ve Mann Whitney U testi kullanıldı ($p<0.05$).

Bulgular: PTU'ya kıyasla, kanalların koronal üçte birine denk gelen 7-10 mm seviyelerinde kök kanal şekillendirme miktarı, PTN'de önemli ölçüde daha yüksekti ($p<0.05$). Apikal kurvatüre karşılık gelen 4 mm seviyesinde ise, transportasyon miktarı PTU grubunda PTN'ye kıyasla anlamlı derecede daha fazlaydı ($p = 0.006$). Diğer mesafelerde kök kanal transportasyon miktarları açısından gruplar arasında istatistiksel olarak anlamlı bir fark bulunmadı ($p>0.05$).

Sonuç: PTU grubu, PTN grubuna kıyasla, koronal ve orta üçlüde daha konservatif bir şekillendirme yaparak periservikal dentini daha etkili bir şekilde koruyabilir. PTU grubu apikal üçlüde transportasyona yol açabilir.

Anahtar Kelimeler: Kök kanal preparasyonu; Kök kanal tedavisi; Kök kanal transportasyonu

REFERENCES

1. Shakouie S, Mokhtari H, Ghasemi N, Gholizadeh S. Two-rooted maxillary first molars with two canals: a case series. Iran Endod J 2013;8:29-32.

2. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004;30:559-67.

3. Işık V, Ersev H. Farklı Teknolojiler Kullanılarak Üretilmiş Güncel Nikel-Titanyum Esaslı Döner Alet Sistemlerinin Şekillendirme Etkinliklerinin İncelenmesi. Yeditepe J Dent 2024;20:4-11.

4. Hülsmann M, Peters OA, Dummer PMH. Mechanical preparation of root canals: Shaping goals, techniques, and means. Endod Topics 2005;10:30–76.

5. Abdellatif D, Iandolo A, Scorziello M, Sangiovanni G, Pisano M. Cyclic fatigue of different Ni-Ti endodontic rotary file alloys: A comprehensive review. Bioengineering (Basel) 2024;11:499.

6. Brasil SC, Marceliano-Alves MF, Marques ML, Grillo JP, Lacerda MFLS, Alves FRF, *et al*. Canal Transportation, Unprepared Areas, and Dentin Removal after Preparation with BT-RaCe and ProTaper Next Systems. J Endod 2017;43:1683-7.

7. Elnaghy AM. Cyclic fatigue resistance of ProTaper Next nickel-titanium rotary files. Int Endod J 2014; 47:1034–9.

8. Zupanc J, Vahdat-Pajouh N, Schäfer E. New thermomechanically treated NiTi alloy – A review. Int Endod J 2018;51:1088-103.

9. Ruddle CJ. The ProTaper endodontic system: Geometries, features, and guidelines for use. Dent Today 2001;20:60–7.

10. Elnaghy AM, Elsaka SE. Assessment of the mechanical properties of ProTaper Next nickel-titanium rotary files. J Endod 2014;40:1830–4.

11. Martins JNR, Silva EJNL, Marques D, Ajuz N, Rito Pereira M, Pereira da Costa R, *et al*. Characterization of the file-specific heat-treated ProTaper Ultimate rotary system. Int Endod J 2023;56:530-42.

12. Mustafa M, Attur K, Bagda KK, Singh S, Oak A, Kathiria N. An Appraisal on Newer Endodontic File Systems: A Narrative Review. J Contemp Dent Pract 2022;23:944-52.

13. Dentsply Sirona. ProTaper Ultimate Endodontic Files. 2023. Available from https://www.dentsplysirona.com/en-gb/categories/endodontics/protaper-ultimate-files.html

14. Unno H, Ebihara A, Hirano K, Kasuga Y, Omori S, Nakatsukasa T, *et al.* Mechanical Properties and Root Canal Shaping Ability of a Nickel-Titanium Rotary System for Minimally Invasive Endodontic Treatment: A Comparative *In Vitro* Study. Materials (Basel) 2022;15:7929.

15. Kim H, Jeon SJ, Seo MS. Comparison of the canal transportation of ProTaper GOLD, WaveOne GOLD, and TruNatomy in simulated double-curved canals. BMC Oral Health 2021;21:533.

16. Nagaraja S, Sreenivasa Murthy BV. CT evaluation of canal preparation using rotary and hand NI-TI instruments: An in vitro study. J Conserv Dent 2010;13:16-22.

17. Goldberg F, Araujo JA. Comparison of three instruments in the preparation of curved root canals. Endod Dent Traumatol 1997;13:265-8.

18. Bueno CRE, Cury MTS, Vasques AMV, Sivieri-Araújo G, Jacinto RC, Gomes-Filho JE, *et al*. Cyclic fatigue resistance of novel Genius and Edgefile nickel-titanium reciprocating instruments. Braz Oral Res 2019;33:e028.

19. Gambarini G, Grande NM, Plotino G, Somma F, Garala M, De Luca M, *et al*. Fatigue resistance of engine-driven rotary nickel-titanium instruments produced by new manufacturing methods. J Endod 2008;34:1003-5.

20. Bürklein S, Poschmann T, Schäfer E. Shaping ability of different nickel-titanium systems in simulated S-shaped canals with and without glide path. J Endod 2014;40:1231-4.

21. Bergmans L, Van Cleynenbreugel J, Beullens M, Wevers M, Van Meerbeek B, Lambrechts P. Progressive versus constant tapered shaft design using NiTi rotary instruments. Int Endod J 2003;36:288-95.

22. Tan BT, Messer HH. The quality of apical canal preparation using hand and rotary instruments with specific criteria for enlargement based on initial apical file size. J Endod 2002;28:658-64.

23. Mohammadzadeh Akhlaghi N, Rahimifard N, Moshari A, Vatanpour M, Darmiani S. The Effect of Size and Taper of Apical Preparation in Reducing Intra-Canal Bacteria: A Quantitative SEM Study. Iran Endod J 2014;9:61-5.

24. López FU, Fachin EV, Camargo Fontanella VR, Barletta FB, Só MV, Grecca FS. Apical transportation: a comparative evaluation of three root canal instrumentation techniques with three different apical diameters. J Endod 2008;34:1545-8.

25. Shenoi PR, Luniya DA, Badole GP, Makade CS, Kubde R, Khode RT. Comparative evaluation of shaping ability of V-Taper 2H, ProTaper Next, and HyFlex CM in curved canals using cone-beam computed tomography: An *in vitro* Study. Indian J Dent Res 2017;28:181-6.

26. Wu H, Peng C, Bai Y, Hu X, Wang L, Li C. Shaping ability of ProTaper Universal, WaveOne and ProTaper Next in simulated L-shaped and S-shaped root canals. BMC Oral Health 2015;15:27.

27. Ribeiro G, Martin V, Rodrigues C, Gomes P. Comparative Evaluation of the Canal Shaping Ability, Pericervical Dentin Preservation, and Smear Layer Removal of TruNatomy, WaveOne Gold, and ProTaper Ultimate-An Ex Vivo Study in Human Teeth. J Endod 2023;49:1733-8.

28. Diaconu CT, Diaconu AE, Tuculina MJ, Mihai LL, Gheorghiță M, Gheorghiță LM, *et al*. Assessment of the Cyclic Fatigue Performance of the Novel Protaper Ultimate File System Used in Different Kinematics: An *In Vitro* Study. J Funct Biomater 2024;15:85.

29. Riyahi AM, Bashiri A, Alshahrani K, Alshahrani S, Alamri HM, Al-Sudani D. Cyclic Fatigue Comparison of TruNatomy, Twisted File, and ProTaper Next Rotary Systems. Int J Dent 2020;3190938.

30. Gouédard C, Pino L, Arbab-Chirani R, Arbab-Chirani S, Chevalier V. Comparison of the cyclic fatigue resistance of One Curve, F6 Skytaper, Protaper Next, and Hyflex CM endodontic files. Restor Dent Endod 2022;47:e16.

31. Rubio J, Zarzosa JI, Aranda S, Casino A, Pallarés A. A comparative study of cyclic fatigue of 6 endodontic systems. An *in vitro* study. J Clin Exp Dent 2022;14:560-5.

32. Kunert GG, Camargo Fontanella VR, de Moura AA, Barletta FB. Analysis of apical root transportation associated with ProTaper Universal F3 and F4 instruments by using digital subtraction radiography. J Endod 2010;36:1052-5.

33. Yang GB, Zhou XD, Zhang H, Wu HK. Shaping ability of progressive versus constant taper instruments in simulated root canals. Int Endod J 2006;39:791-9.

34. Khalilak Z, Fallahdoost A, Dadresanfar B, Rezvani G. Comparison of extracted teeth and simulated resin blocks on apical canal transportation. Iran Endod J 2008;3:109-12.

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Original Research Article

Comparative Outcomes of Arthrocentesis with and without Stabilization Splints in Patients with Disc Displacement without Reduction

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ABSTRACT

Objective: This retrospective study aimed to compare the long-term effectiveness of arthrocentesis alone versus arthrocentesis combined with stabilization splint (SS) therapy in patients diagnosed with disc displacement without reduction (DDwoR).

Materials and Methods: Medical records of 49 patients (57 TMJs) treated between 2018 and 2022 were retrospectively analyzed. Patients were divided into two groups: those who received arthrocentesis only (AO, n=26) and those who received arthrocentesis combined with a stabilization splint (A+SS, n=23). Pain intensity was evaluated using a visual analogue scale (pVAS), and maximum interincisal opening (MIO) was measured at baseline (T0), 1 month (T1), and 12 months (T2) post-treatment. Intragroup and intergroup comparisons were performed using appropriate statistical tests based on data distribution.

Results: Both groups showed significant improvements in pVAS and MIO over time ($p<0.001$). At T1, the AO group demonstrated greater pain reduction ($p<0.05$), while the A+SS group showed greater MIO improvement ($p<0.05$). However, no significant differences were observed between groups at T2 for either parameter ($p>0.05$).

Conclusion: Arthrocentesis alone and in combination with a stabilization splint provided similar long-term outcomes in patients with DDwoR. Although the combined therapy yielded early functional benefits, these advantages were not sustained at the 1-year follow-up. Arthrocentesis appears to be a practical and effective standalone treatment option for DDwoR.

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Keywords: Arthralgia; Joint disorders; Occlusal splints; Temporomandibular joint

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INTRODUCTION

Temporomandibular disorders (TMD) encompass a group of conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures. These disorders can be classified as arthrogenic, myogenic, or a combination of both. One of the most common forms of TMD is disc displacement without reduction (DDwoR), which is characterized by restricted mouth opening and significant functional impairment. According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), Disc Displacement Without Reduction (DDwoR) occurs when the articular disc shifts forward and does not return to its normal position during mouth opening.[1] This leads to restricted jaw movement, reduced lateral mobility, and often pain, with the jaw deviating toward the affected side. Unlike disc displacement with reduction, there are no clicking or popping sounds. Epidemiological studies indicate that TMD is more prevalent in females, with hormonal, anatomical, and functional factors contributing to this gender disparity.[2]

The treatment of DDwoR typically begins with conservative methods, including medical and physical therapy, exercises, as well as occlusal

appliances. If these approaches do not provide sufficient relief, minimally invasive procedures such as arthrocentesis may be considered.[3] The primary goal of treatment is not to reposition the displaced disc but rather to alleviate pain and restore mandibular function. Traditionally, stabilization splints have been utilized as an initial conservative approach before progressing to minimally invasive treatments like arthrocentesis.[4] However, a recent systematic review by Al-Moraissi *et al*.[5] emphasized that minimally invasive techniques—particularly arthrocentesis—are significantly more effective than conservative treatments for joint-related TMD. The authors suggest that arthrocentesis may be considered a first-line treatment.

