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Adress: Cappadocia University, Urgup Campus, Faculty of Dentistry
Urgup / Nevsehir
Phone: +90 (384) 353 5009 Fax: +90 (384) 353 5125

Adress: Cappadocia University, Urgup Campus, Faculty of Dentistry
Urgup / Nevsehir
Phone: +90 (384) 353 5009 Fax: +90 (384) 353 5125

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Adress: Cappadocia University, Urgup Campus, Faculty of Dentistry
Urgup / Nevsehir
Phone: +90 (384) 353 5009 Fax: +90 (384) 353 5125

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Acta Stomatologica Cappadocia

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Clinical Research

Age-Adjusted Analysis of Middle Ear Resonance Frequency Characteristics in Individuals with Temporomandibular Disorders

Serdar Gözler[1*], Beyza Ekşi[2]

[1]Istanbul Atlas University, Faculty of Dentistry, Department of Prosthetic Dentistry, Istanbul, Türkiye.
[2]Istanbul Rumeli University, Vocational School of Health Services, Department of Audiology, Istanbul, Türkiye.

*Corresponding author: sgozler291@gmail.com

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Age-Adjusted Analysis of Middle Ear Resonance Frequency Characteristics in Individuals with Temporomandibular Disorders

Serdar Gözler, Beyza Ekşi

Abstract

Objective: This study aimed to evaluate middle ear resonance frequency characteristics in individuals with temporomandibular disorders (TMD) using wideband tympanometry, with particular emphasis on age-adjusted analysis.

Materials and Methods: A total of 40 participants were included, comprising 24 patients diagnosed with unilateral, chronic TMD and 16 healthy controls. All participants underwent comprehensive audiological assessment, including pure-tone audiometry, acoustic immittance, and wideband tympanometry. Middle ear resonance frequency outcomes were first compared using unadjusted analyses. Due to a significant age difference between groups, age-adjusted analyses were subsequently performed using analysis of covariance (ANCOVA).

Results: Unadjusted analyses suggested higher ipsilateral middle ear resonance frequency values in the TMD group compared with controls. However, after adjustment for age using ANCOVA, no statistically significant group differences were observed for the averaged resonance frequency outcomes.

Conclusion: Although unadjusted analyses suggested higher ipsilateral resonance frequency values in individuals with TMD, age-adjusted analyses demonstrated that these differences were not statistically significant, indicating that age may play an important role in the observed findings.

Keywords: Age-adjusted analysis, Analysis of covariance (ANCOVA), Middle ear resonance frequency, Temporomandibular disorders, Wideband tympanometry.

Introduction

Temporomandibular disorders (TMD) comprise a heterogeneous group of conditions affecting the temporomandibular joint, masticatory muscles, and associated structures and represent a common source of orofacial pain and functional limitation. In addition to classical musculoskeletal symptoms, patients with TMD frequently report otological complaints such as ear fullness, tinnitus, subjective hearing changes, and dizziness, even in the absence of identifiable middle or inner ear pathology (1,2).

The anatomical and functional proximity between the temporomandibular joint and the auditory system has long been proposed as a possible explanation for these symptoms. Costen first suggested that dysfunction of the temporomandibular joint could give rise to otological symptoms through mechanical or functional interactions (1). Subsequent studies proposed that altered mandibular biomechanics, abnormal reflex activity of the tensor tympani and stapedius muscles, or shared neural pathways may contribute to auditory manifestations in patients with TMD (3,4).

Wideband tympanometry has emerged as a valuable tool for the objective assessment of middle ear mechanics across a broad frequency range. Unlike conventional tympanometry, it enables evaluation of resonance frequency–related parameters that reflect stiffness and mass characteristics of the middle ear system (5–8).

Previous studies investigating middle ear resonance in individuals with TMD have reported inconsistent findings. Importantly, many studies did not adequately control for age, which is known to influence middle ear mechanics. Therefore, the present study aimed to evaluate middle ear resonance frequency characteristics in individuals with TMD using wideband tympanometry, with particular emphasis on age-adjusted analysis.

Materials and Methods

Study Population

This cross-sectional study was conducted at the Faculty of Dentistry, Istanbul Aydin University. Ethical approval was obtained from the Istanbul Aydın University Local Ethics Committee (2021/578), and all procedures were performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrollment.

A total of 40 individuals were included in the study, comprising 24 patients diagnosed with temporomandibular disorders (TMD) and 16 healthy control subjects. All participants were aged 18 years or older. Patients in the TMD group were referred from the Oral Diagnosis Department and had a documented history of unilateral TMD symptoms lasting longer than one year, and were therefore classified as having chronic TMD.

Inclusion criteria for the TMD group were as follows: (i) diagnosis of unilateral temporomandibular disorder, (ii) symptom duration exceeding 12 months, and (iii) absence of known middle or inner ear pathology based on otorhinolaryngological examination. Exclusion criteria included a history of otologic surgery, acute or chronic otitis media, sensorineural hearing loss, systemic diseases affecting the musculoskeletal system, or use of medications that could influence neuromuscular function.

The control group consisted of 16 individuals without temporomandibular complaints, otological symptoms, or a history of dental or otologic treatment. All control participants underwent routine dental and otorhinolaryngological examinations and were confirmed to have no middle or inner ear pathology.

Temporomandibular Disorder Assessment

Temporomandibular disorder diagnosis was established by an experienced specialist dentist using the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Clinical assessment included a detailed medical and dental history, evaluation of mandibular range of motion, joint sounds, muscle palpation, and pain localization.

The affected (ipsilateral) side was defined based on the side of dominant temporomandibular joint pain as reported by the patient and confirmed by clinical examination. In cases where pain was unilateral, the corresponding ear was considered the ipsilateral ear for subsequent analyses.

To support clinical diagnosis, digital occlusal analysis using the T-Scan system (Tekscan Inc., Boston, MA, USA) and electromyographic (EMG) evaluation of the masticatory muscles were performed. Occlusal force distribution, timing of occlusal contacts, and muscle activity patterns were assessed and used as adjunctive tools in the comprehensive evaluation of temporomandibular function.

Audiological Evaluation

All participants underwent a comprehensive audiological evaluation performed by an experienced audiologist prior to wideband tympanometric measurements. Pure-tone audiometry was conducted in a sound-treated booth using a calibrated clinical audiometer. Air-conduction thresholds were obtained at octave and inter-octave frequencies between 250 Hz and 8000 Hz. Bone-conduction thresholds were measured when indicated to exclude sensorineural or conductive hearing loss.

Only participants with hearing thresholds ≤ 20 dB HL at all tested frequencies were included in the study. Acoustic immittance testing was performed to assess middle ear status, and individuals showing abnormal tympanometric findings suggestive of middle ear pathology were excluded. These procedures ensured that all participants had normal peripheral auditory function and intact middle ear systems at the time of testing.

Wideband Tympanometry Protocol

Wideband tympanometry measurements were performed using a commercially available wideband acoustic immittance system calibrated according to the manufacturer's specifications. Measurements were conducted with the participant seated comfortably in an upright position, and the probe was carefully inserted into the external auditory canal to ensure an airtight seal.

Wideband tympanometry data were obtained across a broad frequency range under ambient pressure conditions. Middle ear resonance-related outcomes were derived from the wideband measurements. For analysis purposes, two averaged outcome measures were calculated: the mean of measurements obtained from frequency bands y13–y16 and the mean of measurements obtained from frequency bands y17–y20. These averaged values were used as representative resonance frequency-related parameters for subsequent statistical analyses.

In the TMD group, measurements from the ipsilateral ear (corresponding to the clinically affected temporomandibular joint side) were used for primary analysis. In the control group, measurements from both ears were included to reflect normative variability, acknowledging the potential limitation related to statistical independence.

All measurements were performed under identical testing conditions, and care was taken to minimize movement artifacts and environmental noise during data acquisition.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics software (Version XX.X; IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables and are presented as mean ± standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables.

Normality of continuous data was assessed using the Shapiro–Wilk test. Between-group comparisons of demographic variables were performed using the independent samples t-test with Welch correction for age and the chi-square test for sex distribution. A p-value of < 0.05 was considered statistically significant.

Initial group comparisons of middle ear resonance frequency–related outcomes were conducted using unadjusted analyses. Given the presence of a statistically significant age difference between the TMD and control groups, analysis of covariance (ANCOVA) was subsequently performed to evaluate group differences while controlling for age as a covariate. In the ANCOVA models, group (TMD vs. control) was entered as a fixed factor and age as a continuous covariate.