Stabilization splint therapy is widely regarded as a fundamental approach in the management of TMDs.[6,7] The primary objective of managing TMDs with splint therapy is to reestablish a physiological relationship between the mandibular condyle and the glenoid fossa, with proper positioning of the articular disc. This alignment may contribute to the reduction of temporomandibular joint pain and joint sounds, while enhancing mandibular function.[8] Arthrocentesis, on the other hand, is an effective procedure that rapidly eliminates inflammatory components within the joint, restores joint lubrication, and enhances mandibular mobility by removing adhesions.[9-11] While splints have been traditionally utilized before arthrocentesis, emerging evidence supports the simultaneous use of both treatments to maximize therapeutic outcomes.[12,13]

A key question in the management of DDwoR is whether arthrocentesis alone is sufficient for pain relief and functional improvement or if it should be combined with stabilization splint therapy for enhanced results. While some studies[9-11] suggest that arthrocentesis alone can provide significant symptom relief, others[12,13] indicate that combining it with a stabilization splint may lead to better long-term functional outcomes. The lack of consensus on this issue highlights the need for further investigation.

This retrospective study aims to compare the one-year treatment outcomes of patients with DDwoR who underwent arthrocentesis alone versus those who received arthrocentesis combined with stabilization splint therapy. Given the limited literature on this topic, assessing differences in pain reduction and functional improvement will help fill this gap and contribute to existing knowledge. The present study hypothesized that the combination of arthrocentesis and stabilization splint therapy will yield better treatment outcomes compared to arthrocentesis alone.

MATERIALS AND METHODS

A retrospective cohort study was conducted to achieve the objectives of this study. The research adhered to the principles outlined in the Declaration of Helsinki and received approval from the Hamidiye Scientific Research Ethics Committee (registration no. 25/286 and decision no. 7/25, respectively). The study population consisted of patients diagnosed with DDwoR and limited mouth opening, as defined by the DC/TMD criteria. These patients underwent arthrocentesis and received treatment at the oral and maxillofacial surgery outpatient clinics of Hamidiye Faculty of Dentistry, University of Health Sciences, between June 2018 and June 2022. All patients gave informed consent before treatment, and all data were obtained from patient medical records.

This retrospective study included patients aged 24 to 58 years who had been diagnosed with DDwoR, as confirmed by magnetic resonance imaging. Eligible cases also fulfilled the diagnostic criteria for arthralgia based on the DC/TMD guidelines and had a pre-treatment pain score of 50 mm or higher on a 100-mm visual analogue scale (pVAS). This pain threshold represented an institutional criterion for determining suitability for arthrocentesis. Pain localization to the lateral pole of the temporomandibular joint was confirmed through clinical palpation. All arthrocentesis procedures were performed by a single oral and maxillofacial surgeon T.T. Although stabilization splint therapy was routinely recommended, it was not implemented in all cases due to patient-specific factors. When used, splints were manufactured and delivered by a prosthodontist C.K.

Patients with a history of prior invasive TMJ treatments (arthrocentesis, arthroscopy, or open joint surgery) were excluded. Likewise, patients with systemic joint diseases or uncontrolled systemic conditions (e.g., rheumatic, autoimmune, hematologic, or oncologic disorders) were excluded. Additionally, pregnant,

or lactating individuals and those with incomplete or insufficient medical records were not included. Patients who had undergone multiple arthrocentesis procedures, received arthrocentesis with adjunctive injections, or had previously used any type of occlusal splint were also excluded from the study.

The primary independent variable in this study was the treatment approach, categorized as either arthrocentesis only (AO) or arthrocentesis combined with a stabilization splint (A+SS). Although stabilization splints are commonly recommended for the management of DDwoR, many patients do not adhere to this conventional treatment. The main reasons for noncompliance include difficulties in scheduling follow-up appointments and reluctance to wear the splint. As a result, the decision to use a stabilization splint was ultimately based on patient preference.

The primary outcome measure in this study was the severity of pain assessed at the 1-year post-treatment follow-up. Participants reported their perceived joint pain associated with mastication and functional activities using a 100-mm pVAS, where 0 mm represented no pain and 100 mm indicated the most severe pain imaginable. Pain levels were documented at three distinct time points: baseline (T0, pre-treatment), the 1-month follow-up (T1), and the 1-year follow-up (T2).

Secondary outcome measures comprised pain intensity at T1 and maximum interincisal opening (MIO) at T1 and T2. MIO was defined as the interincisal distance (mm) between the upper and lower central incisors at maximum voluntary mouth opening, performed without assistance, irrespective of pain presence. This measurement was obtained using a caliper to ensure precision. The study covariates were limited to the patients' age, ASA status (American Society of Anesthesiologists Physical Status Classification), history of mandibular molar extraction, and duration of symptoms (categorized as < 1 year or ≥ 1 year).

All arthrocentesis procedures were performed under local anesthesia using a standardized technique, as detailed below. After antisepsis, auriculotemporal nerve anesthesia was applied using 1 mL of articaine hydrochloride (Ultracaine DS, Sanofi Aventis, Istanbul, Turkey), followed by accessing the upper joint space using the method of Nitzan *et al*.[3] A total of 100 mL of isotonic saline was used for lavage. No additional intra-articular agents were administered following lavage. Postoperative treatment included 500 mg amoxicillin, 125 mg clavulanic acid, and 25 mg dexketoprofen trometamol. A soft diet and passive stretching for a week were recommended for all patients.

Hard acrylic stabilization splints were provided and adjusted by the same experienced prosthodontist, following the guidelines of Okeson.[14] The appliances were designed to ensure even contact in centric occlusion, with canine guidance during lateral movements and anterior guidance during protrusion. The splints were delivered to the patients during the week following the arthrocentesis procedure. Patients were advised to wear the splints during sleep and, when feasible, during daytime hours over a 6-month period to promote neuromuscular adaptation to the therapeutic jaw position.

A linear mixed-effects model with random intercepts per joint for VAS (joint-based analysis) and per patient for MIO (patient-based analysis) was used to evaluate overall time-dependent changes and the group × time interaction. Following this evaluation, classical statistical tests were applied to examine specific time-point differences and between-group comparisons in accordance with the objectives of the study. The distribution of continuous variables was assessed using the Shapiro–Wilk test. Categorical data were analyzed using the Chi-square test or Fisher's exact test, as appropriate. Intragroup comparisons of time-dependent continuous variables were performed using repeated-measures ANOVA or the Friedman test, depending on normality. Post hoc pairwise analyses were conducted using Bonferroni-adjusted paired t-tests or Wilcoxon signed-rank tests (adjusted significance threshold $p<0.0167$). Intergroup comparisons were performed using the independent samples t-test or Mann–Whitney U test according to the data distribution. Results were reported as mean ± standard deviation, alongside minimum and maximum values. All statistical analyses were performed using MedCalc Statistical Software (v.12.7.7; MedCalc Software bvba, Ostend, Belgium, 2013). A p-value < 0.05 was considered statistically significant.

RESULTS

Patient demographics and baseline characteristics are presented in Table 1. A total of 57 TMJs from 49 patients were included in the study, with ages ranging from 24 to 58 years (mean ± SD: 36.7 ± 8.7 years). The AO group consisted of 26 patients (29 joints; 37.9 ± 9.3 years), whereas the A+SS group comprised 23 patients (28 joints; 35.4 ± 7.9 years). Three patients in the AO group and five patients in the A+SS group presented with bilateral joint involvement. The male-to-female distribution was 4/22 in the AO group and 1/22 in the A+SS group. Early follow-up (T1) was conducted at 1 postoperative month (mean ± SD: 1.0 ± 0.0 months), and long-term follow-up (T2) between postoperative months 11 and 14 (mean ± SD: 12.6 ± 1.0 months). No significant differences were found between the groups in baseline demographic variables or follow-up durations (p>0.05; Table 1).

A linear mixed-effects model was used to evaluate overall temporal changes in VAS and MIO. The analysis demonstrated a significant main effect of time for both outcomes (p<0.001). For VAS, no significant time × treatment interaction was observed (p>0.05), indicating that the pattern of pain reduction over time was similar between the AO and A+SS groups. In contrast, MIO showed a significant time × treatment interaction at T1 (p=0.005), suggesting an earlier and more pronounced improvement in mouth opening in the A+SS group. Model-estimated trajectories for VAS and MIO are illustrated in Figures 1 and 2.

When all patients were regrouped according to their covariate characteristics, none of these covariates—including ASA status, prior molar extraction, or duration of symptoms—showed a significant effect on postoperative pVAS or MIO at T2 (p>0.05). Age likewise demonstrated no meaningful correlation with the outcomes (p>0.05) (Table 2).

Table 1. Comparison of covariates and demographics between the treatment groups

		Arthrocentesis		Arthrocentesis + Stabilization Splint		
Variables		**N**	**%**	**N**	**%**	**p**
ASA	1	20	76.9%	19	82.6%	0.73†
	2	6	23.1%	4	17.4%	
Prior molar extraction	No	12	46.1%	12	52.2%	0.67⸸
	Yes	14	53.9%	11	47,8%	
Duration of Symptoms	Less than a year	6	20.7%	6	21.4%	0.94⸸
	1 year or more	23	79.3%	22	78.6%	
Arthrocentesis procedures	Bilateral	3	11.5%	5	21.7%	0.45†
	Unilateral	23	88.5%	18	78.3%	
Sex	Male	4	15.4%	1	4.3%	0.35†
	Female	22	84.6%	22	95.7%	
		Mean±SD (Min-Max)	**Mean±SD (Min-Max)**			
Age		37.9 ± 9.3 (24-58)	35.4±7.9 (25-55)	0.33*		
T1		1±0 (1-1)	1±0 (1-1)	N/A – All values are identical		
T2		12.5±1.1 (11-14)	12.7±0.8(11-14)	0.29**		

⸸: Chi-Square test
†:Fisher's exact test
*: Independent samples t-test
**: Mann-Whitney U test
ASA, American Society of Anesthesiologists physical status classification system
T1, 1 month post-operative; T2, 12 month post-operative

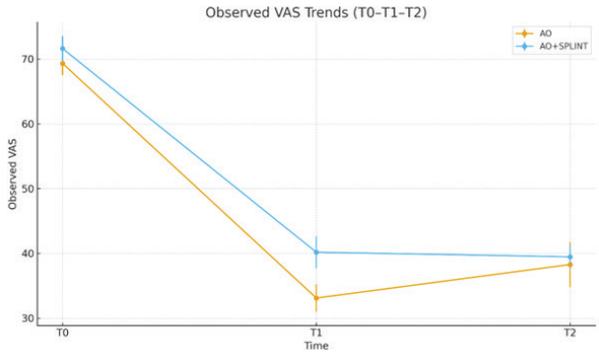

Figure 1. Observed VAS trends across time (T0–T1–T2) in the AO and A+SS groups.

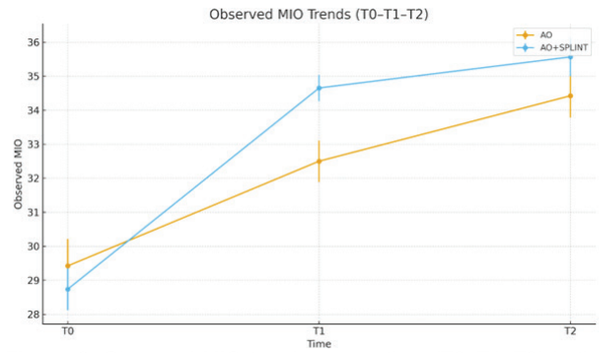

Figure 2. Observed MIO trends across time (T0–T1–T2) in the AO and A+SS groups.

Table 2. Bivariate analyses of the covariates versus pVAS and MIO at T2

		pVAS	p	MIO	p
Variables	**Covariate Group**	**Mean ± Std. Deviation**		**Mean ± Std. Deviation**	
ASA	I	39.36±15.13	0.59*	34.85±2.84	0.59*
	II	36.50±14.54		35.40±3.41	
Prior Molar Extraction	No	39.00±16.27	0.82**	34.92±3.05	0.95*
	Yes	38.75±14.09		34.97±2.87	
Duration of Symptoms	Less than a year	42.50±17.65	0.19**	34.33±2.61	0.42*
	1 year or more	37.89±14.20		35.11±3.01	
Age, year		r = 0.109 (95% CI:-0.15:0.36)	0.42***	r: -0.141 (95% CI:-0.41:0.15)	0.34***

*: Independent samples t-test
**: Mann-Whitney U test
***: Spearman's Rho
ASA: American Society of Anesthesiologists physical status classification system
MIO: Maximum Interincisal Opening
pVAS: Visual Analogue Scale for Pain
T2: 12 month post-operative

Table 3. Comparison between groups in regards of pain and mouth opening

		Arthrocentesis	Arthrocentesis + Stabilization Splint	
Variables		**Mean ± standard dev. Median (Min.-Max.)**	**Mean ± standard dev. Median (Min.-Max.)**	**p**
pVAS (mm)	**T0**	69.3±9.7 70 (50-90)	71.6±10.2 70 (60-90)	0.51*
	T1	33.1±11.5 30 (20-60)	40.2±12.9 40 (20-70)	0.03*
	T2	38.3±18.9 40 (0-70)	39.5±9.7 40 (20-60)	0.67*
	p	<0.001†	<0.001†	
MIO (mm)	**T0**	29.4±4.0 29 (20-35)	28.7±3.0 29 (23-33)	0.51**
	T1	32.5±3.1 32.5(24-37)	34.7±1.8 35 (29-39)	0.02*
	T2	34.4±3.3 34.5(28-41)	35.6±2.7 35 (31-42)	0.22*
	p	<0.001↓	<0.001†	

†: Friedman test
↓: Repeated measures ANOVA
*: Mann-Whitney U test
**Independent samples t-test
T0, Preoperative; T1, 1 month post-operative; T2, 12 month post-operative
p<0.05

Table 4. Post-hoc analysis of changes in pVAS scores between time intervals

	Arthrocentesis	Arthrocentesis + Stabilization Splint
T0-T1	<0.001	<0.001
T0-T2	<0.001	<0.001
T1-T2	0.245	0.742

Wilcoxon test (adjusted using the Bonferroni correction, p<0.05)
T0, Preoperative; T1, 1 month post-operative; T2, 12 month post-operative.

Table 5. Post-hoc analysis of changes in MIO scores between time intervals

	Arthrocentesis	Arthrocentesis + Stabilization Splint
T0-T1	<0.001*	<0.001
T0-T2	<0.001*	<0.001
T1-T2	0.05*	0.07

Wilcoxon test (adjusted using the Bonferroni correction, p<0.05)
*Paired t-test (adjusted using the Bonferroni correction, p<0.05)
T0, Preoperative; T1, 1 month post-operative; T2, 12 month post-operative

Between-group comparisons of pVAS and MIO values are summarized in Table 3. Preoperatively, VAS scores were similar between the AO (69.3 ± 9.7 mm) and A+SS (71.6 ± 10.2 mm) groups (p>0.05). At T1, pVAS scores were significantly lower in the AO group (p<0.05), whereas no significant difference was detected between the groups at T2 (p>0.05). Preoperative MIO values were also comparable between the AO (29.4 ± 4.0 mm) and A+SS (28.7 ± 3.0 mm) groups (p>0.05). At T1, the A+SS group exhibited significantly greater improvement in MIO (p<0.05), while no significant between-group difference was present at T2 (p>0.05).

Time-dependent changes in both VAS and MIO were statistically significant within each group (p<0.001; Table 3). Post-hoc pairwise comparisons showed significant improvements from T0 to both T1 and T2 (p<0.016). No significant difference was observed between T1 and T2 for either parameter (p>0.016), indicating stabilization of outcomes between early and long-term follow-up (Tables 4 and 5).

DISCUSSION

This retrospective study compared one-year outcomes of arthrocentesis alone versus arthrocentesis combined with stabilization splint therapy in patients with DDwoR. It was initially hypothesized that combining splint therapy would yield superior long-term pain relief and functional improvement. However, both treatments provided comparable improvements in pain intensity and mouth opening, leading to rejection of the hypothesis. These results indicate that arthrocentesis alone ensures sustained clinical benefits, suggesting it as an effective long-term option for DDwoR management.

DDwoR is a complex TMD characterized by pain and limited mouth opening, often requiring multimodal treatment. At one month, patients treated with arthrocentesis alone showed faster pain reduction, while those with arthrocentesis and conventional splint therapy had greater MIO improvement. This reflects their differing mechanisms: arthrocentesis reduces inflammation by flushing inflammatory mediators, whereas splints enhance function by optimizing condylar position. The less pronounced short-term pain reduction in the A+SS group may reflect factors extrinsic to the arthrocentesis procedure itself—such as inconsistent adherence to splint use, early splint-adaptation discomfort, or transient occlusal alterations—which could transiently diminish the immediate analgesic benefits expected from lavage. Such early distinctions highlight the potential for individualized treatment strategies, allowing clinicians to prioritize rapid pain relief or functional recovery based on clinical needs.

Hoşgör *et al.*[4] compared four non-surgical treatments-arthrocentesis, splint therapy, medication, and laser therapy—among TMD patients, including DDwoR cases. No significant differences in MIO or pain were found at six months, but arthrocentesis produced the greatest MIO increase, emphasizing its potential superiority for improving mouth opening.

In the present study, both treatment groups underwent arthrocentesis, with one group additionally receiving splint therapy. Given the biomechanical rationale behind splint therapy—reducing joint pressure, stabilizing the condyle, and protecting the articular surfaces—an additive or synergistic effect when combined with arthrocentesis might be expected. However, several studies challenge this assumption. Alpaslan *et al.*[11] reported that in DDwoR patients, arthrocentesis alone effectively improved pain,

and mouth opening, with no additional benefit from the inclusion of hard or soft splints. Similarly, Tatlı *et al*.[9] compared three groups—arthrocentesis alone, splint therapy alone, and a combination of both—and found that while treatments involving arthrocentesis yielded comparable outcomes, the splint-only group was significantly less effective in improving both MIO and pain. This aligns with other studies, reinforcing the idea that splint therapy does not provide additional benefit when combined with arthrocentesis.[15,16] Instead, the evidence suggests that arthrocentesis alone plays a central role in symptom relief.

Nagori *et al*.[17] in 2019 and Dawoud *et al*.[18] in 2024 both conducted systematic reviews and meta-analyses examining the effectiveness of splint therapy in the management of TMDs, but their research questions and conclusions diverge significantly. Nagori *et al*.[17] specifically investigated whether adding splint therapy after arthrocentesis improves clinical outcomes in TMD patients. Analyzing six studies, they found no statistically significant difference in pain reduction or maximum mouth opening between patients treated with arthrocentesis alone versus those who also received splint therapy. They suggested that splints may not provide additional benefit but emphasized that more high-quality randomized controlled trials are needed to confirm this. In contrast, Dawoud *et al*.[18] compared arthrocentesis alone to occlusal splints as standalone treatments for disc displacement without reduction. Their meta-analysis of six studies with 343 participants found that arthrocentesis resulted in a significant improvement in maximum mouth opening but only a non-significant trend toward pain reduction compared to splint therapy. However, due to substantial heterogeneity between studies, a high risk of bias, and a lack of double-blind randomized controlled trials, they concluded that definitive clinical recommendations cannot yet be made. While Nagori *et al*.[17] questioned the necessity of splints after arthrocentesis, Dawoud *et al*.[18] demonstrated that arthrocentesis may be superior to splints in improving maximum mouth opening but with limited evidence supporting its superiority for pain relief. Both studies highlight the ongoing uncertainty in TMD management and reinforce the need for more rigorous clinical trials to establish clearer treatment guidelines.

The absence of additional benefit from splint therapy is somewhat unexpected, as splints are traditionally considered a key component of TMJ stabilization and symptom relief. These findings suggest that while splint therapy may have a role in TMD management, its utility in the context of arthrocentesis remains uncertain. One possible explanation is that the lavage and mechanical effects of arthrocentesis already provide sufficient symptom relief, leaving little room for splint therapy to contribute further. Alternatively, splint therapy may be more beneficial in specific subgroups of TMD patients rather than serving as a universal adjunct to arthrocentesis. For instance, Correa-Silva *et al*.[19] demonstrated that while pain relief was similar between arthrocentesis-only and splint-only groups, mouth opening was greater in the splint-only group, particularly among patients with DDwoR, reducible disc displacement, and intermittent locking. Ghanem *et al*.[20], however, presented contradictory findings in bruxism patients with acute intermittent closed lock: arthrocentesis alone led to symptom relapse (30% success), whereas combining it with splints maintained improvements (90% success). This discrepancy may result from differing patient profiles, as bruxism increases joint loading, potentially enhancing splint effectiveness. Bruxism was not evaluated in the present study due to diagnostic limitations. Manfredini *et al*.[21] note that self-reports, tooth wear, and palpation are insufficient for diagnosis, advocating a multidimensional approach including electromyography or polysomnography. Machon *et al*.[22] assessed four treatments for unilateral TMJ osteoarthritis and found improvement rates of 80% (arthrocentesis + splint), 70% (arthrocentesis), 60% (splint), and 30% (rest therapy). Although combined therapy seemed most effective, statistical comparisons were absent, limiting interpretation.

Although Altaweel *et al*.[13] did not include a standalone arthrocentesis group, they compared four treatment groups: stabilization splint, distraction splint, and their respective combinations with arthrocentesis. While they reported better short-term outcomes for the combined treatments, no significant differences were observed among the groups at the six-month follow-up. In the long term, this study challenges the notion that arthrocentesis is superior to splint-based treatments, suggesting that splint therapy alone

may be sufficient without the need for additional arthrocentesis. Conversely, in the present study, no standalone splint group was included, limiting the comparison to arthrocentesis alone versus arthrocentesis combined with splint therapy, in which similar long-term treatment outcomes were observed. When considering both studies together, it remains unclear whether arthrocentesis alone or splint therapy alone is sufficient. However, as Tatlı *et al*.[9] demonstrated, arthrocentesis-based treatments provided significantly better pain relief and functional improvement compared to splint therapy alone. These results suggest that, although both treatments are individually effective, arthrocentesis may represent a more practical therapeutic option owing to its simplicity, minimal requirement for patient compliance, and shorter treatment duration. This notion is further supported by Wang *et al*.[23] who concluded that the conventional splint therapy following arthrocentesis did not lead to significant improvements in pain reduction or mouth opening capacity, reinforcing the efficacy of arthrocentesis as a standalone intervention. Nonetheless, before definitive conclusions can be drawn, randomized controlled trials directly comparing all treatment modalities within the same study are needed.