Two separate ANCOVA models were constructed for the averaged resonance-related outcome measures: (i) the mean of measurements derived from frequency bands y13–y16 and (ii) the mean of measurements derived from frequency bands y17–y20. Adjusted means, F values, p-values, and partial eta squared (η^2) were calculated to assess the magnitude of group effects after age adjustment.

All statistical analyses were conducted using two-tailed tests, and results were interpreted cautiously, particularly for borderline or non-significant findings.

Results

Demographic and Clinical Characteristics

A total of 40 participants were included in the study, consisting of 24 individuals with temporomandibular disorders (TMD) and 16 healthy controls. The demographic and clinical characteristics of the study population are summarized in Table 1.

Table 1. Demographic and Clinical Characteristics of the Study and Control Groups

Variable	TMD Group (n = 24)	Control Group (n = 16)	p-value
Age (years), mean ± SD	33.3 ± 10.8	26.6 ± 2.2	0.008†
Sex, n (%)			
Female	17 (70.8%)	10 (62.5%)	0.836‡
Male	7 (29.2%)	6 (37.5%)	
TMD symptom duration	≥ 12 months (chronic)	—	—

† Welch independent samples t-test
‡ Chi-square test

The TMD group comprised 17 females (70.8%) and 7 males (29.2%), with a mean age of 33.3 ± 10.8 years. All individuals in the TMD group had a chronic history of temporomandibular disorder symptoms lasting longer than one year. The control group included 10 females (62.5%) and 6 males (37.5%), with a mean age of 26.6 ± 2.2 years. A statistically significant difference in age was observed between the TMD and control groups ($p = 0.008$). In contrast, sex distribution did not differ significantly between groups ($p = 0.836$).

Unadjusted Resonance Frequency Comparisons

Initial unadjusted comparisons of middle ear resonance frequency–related outcomes demonstrated higher ipsilateral values in the TMD group compared with the control group. However, these differences did not consistently reach statistical significance across all outcome measures. Borderline results were interpreted cautiously and were considered suggestive rather than definitive.

Age-Adjusted Analysis of Resonance Frequency Outcomes

Given the significant age difference between the study groups, age-adjusted analyses were performed using analysis of covariance (ANCOVA), with group as a fixed factor and age entered as a covariate.

Averaged Outcome Derived from y13–y16

ANCOVA revealed no statistically significant group effect for the averaged resonance-related outcome derived from frequency bands y13–y16 after adjustment for age ($F = 1.60$, $p = 0.215$). The partial eta squared value indicated a small effect size ($\eta^2 = 0.046$). Adjusted mean values for each group are presented in Table 2.

Table 2. Age-Adjusted Comparison of Resonance Frequency Outcome (Mean of y13–y16)

Statistical analysis: ANCOVA (Group as fixed factor, Age as covariate)

Source	df	F	p-value	Partial η^2
Group (TMD vs Control)	1	**1.60**	**0.215**	**0.046**
Age (covariate)	1	2.96	0.093	0.082
Error	33			

Estimated Marginal Means (Age-adjusted)

Group	Adjusted Mean	Standard Error
Control	15.37	0.54
TMD	14.01	0.58

Model notes:
N = 36 (TMD = 20, Control = 16); age centered at overall mean (31 years)

Averaged Outcome Derived from y17–y20

Similarly, no statistically significant group effect was observed for the averaged resonance-related outcome derived from frequency bands y17–y20 following age adjustment ($F = 2.32$, $p = 0.137$). The corresponding effect size was small to moderate ($\eta^2 = 0.066$). Age-adjusted group means are summarized in Table 3.

Table 3. Age-Adjusted Comparison of Resonance Frequency Outcome (Mean of y17–y20)

Statistical analysis: ANCOVA (Group as fixed factor, Age as covariate)

Source	df	F	p-value	Partial η^2
Group (TMD vs Control)	1	**2.32**	**0.137**	**0.066**
Age (covariate)	1	0.29	0.591	0.009
Error	33			

Estimated Marginal Means (Age-adjusted)

Group	Adjusted Mean	Standard Error
Control	13.44	0.62
TMD	15.23	0.66

Model notes:
N = 36 (TMD = 20, Control = 16); age centered at overall mean (31 years)

Summary of Findings

Overall, while unadjusted analyses suggested higher ipsilateral resonance frequency–related values in individuals with temporomandibular disorders, age-adjusted analyses did not demonstrate statistically significant differences between the TMD and control groups.

Discussion

Interpretation of the Findings

The present study evaluated middle ear resonance frequency characteristics in individuals with temporomandibular disorders using wideband tympanometry, with particular emphasis on controlling for age as a potential confounding factor. The primary finding of this study is that, although unadjusted analyses suggested higher ipsilateral resonance frequency–related values in the TMD group compared with healthy controls, these differences were no longer statistically significant after adjustment for age.

These findings highlight the importance of accounting for age-related effects when interpreting middle ear resonance characteristics. Previous studies investigating the relationship between temporomandibular disorders and middle ear function have reported inconsistent results. Some authors have reported higher ipsilateral resonance frequencies in patients with unilateral TMD, suggesting increased stiffness of the middle ear system, whereas others failed to demonstrate clear differences between affected and unaffected ears or control groups. The present results suggest that at least part of the variability observed in earlier studies may be attributable to differences in age distribution rather than to temporomandibular disorder–related mechanisms alone.

Age-related changes in middle ear mechanics have been well documented, even in individuals with normal hearing. Structural and biomechanical alterations affecting the tympanic membrane, ossicular chain, and supporting ligaments may influence resonance characteristics over time. In the current study, the TMD group was significantly older than the control group, and age-adjusted analyses demonstrated that the observed unadjusted differences were attenuated when age was included as a covariate. This finding underscores the need for cautious interpretation of resonance frequency differences in cross-sectional TMD studies that do not adequately control for age.

Importantly, the absence of statistically significant age-adjusted group differences does not exclude a potential interaction between temporomandibular disorders and middle ear mechanics. Rather, the findings suggest that any such relationship is likely to be subtle, multifactorial, and influenced by individual characteristics such as age, chronicity of symptoms, and neuromuscular adaptation. The small-to-moderate effect sizes observed in the present analyses further support the notion that TMD-related changes in middle ear resonance, if present, are modest and may not be readily detectable without larger and more homogeneous study populations.

Limitations

Several limitations of this study should be acknowledged. First, the sample size was relatively small, which may have limited the statistical power to detect subtle differences in middle ear resonance frequency between groups. Consequently, the present findings should be interpreted as hypothesis-generating rather than definitive.

Second, the study employed a cross-sectional design, which precludes conclusions regarding causality or temporal relationships between temporomandibular disorders and middle ear resonance characteristics. Longitudinal studies assessing changes in resonance frequency before and after TMD treatment would provide more robust evidence regarding potential causal mechanisms.

Third, although age was statistically controlled using ANCOVA, other potential confounding factors such as symptom severity, specific TMD subtypes, and psychosocial variables were not fully quantified. In particular, pain intensity scores were not consistently available due to the retrospective nature of clinical records, and subgroup analyses according to TMD subtype could not be performed.

Finally, in the control group, measurements from both ears were included to reflect normative variability. While this approach increases the representativeness of control data, it may partially violate assumptions of statistical independence. This methodological choice was acknowledged and addressed cautiously in the interpretation of results.

Clinical Implications and Future Directions

From a clinical perspective, the findings of this study suggest that middle ear resonance frequency alterations observed in individuals with temporomandibular disorders should be interpreted with caution, particularly in the absence of age-matched control groups. Wideband tympanometry may provide useful complementary information in the evaluation of patients with TMD and otological complaints; however, resonance frequency measures alone should not be considered diagnostic of TMD-related auditory involvement.

Future studies should aim to include larger, age-matched cohorts and standardized assessments of TMD severity and subtype. Longitudinal designs evaluating resonance frequency changes following conservative or interventional TMD treatment may help clarify whether observed alterations represent reversible functional changes or long-term biomechanical adaptations. Additionally, integration of wideband tympanometry with neuromuscular assessments, such as electromyography and digital occlusal analysis, may provide a more comprehensive understanding of the complex interactions between temporomandibular disorders and middle ear function.

Authors' Contributions

Conceptualization: **S.G.** Study design: **S.G., B.E.** Data collection: **S.G., B.E.** Clinical assessment: **S.G., B.E.** Audiological measurements: **B.E.** Statistical analysis: **S.G.** Interpretation of data: **S.G.** Manuscript drafting: **S.G.** Critical revision of the manuscript: **S.G.**

The author has read and approved the final version of the manuscript.

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Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Research Article

75 Yaş ve Üstü Hastalarda Dental İmplantların Radyografik Olarak Değerlendirilmesi

Tuna Sumer[1*], Ayşe Pınar Sumer[2]

[1]Ondokuz Mayıs Üniversitesi, Diş Hekimliği Fakültesi, Ağız Diş ve Çene Cerrahisi Anabilim Dalı, Samsun, Türkiye.

[2]Ondokuz Mayıs Üniversitesi, Diş Hekimliği Fakültesi, Ağız Diş ve Çene Radyolojisi Anabilim Dalı, Samsun, Türkiye.

Corresponding author: tunasumer@yahoo.com

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75 Yaş ve Üstü Hastalarda Dental İmplantların Radyografik Olarak Değerlendirilmesi

Tuna Sumer, Ayşe Pınar Sumer

Özet

Problemin Açıklaması: Tıp alanındaki gelişmeler ve sağlıklı yaşam biçimlerinin benimsenmesiyle birlikte insan ömrü uzamakta; dolayısıyla yaşlı nüfusun sayısı da artmaktadır. Dental implant uygulamaları, yaş arttıkça dişsizliğin artmasına paralel olarak daha çok yaşlı hasta gruplarında ihtiyaç duyulan bir tedavi seçeneğidir. Bununla beraber yaşlanmayla birlikte görülme sıklığı artan sistemik hastalıklar nedeniyle hem diş hekimleri hem de bu gruptaki hastalar implant uygulamasına mesafeli yaklaşabilmektedir. Bu retrospektif çalışmanın amacı, 75 yaş ve üzerindeki bireylerde uygulanan dental implantları panoramik radyograflar üzerinden değerlendirmektir.

Malzeme ve Yöntemler: Ağız Diş ve Çene Radyolojisi kliniğine başvurmuş yetmiş beş yaş ve üstü hastalara ait sistemde kayıtlı olan toplam 716 panoramik radyograf incelenmiştir. Radyografta dental implantı tespit edilen 207 hastada uygulanan implant sayıları ve lokalizasyonları değerlendirilmiş ve cinsiyete göre dağılımları analiz edilmiştir.

Bulgular: Panoramik radyografı değerlendirilen 207 hastada (113 erkek, 94 kadın) toplam 935 dental implant tespit edilmiştir. Üst çenede 435, alt çenede ise 500 adet implant uygulandığı, bunların 333'ünün ön bölgede konumlandığı görülmüştür. Ayrıca 48 hastada, alt çenede 33-43 numaralı dişler bölgesinde iki implant uygulaması olduğu belirlenmiştir. Cinsiyetler arasında toplam implant sayısı açısından istatistiksel olarak anlamlı fark bulunmamıştır.

Sonuç: Bu çalışma, 75 yaş ve üzeri bireylerde dental implant uygulamalarının tercih edilebildiğini ve yaşlı bireylerin tedavi planlamasında implant uygulamalarının, uygun klinik ve radyografik değerlendirme sonrası önerilebilecek güvenli ve etkili bir seçenek olarak göz önünde bulundurulması gerektiğini göstermektedir.

Anahtar Kelimeler: Dental implant, Panoramik radyograf, Yaşlılık.

Panoramic radiographic assessment of dental implants in patients aged 75 years and older

Tuna Sumer, Ayşe Pınar Sumer

Abstract

Objective: Advancements in medical technology and improvement in healthy lifestyles have led to an increase in human life expectancy; therefore, the number of elderly people is also increas-ing. Dental implant therapy has become an important treatment option in older individuals, parallel to the higher prevalence of edentulism with advancing age. However, due to the increased incidence of systemic diseases associated with aging, both dentists and patients in this age group may approach implant therapy with caution. The aim of this retrospective study was to evaluate dental implants in individuals aged 75 years and older using panoramic radiographs.

Materials and Methods: A total of 716 panoramic radiographs of patients aged 75 years and older, who presented to the Department of Dentomaxillofacial Radiology and were recorded in the system database, were assessed. In 207 patients with dental implants on the radiographs, the number and localization of the implants were evaluated and their distribution by gender was analyzed.

Results: A total of 935 dental implants were identified in the panoramic radiographs of 207 patients (113 male, 94 female). Of these, 435 implants were placed in the maxilla and 500 in the mandible, with 333 implants located in the anterior region. Additionally, 48 patients had two implants placed in the mandibular canine region on teeth 33–43. No statistically significant difference was found between genders in terms of total implant count.

Conclusion: This study demonstrates that dental implant placement can be preferred as a treatment option in individuals aged 75 years and older. Implant therapy could be considered a safe and effective treatment alternative for elderly patients when supported by appropriate clinical and radiographic evaluation during treatment planning.

Keywords: Dental implants, Elderly, Panoramic radiograph.

Giriş

Teknolojinin ilerlemesi, tıbbın ve sağlık hizmetlerinin daha ulaşılabilir hale gelmesi ve sağlıklı yaşam biçimlerinin benimsenmesi, insan ömrünün uzamasına ve dolayısıyla yaşlı nüfusun sayısının artmasına yol açmaktadır (1). Dünya Sağlık Örgütü (DSÖ), yaşlı bireyleri tanımlamak için 65 yaş ve üzerindeki yaş grubunu esas almakta; yaşlılık dönemi ise 65–74 yaş arası "genç yaşlı", 75–85 yaş arası "orta yaşlı" ve 85 yaş ve üzeri "ileri yaşlı" olarak sınıflandırılmaktadır (1,2). Bu sınıflandırma, yaşlanma sürecinde ortaya çıkan fizyolojik ve sistemik değişikliklerin yanı sıra, sağlık hizmetlerine duyulan gereksinimin belirlenmesinde de önemli bir referans oluşturmaktadır (1).

Sağlıklı bir yaşlanma süreci için genel fiziksel ve bilişsel yetilerin korunmasının yanı sıra, sağlıklı ve fonksiyonel dentisyonun sürdürülmesi de kritik öneme sahiptir (3). Diş kaybı, çiğneme fonksiyonunun azalması ve buna bağlı psikososyal sorunlar, ileri yaş gruplarında sık karşılaşılan başlıca problemler arasındadır. Artan yaşlı nüfusun ağız ve diş sağlığına yönelik özel gereksinimlerinin karşılanabilmesi için diş hekimliği pratiğinde ve eğitiminde bu alana özgü yaklaşımların geliştirilmesi ve uygulanması giderek daha büyük önem kazanmaktadır (4). Diş kaybı, yaşla birlikte artan ve yaşam kalitesini doğrudan etkileyen en yaygın ağız sağlığı sorunlarından biridir (5). Yaşlı hastalarda diş kaybının rehabilitasyonu için dental implant uygulamaları, öngörülebilir ve güvenli bir tedavi yöntemi olarak karşımıza çıkmaktadır (6,7)

Yaşlılık tek başına implant tedavisi için bir risk faktörü olmasa da, yaşlanmayla birlikte görülme sıklığı artan sistemik hastalıklar, implant bölgesindeki kemik miktarı ve kalitesi, tedavi başarısını etkileyen temel unsurlardır (6,8) Bu nedenle yaşlı hastalarda implant planlamasında kronolojik yaştan çok, sistemik sağlık durumu ile kemik hacmi ve kalitesi belirleyici rol oynamaktadır (6).

Bu retrospektif çalışma, panoramik radyograflar üzerinden 75 yaş ve üzerindeki bireylere uygulanan dental implantların sayısı, çene lokalizasyonu ve cinsiyete göre demografik dağılımını değerlendirmeyi amaçlamaktadır.

Materyal ve metot

Bu çalışma, 1 Ocak 2024 ile 31 Ağustos 2025 tarihleri arasında Ağız Diş ve Çene Radyolojisi kliniğine başvuran ve bu tarih aralığında panoramik radyografları çekilen 75 yaş ve üzerindeki hastaları kapsamaktadır. Belirtilen dönemde başvuran toplam 716 hastanın pano-

ramik radyografları incelenmiştir. Panoramik radyografiarda dental implant bulunan hastaların yaş ve cinsiyet bilgileri kaydedilmiş, panoramik görüntüler üzerinden yerleştirilen dental implantların toplam sayısı ile alt ve üst çene lokalizasyonları değerlendirilmiştir.

İstatistiksel analizlerde tanımlayıcı istatistikler frekans (f) ve yüzde (%) olarak belirtilmiştir. Araştırmada hastaların cinsiyetine göre dental implant sayıları ve çenelere göre lokalizasyon dağılımları Mann–Whitney U testi ile karşılaştırılmıştır. İstatistiksel anlamlılık $p<0,05$ düzeyinde değerlendirilmiştir.