A key strength of this study is its exclusive focus on a single TMD, which allows for a homogeneous study population and more precise interpretation of outcomes. The application of standardized treatment protocols and consistent follow-up intervals enhances the internal validity of the findings. Furthermore, this study contributes to a still limited body of literature directly comparing arthrocentesis alone versus its combination with splint therapy. However, the retrospective design introduces inherent limitations such as selection bias and recall bias. Patient adherence to splint use was self-reported and may have been overestimated, as individuals tend to underreport noncompliance. The absence of a splint-only group and the relatively small, predominantly female sample may also limit the generalizability of the results. Although Nitzan's technique recommends Ringer's lactate, saline solution was selected for its greater clinical availability, lower cost, and comparable biocompatibility in the present study (Saline: 286 mOsm/L; Ringer's lactate: 273 mOsm/L).[3,24] Studies show no significant clinical outcome differences between saline and Ringer's lactate, with equivalent improvements regardless of solution, thus, saline is a safe, effective, and economical alternative.[25]

CONCLUSION

This study demonstrated that both arthrocentesis alone and arthrocentesis combined with stabilization splint therapy yielded comparable long-term improvements in pain reduction and functional outcomes in patients with DDwoR. The addition of a stabilization splint did not confer any significant advantage over arthrocentesis alone in long-term symptom relief. These findings support the growing body of evidence that arthrocentesis can be an effective standalone intervention, particularly for patients seeking a minimally invasive, time-efficient treatment. Future randomized controlled trials with larger sample sizes and inclusion of splint-only and combination arms are warranted to establish definitive clinical guidelines.

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AUTHORSHIP CONTRIBUTIONS

T.T. and C.K. : Both authors contributed significantly to the surgical and medical practices, concept, design, data collection and processing, analysis and interpretation, literature search, and writing in this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest relevant to the content of this article.

Ethics statement: This study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Hamidiye Scientific Research Ethics Committee of the University of Health Sciences (Approval No: 25/286; Decision No: 7/25, Meeting Date; 27.03.2025). Informed consent for treatment and use of anonymized medical data for research purposes was obtained from all patients prior to procedures.

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Redüksiyonsuz Disk Deplasmanı Olan Hastalarda Stabilizasyon Splinti ile ve Splintsiz Artrosentez Uygulamalarının Karşılaştırmalı Sonuçları

ÖZET

Amaç: Bu retrospektif çalışmanın amacı, redüksiyonsuz disk deplasmanı (RDD) tanısı alan hastalarda artrosentezin tek başına uygulanması ve artrosentez ile birlikte stabilizasyon splint (SS) tedavisi kombinasyonunun uzun dönem etkinliğini karşılaştırmaktır.

Gereç ve Yöntemler: 2018–2022 yılları arasında tedavi edilen 49 hastaya (57 TMJ) ait tıbbi kayıtlar retrospektif olarak incelendi. Hastalar sadece artrosentez uygulananlar (AO, n=26) ve artrosentezle birlikte stabilizasyon splinti uygulananlar (A+SS, n=23) olmak üzere iki gruba ayrıldı. Ağrı şiddeti görsel analog skala (pVAS) ile, maksimum interinsizal açıklık (MIA) ise tedavi öncesi (T0), 1 ay (T1) ve 12 ay (T2) sonrası ölçüldü. Grup içi ve gruplar arası karşılaştırmalar, veri dağılımına uygun istatistiksel testlerle yapıldı.

Bulgular: Her iki grupta da zaman içinde pVAS ve MIA değerlerinde anlamlı iyileşmeler gözlendi ($p<0.001$). T1'de, AO grubunda ağrı düzeyinde daha fazla azalma görülürken ($p<0.05$), A+SS grubunda MIA artışı daha belirgindi ($p<0.05$). Ancak T2 zaman noktasında, her iki parametre açısından gruplar arasında anlamlı fark bulunmadı ($p>0.05$).

Sonuç: Artrosentezin tek başına uygulanması ve artrosentezin stabilizasyon splinti ile birlikte uygulanması, RDD hastalarında benzer uzun dönem sonuçlar sağlamaktadır. Kombine tedavi kısa vadede fonksiyonel faydalar sunsa da, bu avantajlar 1 yıllık takipte kalıcı olmamıştır. Sadece artrosentez, RDD tedavisinde pratik ve etkili bir tedavi seçeneği olarak değerlendirilebilir.

Anahtar Kelimeler: Artralji; Eklem hastalıkları; Oklüzal splintler; Temporomandibuler eklem

REFERENCES

1. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, *et al*. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group†. J Oral Facial Pain Headache 2014;28:6–27.

2. Lazarin R deO., Previdelli ITS, Silva R dosS., Iwaki LCV, Grossmann E, Filho LI. Correlation of gender and age with magnetic resonance imaging findings in patients with arthrogenic temporomandibular disorders: a cross-sectional study. Int J Oral Maxillofac Surg 2016;45:1222–8.

3. Nitzan DW, Franklin Dolwick M, Martinez GA. Temporomandibular joint arthrocentesis: A simplified treatment for severe, limited mouth opening. J Oral Maxillofac Surg 1991;49:1163–7.

4. Hosgor H, Bas B, Celenk C. A comparison of the outcomes of four minimally invasive treatment methods for anterior disc displacement of the temporomandibular joint. Int J Oral Maxillofac Surg 2017;46:1403–10.

5. Al-Moraissi EA, Wolford LM, Ellis E, Neff A. The hierarchy of different treatments for arthrogenous temporomandibular disorders: A network meta-analysis of randomized clinical trials. J Craniomaxillofac Surg 2020;48:9–23.

6. Kuzmanovic Pficer J, Dodic S, Lazic V, Trajkovic G, Milic N, Milicic B. Occlusal stabilization splint for patients with temporomandibular disorders: Meta-analysis of short and long term effects. PLoS One 2017;12:1-21.

7. Zhang C, Wu JY, Deng DL, He BY, Tao Y, Niu YM, *et al*. Efficacy of splint therapy for the management of temporomandibular disorders: a meta-analysis. Oncotarget 2016;51:84043–53.

8. Huang I, Wu J, Kao Y, Chen C, Chen C, Yang Y. Splint therapy for disc displacement with reduction of the temporomandibular joint. Part I: Modified mandibular splint therapy. Kaohsiung J Med Sci 2011;8:323–9.

9. Tatli U, Benlidayi ME, Ekren O, Salimov F. Comparison of the effectiveness of three different treatment methods for temporomandibular joint disc displacement without reduction. Int J Oral Maxillofac Surg 2017;5:603–9.

10. Vos LM, Huddleston Slater JJR, Stegenga B. Arthrocentesis as initial treatment for temporomandibular joint arthropathy: A randomized controlled trial. J Craniomaxillofac Surg 2014;5:134–9.

11. Alpaslan C, Kahraman S, Güner B, Cula S. Does the use of soft or hard splints affect the short-term outcome of temporomandibular joint arthrocentesis? Int J Oral Maxillofac Surg 2008;5:424–7.

12. Lee HS, Baek HS, Song DS, Kim HC, Kim HG, Kim BJ, *et al*. Effect of simultaneous therapy of arthrocentesis and occlusal splints on temporomandibular disorders: anterior disc displacement without reduction. J Korean Assoc Oral Maxillofac Surg 2013;1:14

13. Altaweel AA, Ismail HA, Fayad MI. Effect of simultaneous application of arthrocentesis and occlusal splint versus splint in management of non-reducing TMJ disc displacement. J Dent Sci 2021;2:732–7.

14. Okeson JP. Joint Intracapsular Disorders: Diagnostic and Nonsurgical Management Considerations. Dent Clin North Am 2007;1:85–103.

15. Demir MG. The Effect of Arthrocentesis Treatment for Maximum Mouth Opening and Pain in Temporomandibular Joint Diseases and the Effect of Splint, Drug, and Physical Therapy on This Treatment. Medicina (B Aires) 2023;10:1-10.

16. Osman MM, Hassan K. A comparison of combined therapy of arthrocentesis and bite splint versus arthrocentesis alone in case of nonreducing temporomandibular disc displacement. Egypt J Oral Maxillofac Surg 2016;3:81–5.

17. Nagori SA, Jose A, Roy Chowdhury SK, Roychoudhury A. Is splint therapy required after arthrocentesis to improve outcome in the management of temporomandibular joint disorders? A systematic review and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol 2019;2:97–105.

18. Dawoud BE, Tabbenor O, Crawford C, Bayoumi S. Arthrocentesis versus occlusal coverage splints in the management of disc displacement without reduction: a systematic review and meta-analysis. Int J Oral Maxillofac Surg 2024;9:779–86.

19. Corrêa-Silva M, de Carvalho TMI, Zambon CE, Peres MPS de M, Machado GG. Is there a superiority between arthrocentesis and stabilizing occlusal splint for the treatment of anterior disc displacement with reduction and intermittent block and anterior disc displacement without reduction in TMJ? Randomized clinical trial. Oral Surg Oral Med Oral Pathol Oral Radiol 2024;2:244–54.

20. Ghanem WA. Arthrocentesis and stabilizing splint are the treatment of choice for acute intermittent closed lock in patients with bruxism. J Craniomaxillofac Surg 2011;4:256–60.

21. Manfredini D, Ahlberg J, Aarab G, Bender S, Bracci A, Cistulli PA, *et al*. Standardised Tool for the Assessment of Bruxism. J Oral Rehabil 2024;1:29–58.

22. Machon V, Hirjak D, Lukas J. Therapy of the osteoarthritis of the temporomandibular joint. J Craniomaxillofac Surg 2011;2:127–30.

23. Wang S, Wang Z, Zhou G. Efficacy of added splint therapy after arthrocentesis vs arthrocentesis alone in the management of temporomandibular joint disorders: a systematic review and meta-analysis. Quintessence Int 2024;10:824–33.

24. Yadav P, Kumar V, Yadav P. Efficacy of Various Lavaging Agents and Intraarticular Injections in Temporomandibular Joint Arthrocentesis: A Narrative Review. JCDR 2023;17:10-15.

25. Siewert-Gutowska M, Pokrowiecki R, Kamiński A, Zawadzki P, Stopa Z. (2023). State of the Art in Temporomandibular Joint Arthrocentesis—A Systematic Review. J. Clin. Med. 2023;12:1-12.

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Case Report

Rehabilitation of a Missing Lateral Incisor with a Fiber-reinforced Adhesive Bridge: Case Report

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ABSTRACT

Introduction: Hypodontia, particularly the congenital absence of maxillary lateral incisors, often compromises dental esthetics and function, necessitating case-appropriate treatment approaches. Fiber-reinforced adhesive bridges offer a conservative alternative when fixed prostheses or implants are unsuitable, especially in growing adolescents.

Case Report: This case report describes the interdisciplinary management of a 16-year-old female patient presenting with a congenitally missing maxillary right lateral incisor following orthodontic treatment. A direct fiber-reinforced adhesive bridge using a braided glass fiber system was fabricated after minimal palatal preparation of the abutment teeth, combined with composite restorations to enhance anterior esthetics. The procedure restored the patient's smile, function, and phonation while preserving healthy tooth structure.

Conclusion: Fiber-reinforced adhesive bridges represent a practical, esthetic, and conservative interim solution for anterior tooth replacement in young patients, offering comfort and repairability until definitive treatment becomes feasible.

Keywords: Dental esthetic; Fiberglass; Hypodontia

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INTRODUCTION

Congenital absence of teeth, known as hypodontia, is the most common developmental anomaly in humans. The condition can range from the loss of just one permanent tooth to the complete absence of all permanent dentition, referred to as anodontia.[1] Hypodontia may present as an isolated finding (non-syndromic) or may be associated with a variety of hereditary syndromes, among which the different types of ectodermal dysplasia are the most frequently encountered.[2]

Approximately 1.7% of the population is affected by maxillary lateral incisor hypodontia, and is more common in females than in males. In patients missing one or more of these teeth, the shape and position of the remaining natural teeth can significantly influence smile aesthetics, often making treatment necessary.[3]

In patients with hypodontia, the primary goal of any treatment is to achieve an outcome that is aesthetically pleasing, functional, healthy, and cost-effective in both the short and long term. When planning treatment with a patient-centered approach, several general factors should be considered, including the patient's age at presentation, dietary habits, oral hygiene status, the condition of the existing teeth,

level of cooperation, and overall treatment cost.[3] Assessing these elements is essential not only for determining whether treatment is necessary but also for identifying the most appropriate timing for intervention.[4]

Advances in adhesive systems have enabled more conservative treatment approaches in dentistry, allowing the preservation of healthy tooth structure whenever possible. Although conventional fixed partial dentures offer a long-lasting solution for single-tooth replacements, they require significant preparation of the adjacent teeth, compromising their structural integrity.[5] Dental implants, considered the ideal option for single-tooth replacement, also have certain drawbacks such as high cost, contraindications in growing children and adolescents, and limited suitability for patients with poor systemic health.[6]

Fiber-reinforced adhesive bridges are used in the restoration of teeth lost due to trauma or unsuccessful endodontic treatment, in cases where the periodontal prognosis of the adjacent teeth is questionable, in patients who cannot tolerate local anesthesia or who cannot undergo long treatment procedures for medical reasons, in situations requiring a fixed space maintainer after orthodontic treatment, and in implant cases where a temporary restoration is needed before loading.[7]

In fiber-reinforced adhesive bridges, the pontic can be shaped and applied using either direct or indirect techniques, utilizing the patient's extracted natural tooth, a prefabricated acrylic tooth, or composite resin. However, they are not recommended in cases with long edentulous spans, deep bite relationships, or when the abutment teeth have large restorations or diastemas.[8]

In this case report, the aim is to present the interim restoration of a congenital missing lateral tooth in an adolescent patient using a fiber-reinforced adhesive bridge, planned to re-establish the patient's aesthetics, function, and phonation until a definitive treatment can be performed.

CASE REPORT

A 16-year-old female patient with a congenitally missing maxillary right lateral incisor and a microdontic maxillary left lateral incisor was referred to our clinic following orthodontic treatment. During the anamnesis, the patient reported dissatisfaction with the esthetics of her smile. Intraoral and radiographic examinations revealed an old, discolored composite restoration and root canal treatment on tooth 21, no restorations on the other anterior teeth. Healthy periodontal tissues were examined showing no evidence of occlusal attrition or parafunctional activity (Fig. 1a, 1b, 1c). Considering the patient's age, a fixed prosthetic treatment was not suitable; therefore, a fiber-reinforced adhesive bridge was planned for the missing lateral incisor, a direct composite restoration for the maxillary left anterior region, a composite laminate veneer for tooth 21, and diastema closure for tooth 22. After the treatment plan and alternative options were explained, informed consent for the fiber-reinforced adhesive bridge procedure was obtained from the patient's legal guardian.

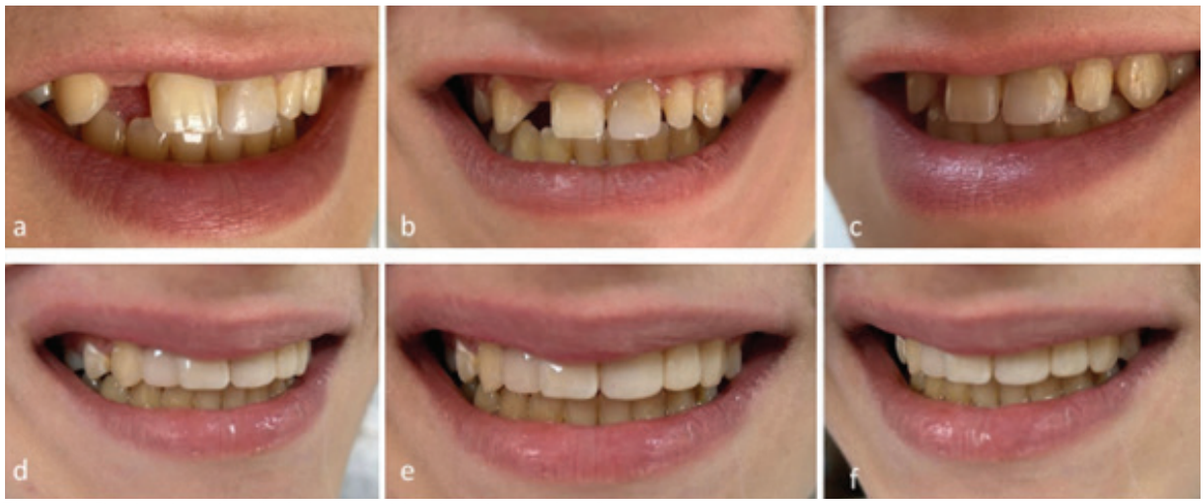

Figure 1. Pre-treatment smile (a,b,c), post-treatment smile (d,e,f).

After treatment planning, the patient's occlusion was checked and shade selection was performed. Following split-dam isolation, tooth 11 was isolated with PTFE tape, and 0.5 mm of enamel was removed from the buccal surface of tooth 21 under water cooling. The enamel surfaces of the left maxillary anterior teeth were etched with 37% phosphoric acid for 30 seconds, rinsed for 30 seconds, and gently air-dried. A universal adhesive system (G-Premio Bond, GC, Tokyo, Japan) was applied to the etched enamel surfaces and light-cured for 10 seconds using an LED curing unit (D-Light Pro, GC).

Using a polyester strip and a wedge, direct composite restorations were applied on teeth 21 and 22 with universal composite system (Estelite Asteria, Tokuyama, Tokyo, Japan) body A1B and enamel NE shades (Fig.1f).

For the restoration of the missing right lateral incisor, after split-dam isolation (Fig. 2a, 2b), minimal palatal preparations (1 mm depth) were performed on teeth 11 and 13 using a round bur under water cooling. The prepared cavities were etched with 37% phosphoric acid for 30 seconds, rinsed for 30 seconds, and air-dried. G-Premio Bond was applied and light-cured for 20 seconds. A piece of braided glass fiber (Interlig, Angelus, Londrina, PR, Brazil) of appropriate length was cut, adapted into the prepared palatal cavities on both teeth, and light-cured for 40 seconds (Fig. 2c). The exposed fiber mesh was covered with an injectable composite (G-ænial Universal Injectable, GC) to seal it from the oral environment. After isolating the gingival region of tooth 12 with PTFE tape, a sectional metal matrix band was placed vertically, and a palatal shell was created using G-ænial Injectable composite (Fig. 2d). Subsequently, the lateral incisor form was built incrementally with Asteria A1B and NE composites, using modeling liquid (Modeling Liquid, GC) and a modeling brush (Modeling Brush Flat, GC) (Fig. 2e).

After completing all restorations, occlusion was checked, ensuring that the pontic had no contact with the mandibular teeth. Finishing and polishing were performed using yellow-band flame-shaped and round-ended composite finishing burs and diamond-impregnated silicone discs (Twist Dia Spiral Wheels, Kuraray, Okayama, Japan).

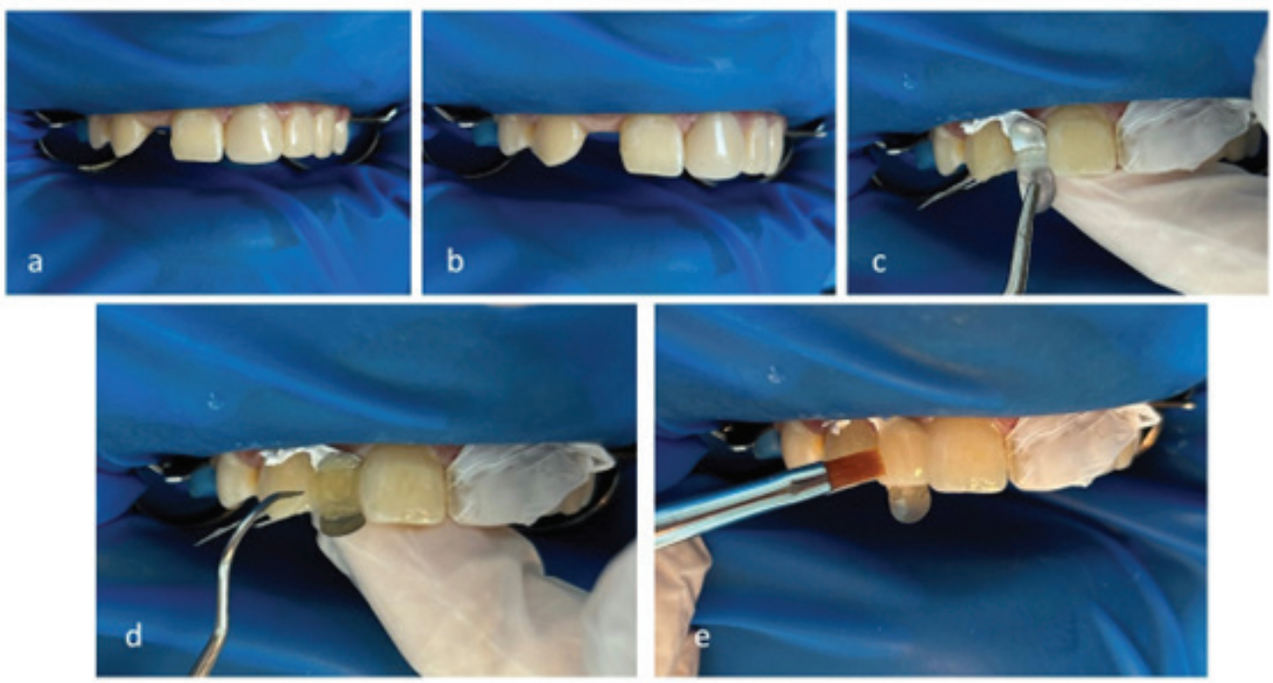

Figure 2. Split-dam isolation (a,b), application of braided fiber to the adjacent teeth (c), obtaining a lateral incisor–shaped pontic by incrementally applying composite resin (d,e).