Bulgular

716 hastanın incelenen panoramik radyografiarında 207 hastada implant yerleştirildiği görüldü. Hastaların 113'ü erkek, 94'ü kadındır. Tüm hastaların yaş ortalaması 78.4 olarak belirlendi. Erkek hastalarda ortalama yaş 78.7, kadın hastalarda ise 78.2 olarak bulundu (Tablo 1).

Table 1. Hastaların demografik özellikleri

Değişken	n (%) veya ortalama (min/maks)
Toplam hasta sayısı	207
Erkek	113 (54.6%)
Kadın	94 (45.4%)
Yaş ortalaması (yıl)	78.4 (75-94)
Erkek yaş ortalaması (yıl)	78.7 (75-94)
Kadın yaş ortalaması (yıl)	78.2 (75-93)

Yapılan panoramik radyografik değerlendirmede, 207 hastada üst çenede 435, alt çenede 500 olmak üzere toplam 935 dental implant olduğu belirlendi. Üst çenede yerleştirilen dental implant sayısı en az 1, en çok 9 olup ortalama 3.8 olarak bulundu. Alt çenede ise implant sayısı en az 1, en çok 10 olup ortalama 3 olarak belirlendi. Her iki çenede toplam implant sayısı ise en az 1, en çok 18 olup ortalama 4.5 olarak hesaplandı (Tablo 2).

Tablo 2. Çenelere ve bölgelere göre dental implant dağılımı

Bölge	Toplam İmplant Sayısı	Ortalama (min/maks)
Üst çene ön bölge	130	2.1 (1-4)
Üst çene	435	3.8 (1-9)
Alt çene ön bölge	203	2.1 (1-4)
Alt çene	500	3.0 (1-10)
Her iki çene toplam	935	4.5 (1-18)

Bölgesel dağılıma bakıldığında, üst çene ön bölgede implant sayısı 130, alt çene ön bölgede implant sayısı ise 203 olarak gözlendi. Şekil 1'de, hem alt hem üst çeneye implant yerleştirilmiş bir olguya ait örnek görüntü verilmiştir. Üst çenede ön bölgede en az 1, en çok 4 olmak üzere ortalama 2 implant; alt çene ön bölgede ise en az 1, en çok 4, ortalama 2 implant uygulandığı tespit edildi. Ayrıca 48 hastada, alt çenede 33-43 numaralı dişler bölgesinde 2 implant uygulaması olduğu belirlendi (Şekil 2).

Şekil 1. Panoramik radyografta, 77 yaşındaki kadın hastada 14,16, 36 ve 37 nolu dişler bölgesinde dental implant izlenmektedir.

Şekil 2. Panoramik radyografta, 77 yaşındaki kadın hastada alt total dişsiz çenede 33 ve 43 nolu dişler bölgesinde dental implant izlenmektedir.

Toplam 7 hastada, alt ve üst çenede sabit protetik rehabilitasyon için tam ark implant uygulaması, 13 hastada yalnızca üst çenede tam ark implant uygulaması ve 8 hastada yalnızca alt çenede tam ark implant uygulaması yapıldığı belirlendi (Şekil 3).

Şekil 3. Panoramik radyografta, 84 yaşındaki erkek hastada üst çenede 6 adet, alt çenede 7 adet dental implant izlenmektedir.

Cinsiyetler arası karşılaştırmada, erkek hastalarda toplam implant sayısı ortalaması 4.7, kadın hastalarda ise 4.3 olarak belirlendi. Erkek ve kadın hastalar arasında toplam implant sayısı açısından istatistiksel olarak anlamlı bir fark bulunmadı. (U=5903.5, p=0.16) Ayrıca, üst çene, alt çene, üst çene ön bölge ve alt çene ön bölge implant sayıları açısından da cinsiyetler arasında belirgin bir fark gözlenmedi. Ortalama değerler birbirine oldukça yakın olup, üst ve alt çene ile ön bölgelerdeki implant dağılımları cinsiyet açısından benzer bulundu.

Tartışma

Bu çalışmada, panoramik radyografları değerlendirilen 716 hastanın 207'sinde dental implant varlığı tespit edilmiş ve 75 yaş ve üzerindeki yaklaşık her 3-4 hastadan birinde implant uygulandığı belirlenmiştir. Bu bulgu, ileri yaş grubunda implant tedavisinin klinik olarak uygulanabilir olduğunu göstermektedir. Literatürde yaşlı bireylerde implant prevalansını doğrudan değerlendiren çalışmalar sınırlı olmakla birlikte, mevcut veriler implant uygulamalarının artış eğiliminde olduğunu ve ileri yaşın tek başına bir kontrendikasyon olarak kabul edilmediğini ortaya koymaktadır. 2014 yılında implant hastalarının %21'inin 70 yaşın üzerinde olduğu, ayrıca implant prevalansındaki en büyük mutlak artışın 65-74 yaş grubunda gerçekleştiği ve ileri yaştaki bireylerde implant kullanımının genç yetişkinlere kıyasla yaklaşık 13 kat daha yüksek olduğu bildirilmiştir (9,10).

Zarb&Schmitt (11), yaşlı bireylerde implant uygulamalarında osseointegrasyonun başarılı olduğunu ve dişsiz hastalarda uygulamanın yaşam kalitesini artırdığını bildirmişlerdir. Grant ve Kraut (12) yaptıkları çalışmada, 79 yaş ve üzeri olan toplam 47 geriatri hastasına 160 dental implant uygulamışlar ve sadece bir implantta başarısızlık gözlemlemişlerdir. Çalışmada, geriatri hastalarında dental implantların sabit veya hareketli implant destekli protezlerle başarılı bir şekilde uygulanabileceğini ve dental implant uygulamalarının hızla artan yaşlı nüfus için öngörülebilir ve güvenli bir yöntem olduğunu, ağız fonksiyonlarını, konforu ve yaşam kalitesini önemli ölçüde artırdığını rapor etmişlerdir (12). Çalışmamızda ise yaklaşık 1.5 yıllık periyotta, panoramik radyografı bulunan 207 hastada toplam 935 adet dental implant uygulandığı belirlenmiştir. Kanat ve ark (13)'ın çalışmasına benzer olarak, implantların çoğunluğu mandibulaya yerleştirilmiştir. Elde edilen veriler, ileri yaş grubundaki bireylerde de implant tedavilerinin yaygın biçimde uygulandığını ve bu hasta grubunun implant rehabilitasyonuna artan bir oranda yöneldiğini göstermektedir.

Çalışmamızda, erkek ve kadın hastalar arasında toplam implant sayısı açısından istatistiksel olarak anlamlı bir fark bulunmamıştır. Bu bulgu, cinsiyetin ileri yaş grubunda implant sayısını veya tedavi planlamasını belirleyen temel bir faktör olmadığını göstermektedir. Bununla birlikte yapılan bir çalışmada, dental implantların, erkek hastalara kadın hastalara göre daha fazla uygulandığı bildirilmiştir (13). Negri ve ark (14) yaptıkları klinik araştırmada, diş eksikliği olan hastalarda yerleştirilen kemik içi implantların çevresindeki kemik değişimlerini değerlendirmişler ve implant yerleşim bölgesinin, hasta yaşının ve cinsiyetin, marjinal kemik kaybını etkilediğini rapor etmişlerdir. Bu nedenle, implant uygulamalarında, implantın yerleştirileceği bölgenin, implant özelliklerinin ve hasta faktörlerinin dikkatle değerlendirilmesi gerekmektedir (14).

Dişlerin kaybedilmesiyle birlikte alveoler kemik rezorpsiyonu kaçınılmazdır, ancak bu rezorpsiyonun şiddeti; bireyler arasında, hatta aynı bireyin farklı çeneleri arasında ve zaman içinde değişkenlik göstermektedir (7). Eltas ve ark (15) yaptıkları çalışmada, 65 yaş üzeri bireylerde, 50–65 yaş grubuna göre mevcut diş sayısının anlamlı derecede daha az olduğunu ve periodontal hastalıklara bağlı kemik rezorpsiyonu görülen birey sayısının daha yüksek olduğunu bildirmişlerdir. Ayrıca, sistemik hastalıkların ve cinsiyetin mevcut diş sayısı ile kemik rezorpsiyonu görülme sıklığı üzerinde anlamlı bir etkisinin bulunmadığını rapor etmişlerdir. Yaşlı bireylerde, osteoporoz gibi sistemik hastalıklar, metabolik aktivitenin azalması ve diş kayıpları gibi faktörlere bağlı olarak çene kemiklerinde rezorpsiyon artışı gözlenmektedir (16). Bu rezorpsiyon mandibulada maksillaya kıyasla daha belirgindir. Rezorpsiyonun ileri düzeylere ulaşması durumunda, mandibuladaki alveoler kret belirgin biçimde incelmekte ve bu durum, konvansiyonel tam protezlerin stabilitesini ve tutuculuğunu olumsuz yönde etkilemektedir (16). Bu çalışmada, implant destekli overdenture için 33-43 numaralı diş bölgesinde implant uygulaması yapılan hasta sayısının yüksek bulunması, mandibuladaki rezorbsiyona bağlı hastaların tam protez kullanımındaki sıkıntısını gösteren literatürle uyumlu bir sonuçtur. Bural ve ark (17) yaptıkları çalışmada, 60-69 yaş ve 70-79 yaş grupları için, implant yerleştirilmesine yönelik en yaygın endikasyonun total dişsizlik olduğunu ve genellikle iki implant destekli overdenture tedavi seçeneğinin tercih edilmesine bağlı olarak, mandibular kanin bölgelerine istatistiksel olarak anlamlı düzeyde daha fazla implant yerleştirildiğini rapor etmişlerdir.

Yaşlanma süreci ile birlikte oluşan ileri derecede alveoler kret rezorpsiyonu, özellikle tam protez kullanımını zorlaştırabilir. Artan ağız kuruluğu, protezin tutuculuğunu engelleyebilir ve yumuşak dokuda ağrı ve rahatsızlığa neden olabilir (18). Bunun yanı sıra, yaşlı hastaların yeterli bilince sahip olmaması, yaş ilerledikçe azalan motor beceriler ve algının azalması sebebiyle de hareketli proteze uyum sağlama sürecinde ciddi zorluklar yaşanabilir (19). Motor kontrolde zayıflık ve çeşitli eklem hastalıkları nedeniyle protezi düşürüp kırma riski yanında, ileri yaşlarda ciddi ve yaşamı tehdit eden bir komplikasyon olarak protezin aspire edilmesine de rastlanabilir (6,20). Çalışmamızda, tam protez yerine sabit protetik rehabilitasyon amacıyla alt ve/veya üst çenede tam ark implant uygulaması yapılan hastalar mevcuttur; bu sayede hastaların protez kullanımı ve fonksiyonel konfor açısından daha iyi uyum sağladıkları düşünülmektedir. Ayrıca, sabit restorasyonlar, yaşlı bireylerin ağız ve yüz estetiğini iyileştirerek özsaygının artmasına katkı sağlayabilir ve iletişim ve sosyal etkileşim gibi sosyal yönlerden de genel yaşam kalitesi üzerinde önemli bir etkiye sahip olabilir.18 Müller ve ark (21), iyi planlanmış ve doğru şekilde tasarlanmış protezlerin, hastaların ağız sağlığına bağlı yaşam kalitesini artırdığını ve oral fonksiyonların daha etkin bir şekilde sürdürülmesini sağladığını bildirmiştir. Ayrıca bu protezlerin, morbiditenin azaltılmasına ve sağlıklı/başarılı yaşlanma sürecinin desteklenmesine katkı sağlayabileceğini vurgulamışlardır.

Klinik gözlemler, farklı yaş gruplarındaki hastaların önemli bir kısmının hareketli protezlerinden memnuniyetsizlik bildirdiğini göstermektedir. Bu durum özellikle yaşlı bireylerde sindirim ve beslenme açısından önemlidir. Yaşam süresinin uzaması, protezlere uyum güçlüğü ve memnuniyetsizlik riskini, aynı zamanda buna bağlı fonksiyonel yetersizlikleri artırmaktadır. Ayrıca, yumuşak dokuların uzun süreli hareketli protez kullanımı sonucunda duyarlılığının artması klinik bir sorun olarak ortaya çıkmaktadır (11). Yen ve ark (22), yaş ortalaması 76 olan ve hareketli protez kullanan hastaları değerlendirdikleri çalışmalarında, protez memnuniyetinin, ağız sağlığına bağlı yaşam kalitesini belirleyen en etkili değişken olduğunu bildirmişlerdir. İmplant destekli protezlerdeki teknolojik gelişmeler, dental implant uygulamalarının yaşlı bireylerde giderek daha yaygın ve etkili bir tedavi seçeneği haline gelmesine neden olmuştur. Ancak bu hasta grubunda, mevcut sistemik hastalıkların ve kronik rahatsızlıkların dikkatle değerlendirilmesi, olası komplikasyon risklerinin öngörülmesi ve buna uygun kişiye özel tedavi planlamasının yapılması elbette büyük önem taşımaktadır. Ayrıca, implant tedavisinin maliyetli olması, hastaların sosyoekonomik düzeyi, cerrahi işlemlere yönelik

kaygıları ve bilgi eksikliği gibi faktörler de yaşlı bireylerin bu tedaviye erişimini kısıtlayabilmektedir (23).

Bu çalışmada, 75 yaş ve üzeri bireylerde gerçekleştirilen implant uygulamalarının demografik özellikleri incelenmiş fakat hastaların klinik muayenesi ve takibi yapılmadığı için implant başarısı ve uzun dönem klinik sonuçları değerlendirilememiştir. Gelecekte, uzun dönem takip verilerini içeren ve sistemik hastalıklar ile implant başarısı arasındaki ilişkiyi değerlendiren daha kapsamlı klinik çalışmaların, yaşlı bireylerde implant tedavisinin başarısını daha net ortaya koyacağı ve bu alandaki tedavi protokollerinin geliştirilmesine katkı sağlayacağı düşünülmektedir.

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Research Article

Effects of Whitening Toothpastes on the Surface Roughness of Contemporary Restorative Materials: A Profilometric Study

Cansu Yıkıcı Çöl[1*]

[1]Specialists in Restorative Dentistry, Panorama Ankara Oral and Dental Health Clinic, Ankara, Turkey.

*Corresponding author: cansu.yikici@gmail.com

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Effects of Whitening Toothpastes on the Surface Roughness of Contemporary Restorative Materials: A Profilometric Study

Cansu Yıkıcı Çöl

Abstract

Objectives: This in-vitro study aimed to evaluate the effects of four commercially available whitening and conventional toothpastes on the surface roughness of contemporary restorative materials, including an alkasite, a nano-hybrid composite, a nano-hybrid flowable composite, an ormocer-based flowable material, and a zirconia-reinforced glass ionomer.

Materials and Methods: A total of 225 specimens were prepared and subjected to standardized simulated tooth-brushing equivalent to one month of clinical use. Surface roughness (Ra) values were measured before and after brushing using a contact profilometer. Non-parametric statistical tests (Wilcoxon, Kruskal–Wallis, Dunn with Bonferroni correction) were used to analyze changes within and between material–toothpaste combinations.

Results: Significant differences in surface roughness were found among most material–toothpaste combinations ($p < 0.05$). Ormocer, flowable composites (NF0, NF2), and Zirconomer (Z2, Z3) showed the greatest susceptibility to abrasion, while NF3–NF4, A3–A4, and several nanohybrid subgroups (N1–N3–N4) demonstrated similar resistance with no significant changes.

Conclusion: These findings indicate that the abrasivity of toothpastes influences restorative materials in a highly material-dependent manner. Clinical toothpaste selection should therefore consider the type of restorative material present.

Keywords: Restorative material, Surface roughness, Toothbrushing, Whitening toothpaste.

Introduction

Dental restorative materials are continuously exposed to mechanical and chemical challenges in the oral environment, with tooth-brushing being one of the most frequent actions affecting their surface integrity (1). Surface roughness (Ra) of restorative materials is a critical property, because increased roughness can promote plaque accumulation, staining, and compromise both esthetic appearance and longevity of restorations (2).

Whitening toothpastes are widely used by patients to improve tooth appearance. However, these dentifrices often contain more abrasive particles (e.g. hydrated silica, activated charcoal, or peroxide-based agents) compared to conventional toothpastes, which may enhance their cleaning/whitening effect but also increase the risk of surface wear when used on restorative materials (3).

In-vitro studies investigating the effect of whitening toothpastes on composite resins have reported mixed but concerning findings. Some studies observed significant increases in surface roughness after simulated tooth-brushing with whitening dentifrices compared to non-whitening controls (2, 4, 5). On the other hand, other investigations found no statistically significant difference in roughness increase between whitening and non-whitening dentifrices for certain nanohybrid composite materials after short-term brushing simulation (1, 6, 7). Thus, the effect may depend on variables such as toothpaste abrasive content, resin composition, filler type/size, brushing protocol (cycles, force), and polymer matrix characteristics.