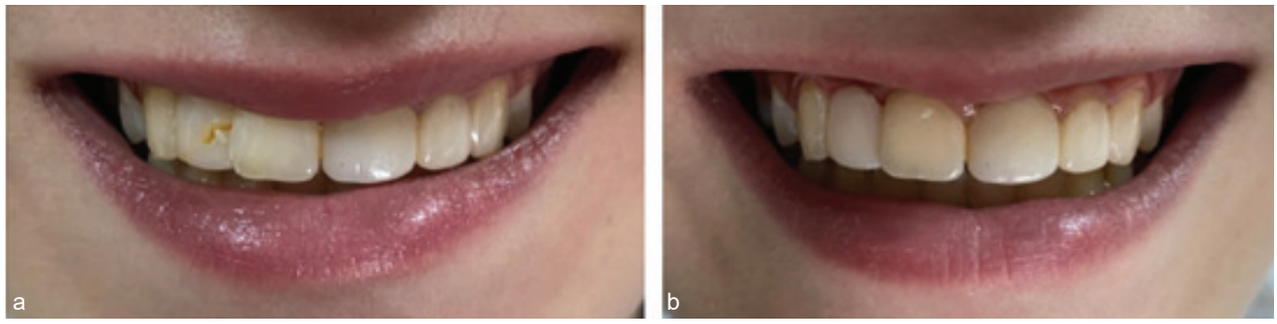

Figure 3. 2-year follow-up (a), after re-polishing procedures (b)

During the 6-month and 1-year follow-up appointments, no failures were observed except for slight discoloration on the composite surfaces; however, at the 2-year follow-up, chipping and discoloration were observed on the composite pontic surface (Fig. 3a), and a fracture was noted at the distal connector of the fiber-reinforced adhesive bridge.

Since the patient had not yet completed the growth period and the fiber-reinforced adhesive bridge needed to be maintained until implant treatment could be performed, the fiber-reinforced adhesive bridge was repaired, and the discolorations were removed by polishing (Fig. 3b).

DISCUSSION

Various treatment options are available for the replacement of anterior tooth loss, including implants, conventional fixed bridges, retainers, and adhesive bridges as an alternative approach.

Fiber-reinforced adhesive bridges are more esthetic than metal-supported adhesive bridges and require only minimal preparation on the abutment teeth. Since they are metal-free, they are safe for patients with metal allergies and pose no risk of corrosion. Compared with other adhesive bridge systems, they also cause less wear on the opposing arch. When applied using the direct technique, the treatment can be completed in a single appointment, and the restoration can be easily repaired if necessary.[9]

Despite these advantages, their resistance to occlusal forces is lower than that of other types of adhesive bridges. Their color stability is not ideal, and they require a technique-sensitive application. They are contraindicated in patients for whom adequate moisture control cannot be achieved, in cases involving multiple missing teeth, and in individuals with parafunctional habits.[10]

Various types of fibers are used in minimally invasive dental treatments, and among them, polyethylene and glass fibers are the most commonly preferred due to their superior mechanical and aesthetic properties. Studies have shown that, because of their translucency, esthetic appearance, and ability to bond to dentin, glass fibers are the most suitable option for dental applications compared with other fiber types.[11] The reinforcing effect of fibers varies depending on their orientation (unidirectional, braided, or woven), the amount of fiber (by volume), and whether they are pre-impregnated with resin.[12]

Interlig Angelus is a braided glass fiber impregnated with light-cured composite resin material with a high flexural strength and favorable elastic behavior, contributing to enhanced mechanical performance of composite restorations. It is a metal-free material with translucent, transparent, inert, and biocompatible characteristics. When used in combination with composite resins, it can yield highly satisfactory esthetic results. This material can be used for periodontal splinting, trauma stabilization, orthodontic applications, and fabrication of temporary or permanent bridges.[13]

In a study evaluating the survival rates of anterior fiber-reinforced adhesive bridges, a 7.5-year survival rate of 97.7% was reported for 175 restorations.[14] In another study, fiber-reinforced adhesive bridge restorations were placed in 29 patients, and after a mean follow-up period of 42 months, the overall survival rate was found to be 75%, while the functional survival rate reached 93%.[15]

The most common site of fracture in fiber-reinforced adhesive bridges is the connector area between the pontic and the abutment tooth.[16] In this high-stress region, cavity preparation on the proximal surface is recommended to achieve adequate connector height and thickness.[17] Moreover, it has been shown that restorations with minimal tooth preparation exhibit longer longevity compared with restorations fabricated without any preparation.[18]

Several studies have also reported higher fracture rates—and therefore higher failure rates—in adhesive bridges placed after orthodontic treatment, likely due to the increased tendency for relapse.[19,20]

In the presented case, despite minor complications observed during follow-up, the fiber-reinforced adhesive bridge provided satisfactory esthetics and function throughout the growth period, supporting its role as a reliable interim solution until definitive implant therapy becomes feasible.

CONCLUSION

In summary, the fabrication of fiber-reinforced adhesive bridge offers a valuable alternative for the temporary or definitive replacement of a missing tooth. It is non-irritating, easy to maintain, and typically requires little to no removal of healthy tooth structure. Additionally, the restoration can be repaired, adjusted, or removed without causing harm to the supporting teeth. However, long-term clinical studies are still needed to determine whether this method can reliably serve as a permanent treatment option.

Eksik Lateral Dişin Fiber Destekli Adeziv Köprü ile Rehabilitasyonu: Olgu Sunumu

ÖZET

Giriş: Hipodonti, özellikle maksiller lateral kesici dişlerin konjenital eksikliği, dental estetik ve fonksiyonu olumsuz etkileyerek vakaya uygun tedavi yaklaşımlarını gerekli kılar. Fiber destekli adeziv köprüler, özellikle büyüme gelişimi devam eden genç hastalarda sabit protezlerin veya implantların uygun olmadığı durumlarda konservatif bir alternatif sunar.

Vaka Raporu: Bu olgu sunumunda, ortodontik tedavi sonrası konjenital olarak sağ üst lateral kesici dişi eksik olan 16 yaşındaki bir kadın hastanın multidisipliner yönetimi açıklanmaktadır. Dayanak dişlerde minimal palatinal preparasyon sonrası direkt fiber destekli adeziv köprü hazırlanmış ve estetiği artırmak amacıyla anterior bölgeye kompozit restorasyonlar uygulanmıştır. Bu işlem, sağlam diş dokusu korunarak hastanın gülüş estetiğini, fonksiyon ve fonasyonunu yeniden kazandırmıştır.

Sonuç: Fiber destekli adeziv köprüler, genç hastalarda anterior diş eksikliklerinin geçici tedavisinde estetik, konforlu ve konservatif bir çözüm sunarak kesin tedavi mümkün olana kadar etkili bir seçenek oluşturmaktadır.

Anahtar Kelimeler: Dental estetik; Fiberglas; Hipodonti

REFERENCES

1. Créton M, Cune M, Verhoeven W, Muradin M, Wismeijer D, Meijer G. Implant treatment in patients with severe hypodontia: a retrospective evaluation. J Oral Maxillofac Surg 2010;68:530-8.

2. Bergendal B. Oligodontia ectodermal dysplasia--on signs, symptoms, genetics, and outcomes of dental treatment. Swed Dent J Suppl 2010;205:13-78,7-8.

3. Dolan S, Calvert G, Crane L, Savarrio L, P Ashley M. Restorative dentistry clinical decision-making for hypodontia: peg and missing lateral incisor teeth. Br Dent J 2023;235:471-6.

4. Alkadhimi A, Razaghi N, Elder A, DiBiase AT. Camouflaging the permanent maxillary canine to substitute an absent lateral incisor - part 1: assessment and management. Br Dent J 2022;232:20-6.

5. Hachami I, Amessegher FZ, Ben El Hammi N, Moussaoui H. Cantilever Resin-Bonded Bridge as a Solution for the Replacement of a Single Missing Anterior Tooth: A Case-Based Review. Cureus 2025;17:e93702.

6. Schwartz-Arad D, Bichacho N. Effect of Age on Single Implant Submersion Rate in the Central Maxillary Incisor Region: A Long-Term Retrospective Study. Clin Implant Dent Relat Res 2015;17:509-14.

7. Meiers JC, Freilich MA. Conservative anterior tooth replacement using fiber-reinforced composite. Oper Dent 2000;25:239-43.

8. Perea L, Matinlinna JP, Tolvanen M, Lassila LV, Vallittu PK. Fiber-reinforced composite fixed dental prostheses with various pontics. J Adhes Dent 2014;16:161-8.

9. Botelho M. Resin-bonded prostheses: the current state of development. Quintessence Int 1999;30:525-34.

10. Aydos Ekiz M. Adeziv köprü uygulamaları. Üçtaşlı MB, Editör. Güncel Adeziv Yaklaşımlar ve Klinik Adeziv Uygulamalar. 1. Baskı. Ankara: Türkiye Klinikleri; 2022. s.38-45.

11. Lassila LVJ, Tezvergil A, Lahdenperä M, Alander P, Shinya A, Shinya A et al. Evaluation of some properties of two fiber-reinforced composite materials. Acta Odontol Scand 2005;63:196-204.

12. Kern M. When RBFDPs should bond long term. RBFDPs: Resin-bonded fixed dental prostheses: Minimally invasive – esthetic – reliable. 1st ed. Berlin: Quintessence Publishing; 2017. p.158-82.

13. Gaspar Junior A de A, Lopes MWF, Gaspar G da S, Braz R. Comparative study of flexural strength and elasticity modulus in two types of direct fiber-reinforced systems. Braz Oral Res 2009;23:236-40.

14. Kumbuloglu O, Özcan M. Clinical survival of indirect, anterior 3-unit surface-retained fibre-reinforced composite fixed dental prosthesis: Up to 7.5-years follow-up. J Dent 2015;43:656-63.

15. Vallittu PK. Survival rates of resin-bonded, glass fiber-reinforced composite fixed partial dentures with a mean follow-up of 42 months: a pilot study. J Prosthet Dent 2004;91:241-6.

16. Li W, Swain M V, Li Q, Ironside J, Steven GP. Fibre reinforced composite dental bridge. Part I: Experimental investigation. Biomaterials 2004;25:4987-93.

17. Edelhoff D, Spiekermann H, Yildirim M. Metal-free inlay-retained fixed partial dentures. Quintessence Int 2001;32:269-81.

18. Pjetursson BE, Tan WC, Tan K, Brägger U, Zwahlen M, Lang NP. A systematic review of the survival and complication rates of resin-bonded bridges after an observation period of at least 5 years. Clin Oral Implants Res 2008;19:131-41.

19. Zalkind M, Ever-Hadani P, Hochman N. Resin-bonded fixed partial denture retention: a retrospective 13-year follow-up. J Oral Rehabil 2003;30:971-7.

20. Garnett MJ, Wassell RW, Jepson NJ, Nohl FS. Survival of resin-bonded bridgework provided for post-orthodontic hypodontia patients with missing maxillary lateral incisors. Br Dent J 2006;201:527-34.

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Case Report

Erupted Complex Odontoma in the Mandible: Report of A Rare Case

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ABSTRACT

Introduction: Odontomas are most often located within the bone but can occasionally erupt into the oral cavity due to the eruption forces generated by surrounding reactive tissues. This case report presents the clinical and radiographic findings of a rare case of complex odontoma that erupted in the oral cavity.

Case Report: A 23-year-old female patient presented to our clinic complaining of a tooth-like hard mass in the posterior right mandible. Intraoral examination revealed a hard mass with a rough surface, shiny black and yellow discoloration in the area of tooth 47. Panoramic radiographs revealed that tooth 47 was impacted, and an amorphous, well-defined, dentin-opaque structure was present on the eruption path and at the apex of the alveolar crest. The patient was referred to the Oral and Maxillofacial Surgery Clinic with a preliminary diagnosis of erupted complex odontoma.

Conclusion: Clinical and radiographic examinations are crucial for accurately diagnosing erupted complex odontomas and formulating an appropriate treatment plan.