Given the increasing use of novel restorative materials including resin-based composites, ormocer-based materials, glass-ionomer hybrids or alkasites and the widespread patient use of whitening toothpastes, it is of practical importance to systematically evaluate how different dentifrices affect surface properties (especially roughness) of various restorative materials.

Therefore, the present study aims to assess under standardized simulated tooth-brushing conditions the effect of several commercially available whitening and conventional toothpastes on the surface roughness of a diverse range of contemporary restorative materials (including alkasite, nano-hybrid composite, nano-hybrid flowable composite, ormocer-based flowable restorative material and zirconia-reinforced glass ionomer).

The null hypotheses of the study were as follows:

1. Whitening toothpastes would have no effect on the surface roughness of restorative materials.

2. The type of toothpaste does not affect the surface roughness of the restorative materials.

3. There is no statistically significant difference in surface roughness changes between whitening and non-whitening toothpastes.

Materials and Methods

Study Design

This in-vitro study evaluated the effect of commercially available whitening and non-whitening toothpastes on the surface roughness of contemporary restorative materials under standardized simulated tooth-brushing conditions. Surface roughness (Ra) was quantified initial and after brushing simulation using a profilometric measurement system.

Specimen Preparation

The required sample size was determined using the G*Power software (version 3.1.9.4, Düsseldorf, Germany). Assuming a 95% confidence level, 80% statistical power, and an effect size of 0.50, the analysis indicated that a total of 225 specimens would be sufficient. Accordingly, the minimum number of samples per group was calculated as nine.

Five different restorative materials were selected: An alkasite (Cention-N), a nano-hybrid composite (Grandio SO, VOCO), a nano-hybrid flowable composite (Grandio SO Light Flow), an ormocer-based flowable restorative material (Admira Fusion Flow), and a zirconia-reinforced glass ionomer (Zirconomer P). Their compositions and manufacturers are presented in Table 1.

For each material, cylindrical specimens (n = 9 per group) were prepared using a plastic mold (8 mm diameter × 2 mm thickness). Materials were inserted in a single increment and covered with Mylar strips and glass slides to obtain a standardized surface. Light-curable materials were polymerized for 20 seconds using an LED curing unit (Woodpecker,Guilin Woodpecker Medical Instrument Co., China) at an intensity of ~1200 mW/cm². Self-curing materials were allowed to set according to manufacturer instructions.

To standardize the surfaces, specimens were polished using silicon carbide abrasive papers (600, 800, and 1200 grit) under continuous water irrigation. Samples were ultrasonically

cleaned for 10 minutes to remove residual debris and then stored in distilled water at 37°C for 24 hours until initial roughness measurements.

Table 1. Composition and manufacturing details of the materials

Material type	Abbr	Polymerization	Contents	Trade name (Manufacturers)
Alkasite	A	Self or light (20 sec)	Dimethacrylates, initiators, stabilizers, additives and mint flavour. Calcium fluoro-silicate glass, barium glass, calcium-barium-aluminium fluoro-silicate glass, iso-fillers, ytterbium trifluoride, initiators and pigments	Cention-N (Ivoclar Vivadent, Schaan, Liechtenstein)
Universal, nano-hybrid composite	N	Light (20sec)	Barium aluminum borosilicate glass, silicon dioxide, HEDMA, BisGMA, TCDDMA, Fumed silica, TEGDMA, BisEMA, initiator, stabilizer, pigment	Grandio SO (VOCO, Cuxhaven, Germany)
Nano-hybrid flowable restorative material	NF	Light (20 sec)	Barium aluminum borosilicate glass, silicon dioxide, HEDMA, BisGMA, TCDDMA, Fumed silica, TEGDMA, BisEMA, initiator, stabilizer, pigment	Grandio SO Light flow (VOCO, Cuxhaven, Germany)
Ormocer-based light-cured flowable restorative material	OR	Light (20 sec)	Barium aluminum borosilicate glass, ormocer resin, silicon dioxide, initiator, stabilizer, pigment	Admira fusion flow (VOCO, Cuxhaven, Germany)
Zirconia-reinforced glass ionomers	Z	Self	Fluoroaluminosilicate glass, Zirconium oxide, pigments and others Polyacrylic acid solution and Tartaric acid	Zirconomer P (Shofu, Kyoto, Japan)

Toothpaste Groups

Four commercially available toothpastes were tested:

- Sensodyne Pronamel (non-whitening)
- R.O.C.S UNO (whitening)
- Oral-B PRO-3D WHİTE CLINICAL (whitening)
- Opalescence (whitening)

Their compositions and manufacturers are listed in Table 2.

The assignment of the study groups was performed by combining the material abbreviations and the toothpaste codes provided in Tables 1 and 2. In this coding system, each restorative material (A, N, NF, O, and Z) was paired with five brushing conditions, represented by the toothpaste numbers 0 through 4, where '0' corresponded to the control group brushed solely with distilled water. Consequently, every material was allocated to one control and four dentifrice conditions, yielding a total of 25 experimental groups. For instance, the code 'A1' denotes the alkasite material brushed with toothpaste 1, whereas 'Z0' refers to the zirconia-reinforced glass ionomer assigned to the control condition. The coding system of the material–toothpaste combinations is presented in Table 3 to facilitate interpretation of the experimental groups.

Table 2. Composition and manufacturing details of the toothpastes (Abrasive components are indicated in bold, whereas remineralizing or auxiliary ingredients are underlined)used.

Toothpastes	Group code	Compositions	Manufacturers
Control Group	0	Distilled Water	-
Sensodyne Pronamel	1	Aqua, Sorbitol, **Hydrated Silica**, Glycerin, Potassium Nitrate, PEG-6, Cocamidopropyl Betaine, Sodium Lactate, Glaxosmithkline Aroma, Xanthan Gum, Sodium Flüoride (1450ppm), Sodium Saccharin, **Titanium Dioxide**, PVM/MA Copolymer, Sodium Hydroxide, Limonene.	Haleon (Weybridge, United Kingdom)
R.O.C.S UNO	2	Aqua, **Silica,** Glycerin, Xylitol (%2,2), Xanthan Gum, Aroma (Flavor), Sodium Glycerophosphate, Magnesium Chloride, Calcium Glycerophosphate, Sodium Lauryl Sulfate (SLS), Sodium Saccharin, **Sodium Silicate**, Methylparaben, Propylparaben And Limonene.	R.O.C.S. Laboratories AG (Switzerland)
Oral-B PRO-3D WHITE CLINICAL	3	Active Ingredient Sodyum Monoflorofosfat (1450ppm)	GmbH, Procter &Gamble, Germany
Opalescence	4	Aqua, **Silica,** Glycerin, Sorbitol, Xylitol, Aroma (Flavor), Poloxamer 407, Sodium Lauryl Sulfate, Carbomer, Sodium Benzoat, Sodium Flüoride (1100 Ppm), Sodium Hydroxide, Sucralose, Xantan Gum, FD&C, Blue No.1(CI 42090), FD&C Yellow No.5(CI 19140)	Opalescence (Ultradent Products, South Jordan USA)

Table 3. Matrix of material–toothpaste combinations and coding system used in the studyused.

	Control (0)	**Sensodyne (1)**	**R.O.C.S (2)**	**Oral-B (3)**	**Opalescence (4)**
Alkasite (A)	A0	A1	A2	A3	A4
Nanohybrid (N)	N0	N1	N2	N3	N4
Flowable (NF)	NF0	NF1	NF2	NF3	NF4
Ormocer (OR)	OR0	OR1	OR2	OR3	OR4
Zirconomer (Z)	Z0	Z1	Z2	Z3	Z4

Table 4. Descriptive statistics of the study

	İnitial (Median [IQR])	After (Median [IQR])	Δ Final-Initial [IQR])	p	Effect Size (r)
A0	0.42 [0.035]	0.33 [0.018]	-0.093[0.021]	0.0039	r ≥ 0.70, very large effect
A1	0.44 [0.003]	0.48 [0.075]	0.038 [0.068]	0.054	r=0.64, large effect
A2	0.26 [0.003]	0.24 [0.011]	-0.013 [0.010]	0.0039	r ≥ 0.70, very large effect
A3	0.30 [0.011]	0.23 [0.008]	-0.073 [0.020]	0.0039	r ≥ 0.70, very large effect
A4	0.79 [0.083]	0.71 [0.068]	-0.056 [0.048]	0.0078	r ≥ 0.70, very large effect
N0	0.26 [0.016]	0.20 [0.006]	-0.066 [0.020]	0.0039	r ≥ 0.70, very large effect
N1	0.24 [0.015]	0.24 [0.011]	-0.001 [0.018]	0.734	r≤ 0.20, small effect
N2	0.21 [0.008]	0.17 [0.003]	-0.040 [0.015]	0.0039	r ≥ 0.70, very large effect
N3	0.23 [0.013]	0.24 [0.003]	0.010 [0.016]	0.496	0.20<r<0.49, medium efect
N4	0.24 [0.018]	0.25 [0.045]	0.001 [0.036]	0.208	0.20<r<0.49, medium efect
NF0	0.28 [0.015]	0.17 [0.008]	-0.105 [0.008]	0.0039	r ≥ 0.70, very large effect
NF1	0.23 [0.006]	0.24 [0.013]	0.003 [0.018]	0.570	0.20<r<0.49, medium efect
NF2	0.28 [0.025]	0.18 [0.013]	-0.118 [0.045]	0.0039	r ≥ 0.70, very large effect
NF3	0.36 [0.036]	0.32 [0.010]	-0.035 [0.033]	0.074	r=0.59, large effect
NF4	0.21 [0.016]	0.20 [0.011]	-0.021 [0.025]	0.0078	r ≥ 0.70, very large effect
OR0	0.31 [0.041]	0.19 [0.008]	-0.128 [0.036]	0.0039	r ≥ 0.70, very large effect
OR1	0.24 [0.010]	0.18 [0.006]	-0.061 [0.018]	0.0039	r ≥ 0.70, very large effect
OR2	0.24 [0.008]	0.17 [0.008]	-0.068 [0.018]	0.0039	r ≥ 0.70, very large effect
OR3	0.26 [0.013]	0.22 [0.018]	-0.035 [0.016]	0.0039	r ≥ 0.70, very large effect
OR4	0.21 [0.013]	0.19 [0.005]	-0.013 [0.010]	0.0039	r ≥ 0.70, very large effect
Z0	0.31 [0.041]	0.32 [0.125]	0.021 [0.108]	0.128	r=0.50, large effect
Z1	0.44 [0.040]	0.42 [0.076]	-0.081 [0.138]	0.074	r=0.59, large effect
Z2	0.57 [0.051]	0.40 [0.009]	-0.013 [0.081]	0.0039	r ≥ 0.70, very large effect
Z3	0.32 [0.031]	0.52 [0.143]	0.183 [0.146]	0.0039	r ≥ 0.70, very large effect
Z4	0.64 [0.016]	0.62 [0.170]	-0.031 [0.286]	0.652	0.20<r<0.49, medium efect

Brushing Simulation

Each sample was brushed manually using an electric toothbrush (Oral-B iO, Braun, Germany) with slurry of the toothpastes prepared at a 1:1 ratio with distilled water. In the control group, specimens were brushed with distilled water only, for an equivalent duration. Considering that individuals typically brush their teeth twice a day for approximately two minutes (approximately eight seconds of brushing time per tooth for a person with thirty-two teeth), as described by Gömleksiz and Okumuş (2024) (2), the samples were brushed for a total of four minutes to simulate one month of toothbrushing time. After the toothbrushing the samples were washed using tap water and stored again for 24 hours at 37°C before the final surface roughness.

Surface Roughness Measurement

Surface roughness (Ra, μm) was measured before and after brushing using a contact profilometer (Perthometer; Mahr Gmbh, Ingolstadt, Germany), as commonly used in previous studies (2, 8). Each specimen was scanned in three different locations. The mean Ra value was used for statistical analysis. Initial and after brushing Ra values were recorded to calculate change in surface roughness.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics software (version 26, IBM Corp., Armonk, NY, USA). Descriptive data were summarized as mean ± standard deviation, median (interquartile range, IQR), and minimum–maximum values. The Shapiro–Wilk test was used to evaluate the normality of the data distribution, while Levene's test assessed the homogeneity of variances. As the assumptions of normality and homogeneity were not met ($p < 0.05$), non-parametric statistical methods were applied. Within-group comparisons between before and after brushing measurements were conducted using the Wilcoxon Signed-Rank test. Intergroup comparisons were performed using the Kruskal–Wallis H test, and when significant differences were observed, pairwise post-hoc analyses were carried out using the Dunn test with Bonferroni adjustment to control for type I error. Effect sizes (r) were calculated for Wilcoxon outcomes and interpreted according to the following criteria: 0.10–0.29 = small, 0.30–0.49 = medium, 0.50–0.69 = large, and ≥0.70 = very large effect. A significance level of $p < 0.05$ was adopted for all statistical evaluations.

Results

All analyses were performed on the original assigned groups, with 9 specimens included in each group. Table 4 presents descriptive statistics including the initial and after brushing median surface roughness (Ra, μm [interquartile range (IQR)]) values of the test groups, ΔFinal-Initial [IQR]), within-group statistical comparisons and the effect size (r).

The Kruskal–Wallis H test was conducted to compare the surface roughness values among all material–toothpaste combinations at three levels: Initial (H statistic=214.46, $p < 0.001$), After brushing (H statistic=214.06, $p < 0.001$), and Delta (the difference between initial and after) (H statistic=165.97, $p < 0.001$). The analysis revealed statistically significant differences across groups for all variables ($p < 0.05$).

Post-hoc pairwise comparisons performed using the Dunn test with Bonferroni adjustment revealed that the majority of material–toothpaste combinations differed significantly in terms of brushing-induced changes in surface roughness. Several groups, particularly those involving Ormocer (OR series), flowable composite (NF0 and NF2), and Zirkonomer (Z2 and Z3), showed highly significant differences from a wide range of other groups, indicating a pronounced sensitivity to abrasive effects. In contrast, some combinations exhibited comparable surface responses, with non-significant differences observed between NF3–NF4, A3–A4, and among several nano-hybrid composite subgroups (N1–N3–N4), suggesting similar levels of resistance to brushing-induced alterations. Dunn post-hoc test heat map (p values) is shown in Figure 1.

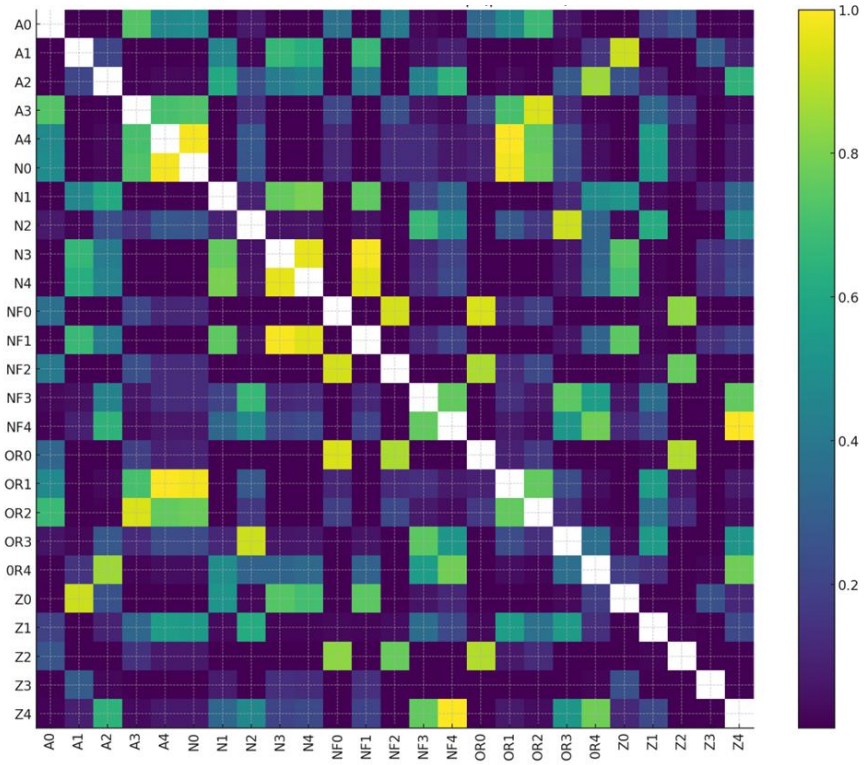

Figure 1. Dunn post-hoc test heat map (p values)

Discussion

The aim of this study was to evaluate the surface roughness of contemporary restorative materials with several commercially available whitening and conventional toothpastes under standardized simulated toothbrushing. The first null hypothesis was partially rejected, as whitening toothpastes caused significant changes in surface roughness in several material groups; however, no statistically significant differences were observed in certain subgroups (N3, N4, NF3, Z4), indicating that the effect was material-dependent.The second null hypothesis was also partially rejected. Although some nanohybrid composite subgroups (N1, N3, N4) showed similar surface roughness changes regardless of toothpaste type, other material groups demonstrated significant differences, suggesting that toothpaste composition influenced surface roughness depending on the material.The third null hypothesis was rejected, as significant differences in surface roughness changes were observed between whitening and non-whitening toothpastes in several material groups (A1–A3, A1–A4, NF1–NF2, OR1–OR4, Z1–Z2, Z1–Z3).