Keywords: Erupted odontoma; Panoramic radiography; Periapical radiography

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INTRODUCTION

Although odontomas are classified as odontogenic tumors, they are generally considered developmental anomalies, that is, hamartomas. Their slow growth, long-term stability in size, and low tendency to recur support the view that these formations are hamartomatous in nature.[1,2]

Advanced odontomas mainly consist of enamel and dentine, with varying amounts of pulp and cementum. During the early stages of development, odontogenic epithelium and mesenchymal tissues are present at varying rates.[1] Although the etiology of odontomas is not fully understood, the most widely accepted view links them to trauma, infection, growth pressure, and genetic anomalies occurring during the deciduous dentition period.[3]

Odontomas are most commonly detected between the ages of 10 and 20 and show no significant gender predilection. They are rarely associated with deciduous teeth,[4,5,6] and occur more frequently in the maxilla than in the mandible. In the maxilla, odontomas are localised in the anterior region, whereas in the mandible, they are most commonly found in the molar region.[7,8]

These lesions are typically asymptomatic; however, patients often present with delayed eruption of permanent teeth, as odontomas can obstruct their normal eruption.[4,5,6]

According to the 1992 report of the World Health Organization (WHO), odontomas are classified into two subtypes: compound and complex.[9] Compound odontomas occur with the uniform arrangement of multiple small tooth-like structures, whereas complex odontomas are irregular masses that do not anatomically resemble teeth and are composed of enamel and dentine. In addition to these types, a rare variant known as the "dilated odontoma", considered an advanced form of dens invaginatus, is also defined in the literature.[5,10]

Complex odontomas are more frequently observed in the posterior region of the jaw, whereas compound odontomas are predominantly located in the anterior maxilla, typically around the canine teeth.[11] They have radiographically distinct cortical borders and a soft tissue capsule immediately inferior to the cortical border. The lesion content is largely radiopaque, with the degree of opacity varying depending on the amount of hard tissue. Compound odontomas contain irregular tooth-like structures, whereas complex odontomas consist of calcified tissue masses.[5] Radiographically, dilated odontomas appear "doughnut"-shaped, with a radiolucent center surrounded by a radiopaque border.[10]

Clinically, odontomas are observed in three forms: intraosseous, peripheral (extraosseous), and erupted odontomas. The intraosseous form has a higher incidence and is usually diagnosed during routine examinations.[12] Peripheral odontomas are histologically similar to intraosseous odontomas, but they are surrounded by soft tissue and are relatively rare.[13] An erupted odontoma refers to a lesion that develops within the bone and subsequently erupts into the oral cavity. This occurs due to the eruptive force created by reactive tissues surrounding the lesion.[6,9,12] Erupted odontomas are extremely rare. Amado *et al.*[14] reported that erupted odontomas accounted for only 1.6% of cases. While infection is uncommon in odontomas covered by bone, secondary infection may occur in erupted lesions due to exposure to the oral microflora.[6,9,12] Asymptomatic intraosseous lesions are typically managed with follow-up. In contrast, erupted odontomas are treated by simple surgical excision, with recurrence or local invasion being exceptionally rare.[5]

CASE REPORT

A 23-year-old systematically healthy female patient presented to our clinic with a hard, tooth-like mass in the posterior region of the right mandible, which had been present for approximately one year. She stated that the lesion occasionally caused a stabbing sensation while chewing, but did not cause any significant pain.

Intraoral examination revealed the absence of tooth number 47, and the presence of a hard structure on the alveolar crest, with an irregular surface and shiny black and yellow discoloration in the relevant area (Figure 1).

The periapical radiograph of the patient showed that tooth number 47 was impacted in a distoangular position. A well-defined, amorphous, heterogeneous radiopaque mass, approximately 13 x 8 mm in size with dentin-like opacity, was observed along the eruption path of this tooth. The radiograph also demonstrated incomplete root canal treatment and rarefying osteitis in the furcation area and mesial root of tooth number 46 (Figure 2).

The panoramic radiograph revealed that tooth number 47 was impacted in a distoangular position, with an amorphous, well-defined, radiopaque mass exhibiting dentin-like opacity along its eruption path. The radiograph also demonstrated fixed prosthetic restorations on teeth numbers 11, 12, 13, and 14;

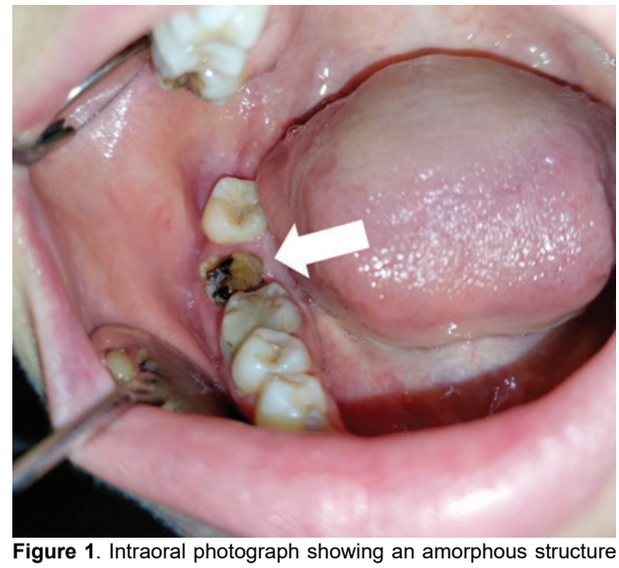

Figure 1. Intraoral photograph showing an amorphous structure with an irregular surface and shiny black and yellow areas on the alveolar crest at the site of tooth number 47 (white arrow).

Figure 2. Periapical radiograph of the right mandibular region showing a complex odontoma along the eruption path of tooth number 47.

incomplete root canal treatment and apical rarefying osteitis on teeth numbers 14, 26, 35, and 46; a filling restoration on teeth numbers 25, 36, 37 and 37; and impaction of tooth number 37 in mesioangular position (Figure 3).

The lesion was evaluated as an erupted complex odontoma because it appeared in the oral cavity as a hard, irregular-surfaced amorphous mass with dentin-like opacity; radiographically presented as a fully calcified structure without enamel–pulp organization; and was located along the eruption path of the impacted tooth number 47.

The patient was referred to the Oral and Maxillofacial Surgery Clinic for excision of the odontoma, diagnosis as a complex odontoma; to the Endodontics Clinic for retreatment of the root canal of tooth number 46; and to the Orthodontics Clinic for management of the eruption of tooth number 47. The patient underwent only surgical treatment and refused all other dental interventions. One year after the excision of the odontoma, a follow-up panoramic radiograph showed slight eruption of tooth number 47, while tooth number 48 remained impacted because it had mesialized into the area (Figure 4). Written informed consent was obtained from the patient for this case report.

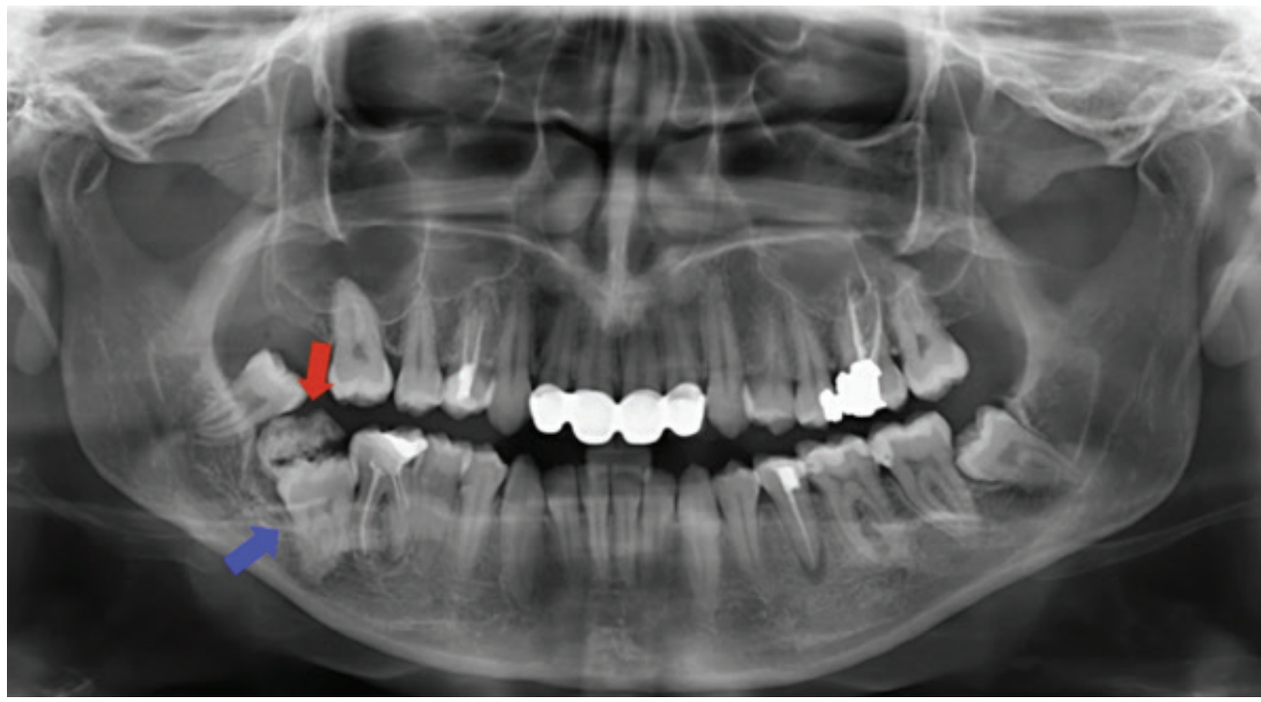

Figure 3. Panoramic radiograph showing tooth number 47 impacted (blue arrow) and a complex odontoma along its eruption path (red arrow).

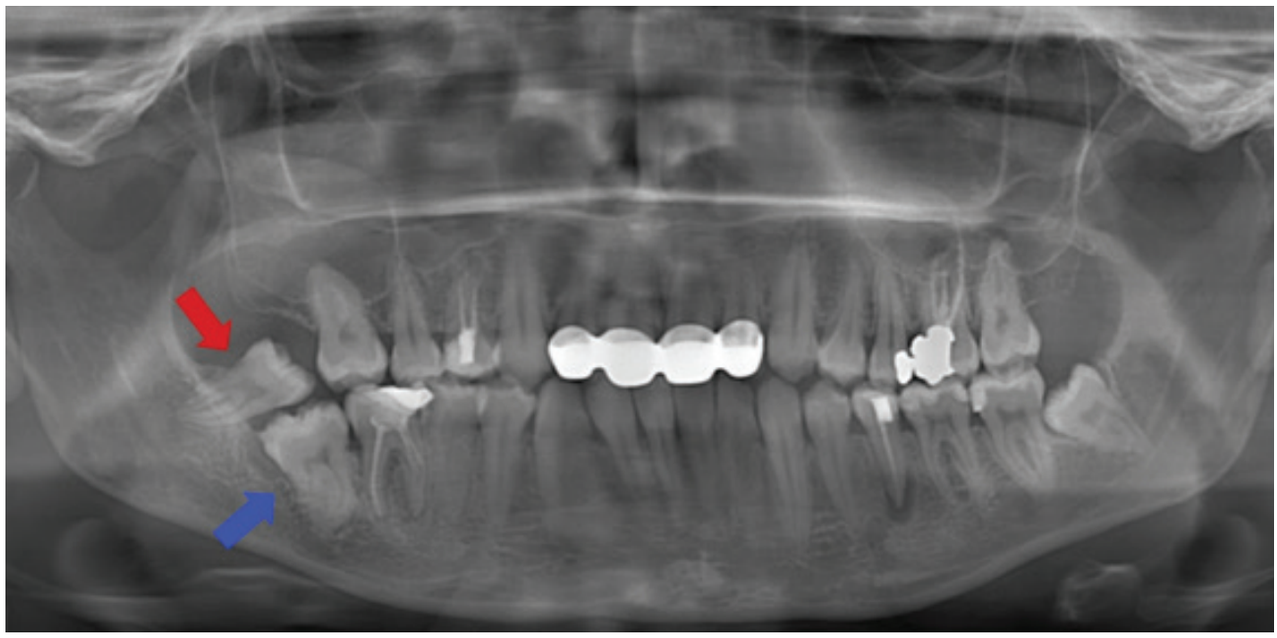

Figure 4. Panoramic radiograph taken one year after excision of an erupted complex odontoma, showing tooth number 48 mesialized into the area (red arrow) and the impacted tooth number 47 (blue arrow).

DISCUSSION

Odontomas are currently regarded as hamartomas and are reported to be the second most frequently encountered odontogenic lesion after ameloblastoma.[15] A great majority of cases are reported to be diagnosed within the first two decades of life. While some studies indicate no gender predilection, others report a higher prevalence in either men or women.[5,16] The case presented in this study involved a 23-year-old female patient, in parallel with the age range reported in the literature.

The WHO has classified odontomas as compound and complex based on their macroscopic and radiographic characteristics. Compound odontomas are distinguished by regular and tooth-like structures and are often accompanied by adjacent fibrous connective tissue matching the tooth follicle. In contrast, complex odontomas consist of irregular, amorphous calcified hard tissue. Compound odontomas are approximately twice as common as complex odontomas. While compound odontomas more commonly occur in the anterior maxilla, complex odontomas are more frequently observed in the molar regions of both jaws.[17] Dilated odontomas can develop in any part of the jaw, affecting both deciduous and permanent teeth, and most commonly affect the lateral incisors of the maxilla, often bilaterally.[5,18]

It is rare for odontomas to erupt into the oral cavity, a phenomenon first described as “erupted odontomas” in 1980.[6] Pamukçu *et al*.[19] identified 74 erupted odontomas in 73 cases in a literature review covering 1989-2020. The study reported that erupted odontomas were predominantly of the complex type with a rate of 65.8%, while compound odontomas accounted for 30.1% and dilated odontomas for 4.1%. Most cases were localized in the maxilla.[19]

In the present case, the complex odontoma, observed as an amorphous calcified hard tissue mass, was located in the posterior region of the mandible, consistent with general localization reported in the literature. However, unlike most erupted odontomas described in the literature, it was situated in the mandible rather than the maxilla.

The eruption of odontomas is considered to be associated with factors such as the eruptive force of impacted teeth, an increase in lesion size, bone resorption, and remodeling of the jaw bones. The absence of periodontal ligament in complex odontomas indicates that eruption does not occur through the pulling force created by the periodontal ligament, as in normal tooth eruption.[20] In cases where odontomas are associated with impacted teeth, the eruption of the teeth may facilitate the eruption of the odontomas. However, erupted odontomas not associated with impacted teeth have

also been reported. In such cases, remodeling and resorption of the overlying bone play an important role in eruption, indicating that the etiology of eruption is likely multifactorial.[17]

The literature reports both asymptomatic odontomas and cases accompanied by a wide range of symptoms such as pain, swelling, suppuration, and lymphadenopathy. The rough surfaces of erupted odontomas promote the adhesion and proliferation of dental plaque, while the absence of periodontal ligament facilitates the invasion of oral microorganisms into the bone. Consequently, erupted odontomas may give rise to more serious complications than non-erupted lesions.[9] The present case exhibited no clinical or radiographic signs of infection, and the only complaint was an occasional stabbing sensation during mastication. In the present case, a complex odontoma in the eruption path prevented the eruption of the tooth number 47. Although tooth number 47 partially erupted following excision, it remained impacted due to the mesialization of tooth number 48, as the patient refused orthodontic treatment.

The differential diagnosis of odontomas includes eruption sequestrum, peripheral osteomas, supernumerary teeth, ameloblastic fibro-odontomas, cementomas, calcified epithelial odontogenic tumors, and osteoblastomas. Eruption sequestrum is a rare condition typically associated with the mandibular first molar and appears as a small, irregular bone protrusion. Peripheral osteomas are radiopaque, well-defined lesions that lack tooth-like structures; they are slow-growing, asymptomatic, and non-odontogenic masses that are not associated with impacted teeth. Supernumerary teeth are most commonly observed in the premaxilla region and are usually conical. Ameloblastic fibro-odontomas are radiographically similar to compound odontomas and are typically present as mixed radiolucent-radiopaque lesions associated with impacted teeth. However, they are more aggressive and occur far less frequently than odontomas.[4,14]

In the present case, the hardness of the lesion, resembling that of a tooth and its odontogenic origin excluded the diagnoses of secestrum and osteoma. Furthermore, its amorphous structure and absence of enamel-pulp tissue ruled out a supernumerary tooth.

CONCLUSION

This study presents the clinical and radiographic findings of a rare complex odontoma in the oral cavity. The lesion was successfully removed via surgical excision; however, the patient's refusal of orthodontic treatment resulted in unfavorable changes in occlusion and tooth alignment. This case highlights the importance of early diagnosis and treatment of odontoma, as well as patient compliance for optimal oral health outcomes.

FINANCIAL SUPPORT

No financial or material support was received from any pharmaceutical company, medical equipment, device, or material provider, or any other commercial firm with a direct connection to the research topic during this study. Furthermore, no financial or moral support was obtained that could negatively influence the decisions made during the study's evaluation process.

CONFLICT OF INTEREST

The authors and/or their family members have no potential conflicts of interest related to this study, such as scientific and medical committee memberships or affiliations, consultancy, expert witness activities, employment at any company, shareholding, or similar circumstances.

Mandibulada Sürmüş Kompleks Odontoma: Nadir Bir Olgu Sunumu

ÖZET

Giriş: Odontomalar çoğunlukla kemik içerisinde yerleşim gösterir ancak nadiren çevresindeki reaktif dokuların oluşturduğu sürme kuvvetleri sayesinde ağız boşluğuna sürebilir. Bu olgu sunumunda ağız boşluğunda sürmüş nadir görülen bir kompleks odontoma vakasının klinik ve radyografik bulguları sunulmuştur.

Olgu Sunumu: 23 yaşında kadın hasta, sağ mandibula posteriorda diş benzeri sert kitle şikayetiyle kliniğimize başvurdu. İntraoral muayenede 47 numaralı diş bölgesinde yüzeyi pürüzlü, parlak siyah ve sarı renk değişiklikleri içeren, sert kitle görüldü. Panoramik radyografta 47 numaralı dişin gömülü olduğu ve sürme yolunda, alveol kret tepesinde, amorf yapıda, iyi sınırlı, dentin opasitesinde yapı bulunduğu görüldü. Hasta, sürmüş kompleks odontoma ön tanısı ile Ağız, Diş ve Çene Cerrahisi Kliniği'ne yönlendirildi.

Sonuç: Klinik ve radyografik incelemeler, sürmüş kompleks odontoma vakalarının doğru şekilde teşhisi ve uygun tedavi planının oluşturulmasında büyük önem taşımaktadır.

Anahtar Kelimeler: Panoramik radyografi; Periapikal radyografi; Sürmüş odontoma

REFERENCES

1. Neville BW, Damm DD, Allen CM, Bouquot JE. Oral and Maxillofacial Pathology. 2nd ed. China: Elsevier; 2008.

2. Günhan Ö. [Odontogenic cyst and tumors]. In: Günhan Ö, editor. Oral ve Maksillofasiyal Patoloji. 1. baskı. Ankara: Atlas Kitapçılık; 2001. p.51–2.

3. Swaidan RF. Management of complex erupting odontoma in the maxilla. Int J Dent Oral Health 2017;3:74–7.

4. Mirzania N, Hosseinzadeh M, Rahimipour E, Mohammadpour M. An uncommon presentation of an erupted compound odontoma in the anterior maxilla: a case report. Radiol Case Rep 2025;20:4001–3.

5. White SC, Pharoah MJ. White and Pharoah's Oral Radiology: Principles and Interpretation. 8th ed. St. Louis: Elsevier; 2018. p. 1000-6

6. Agarwal S, Rao S, Lepcha J, Galhotra V. Large erupted complex odontoma mimicking maxillary osteomyelitis. BMJ Case Rep 2023;16:e253322.

7. Güngör K, Akdevelioğlu M, Sağiroğlu A, Tokman B, Barış B. A retrospective study on odontomas. J Gazi Univ Fac Dent 2003;20:1–3.

8. Hisatomi M, Asaumi JI, Konouchi H, Honda Y, Wakasa T, Kishi K. A case of complex odontoma associated with an impacted lower deciduous second molar and analysis of 107 odontomas. Oral Dis 2002;8:100–5.

9. Ragalli CC, Ferreira JL, Blasco F. Large erupting complex odontoma. Int J Oral Maxillofac Surg 2000;29:373–4.

10. Zara F, D'Angeli G, Corsi A, Polimeni A, Sfasciotti GL. Dilated Odontoma Arising in the Mandibular Third Molar Germ: Report of a Case of an Unusual Lesion in an Uncommon Site. Diagnostics (Basel). 2021 Dec 2;11:2256.

11. Koenig LJ, Tamimi D, Petrikowski CG, Perschbacher SE. Diagnostic Imaging: Oral and Maxillofacial. 2nd ed. Canada: Elsevier; 2017. p.577–82.

12. Junquera L, de Vicente JC, Roig P, Olay S, Rodríguez-Recio O. Intraosseous odontoma erupted into the oral cavity: an unusual pathology. Med Oral Pathol Oral Cir Bucal 2005;10:248–51.

13. Hisatomi M, Asaumi JI, Konouchi H, Honda Y, Wakasa T, Kishi K. A case of complex odontoma associated with an impacted lower deciduous second molar and analysis of the 107 odontomas. Oral Dis 2002;8:100-5.

14. Amado Cuesta S, Gargallo Albiol J, Berini Aytes L, Gay Escoda C. Review of 61 cases of odontoma: presentation of an erupted complex odontoma. Med Oral 2003;8:366–73.

15. Vered M, Wright JM. Update from the 5th Edition of the World Health Organization Classification of Head and Neck Tumors: Odontogenic and Maxillofacial Bone Tumours. Head Neck Pathol 2022 Mar;16:63-75.

16. Hidalgo-Sánchez O, Leco-Berrocal MI, Martínez-González JM. Meta-analysis of the epidemiology and clinical manifestations of odontomas. Med Oral Patol Oral Cir Bucal 2008;13:E730–4.

17. Zhuoying C, Fengguo Y. Huge erupted complex odontoma in maxilla. Oral Maxillofac Surg Cases 2019;5:100096.

18. Bayram H, Aktaş A. Oral kaviteye perforasyon gösteren odontoma. Turkiye Klin J Dent Sci 2014;20:57-61.

19. Pamukçu U, Bağcı N, Peker İ. Erupted odontoma: a report of three cases and a review of the literature. Selcuk Dent J 2021;8:926–35.

20. Vasudevan V, Manjunath V, Bavle RM. Large erupted complex odontoma. J Indian Acad Oral Med Radiol 2009;21:92–7.

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