Alkasite is a resin-based restorative material containing alkaline glass fillers capable of releasing calcium, fluoride, and hydroxide ions, thereby providing acid-neutralizing and anticariogenic benefits (9). Universal nanohybrid composites, composed of a combination of nano- and micro-sized fillers within monomer systems such as UDMA, Bis-GMA, and Bis-EMA, offer high mechanical strength and excellent polishability for both anterior and posterior restorations (10). Flowable nanohybrid composites represent a lower-viscosity variant with reduced filler content, resulting in enhanced adaptability to cavity walls but slightly lower mechanical resistance, making them suitable for small restorations, liners, and cervical lesions (11). Ormocer-based materials, formulated with organically modified ceramic networks instead of traditional methacrylate monomers, exhibit low polymerization shrinkage, improved biocompatibility, and superior wear resistance (12). Zirconomer, a zirconia-reinforced glass ionomer cement, combines the fluoride-releasing capability of conventional glass ionomers with significantly enhanced strength and durability attributed to the incorporation of zirconia particles (13).

When combined, the abrasive effects of toothpastes and the mechanical effects of toothbrushes can cause abrasions (14). To prevent abrasion with abrasive concentration, all

samples had the same toothbrush used by the same operator with similar force applied. Numerous in-vitro investigations have relied on simulated tooth brushing to assess the long-term effects of dentifrices, often extending their experimental periods to six months or longer. In contrast, the present study employed a shorter brushing interval of one month (1). This decision was based on evidence showing that dentifrices with effective whitening properties typically demonstrate noticeable benefits within the first two weeks of use, with these effects remaining consistent for up to twelve weeks (15). In the present study, the observed variations in surface roughness among different toothpaste groups may be attributed to differences in abrasive composition, supporting the role of dentifrice formulation in influencing material surface properties.

The Kruskal-Wallis H test revealed statistically significant differences between the groups for each variable when examining surface roughness at initial, after brushing, and delta levels ($p < 0.05$). These results indicate that the initial surface roughness values differed significantly among the groups, Similarly, after brushing surface roughness values also varied significantly, demonstrating that the brushing procedures produced markedly different effects on the materials tested. Importantly, the delta values showed a strong and significant difference across groups, indicating that each material toothpaste combination responded differently to brushing and that the magnitude of change in surface roughness was not homogeneous among the groups.

Post-hoc Dunn analysis with Bonferroni correction showed that ormocer series, flowable composites (NF0, NF2), and zirconomer (Z2, Z3) were particularly sensitive to abrasive effects. In contrast, combinations such as NF3–NF4, A3–A4, and various nanohybrid subgroups (N1–N3–N4) showed no significant difference, exhibiting similar resistance to brushing-induced alterations. The overall Dunn test pattern demonstrates substantial heterogeneity among the groups, confirming that the magnitude of surface roughness change is strongly dependent on the specific restorative material and toothpaste combination.

From a clinical perspective, surface roughness values exceeding the commonly accepted threshold of Ra = 0.2 μm are considered critical, as they may promote plaque accumulation and increase the risk of staining and secondary caries (16). In the present study, both increases and decreases in surface roughness were observed depending on the material toothpaste combination. While certain group exhibited an increase in Ra values after brushing, other groups

demonstrated a reduction in surface roughness, which may be attributed to a polishing effect of the abrasive particles present in the dentifrices. This finding highlights that the interaction between restorative materials and toothpastes is not unidirectional but rather material-dependent. Importantly, even in cases where surface roughness decreased, the final Ra values should be interpreted in relation to the clinical threshold. Some groups remained above the Ra = 0.2 μm limit despite a reduction (A0, A4, Z2), suggesting that the clinical risk associated with plaque retention may still persist. Based on these findings, clinicians should consider both the restorative material and the abrasivity of the toothpaste when making clinical recommendations.

Numerous investigations have examined the impact of whitening toothpastes on the surface roughness of restorative materials. Yılmaz et al. (2021) (7) reported that the whitening effect is primarily associated with effective tooth brushing rather than the toothpaste formulation itself. Similarly, the study conducted by da Rosa et al. (2016) (1) demonstrated that whitening dentifrices did not significantly increase the surface roughness of nanohybrid composite resin following a one-month tooth-brushing simulation. These findings are partially consistent with the present study, in which certain nanohybrid composite groups (N3, N4) also showed no statistically significant change in surface roughness after brushing. In contrast, several studies have indicated that oral hygiene practices particularly tooth brushing may actually contribute to increased surface roughness in composite resins (8, 17), suggesting the need for repeated polishing procedures for restorations (17). Consistent with the present findings, de Moraes et al. (18) observed that brushing with whitening toothpastes resulted in material-dependent alterations in surface roughness. In this study, significant changes were observed in certain material groups; this indicates that the effect of toothpaste can vary depending on the material composition.

Whitening dentifrices commonly contain silica-based abrasives, which have been shown to increase surface roughness on enamel and resin composites due to their mechanical cleaning action (18, 19). In addition, xylitol is often included as a non-cariogenic sweetener that reduces Streptococcus mutans levels and lowers caries risk, although it does not directly contribute to enamel remineralization (20, 21). Among the active remineralizing agents, fluoride remains the primary component responsible for promoting mineral deposition and reversing early enamel subsurface lesions (22). Fluoride toothpastes further protect tooth structure by

stabilizing hydroxyapatite crystals and reducing demineralization during acidic challenges, thereby enhancing overall surface resistance (23, 24).

Relative Dentin Abrasivity (RDA) is a standardized measure used to quantify the abrasive potential of dentifrices during brushing. Values within the range of 0–70 indicate low abrasivity and are generally considered safe for routine use. An RDA of 71–100 reflects medium abrasivity, while values between 101–150 are classified as highly abrasive. RDA levels exceeding 151–250 are regarded as entering a harmful range (25).

Sensodyne ProNamel is one of the few commercially available dentifrices with a clearly disclosed Relative Dentin Abrasivity (RDA) value, reported to be approximately 37 (26), which falls within the 'low-abrasivity' category. For most other whitening toothpastes, manufacturers do not publicly provide RDA values, making direct product-to-product comparisons difficult. However, the scientific literature consistently shows that silica-based whitening dentifrices depending on the amount, hardness, and particle size of hydrated/amorphous silica tend to exhibit moderate abrasivity, with reported RDA or RDA-PE values typically ranging between 80 and 110 (27). These findings have been demonstrated in controlled laboratory studies evaluating dentin wear and abrasivity of silica-containing whitening formulations. Therefore, while silica-based whitening toothpastes may enhance stain removal effectiveness, their abrasivity levels can vary significantly based on formulation, necessitating careful interpretation of their mechanical cleaning effects (28).

Hydrated silica, silica and titanium dioxide are the corrosive agents used in the study. It is known that the abrasiveness of hydrated silica is higher than that of silica (18). Hydrated silica consists of mineral compounds with diverse physicochemical characteristics and is regarded as an effective cleaning agent due to its high abrasive capacity, while remaining compatible with most fluoride-containing substances. Additionally, it functions as a thickening and stabilizing ingredient in dentifrices. Titanium dioxide, on the other hand, can temporarily alter the enamel shade by penetrating surface irregularities. As a result, users may perceive their teeth as whiter; However, both dental tissues and restorative materials may experience increased surface roughness, making them more susceptible to future staining (16, 29). In the present study, the variability in surface roughness changes observed among different toothpaste groups may be associated with differences in the type and abrasivity of these agents.

Toothpastes containing more aggressive abrasive components may have contributed to increased surface roughness in certain material groups, whereas less abrasive formulations may have resulted in minimal changes or even a reduction in roughness due to a polishing effect.

This in-vitro investigation has several limitations that should be considered when interpreting the results. First, all specimens were finished using a single standardized polishing procedure, which does not reflect the variability of clinical finishing and polishing systems; therefore, future studies should compare different surface finishing protocols to better simulate clinical practice. Second, the brushing simulation was limited to a one-month equivalent duration, and longer or variable brushing intervals are needed to determine the cumulative effects of dentifrices on restorative materials. Third, only one type of electric toothbrush was used, despite the fact that bristle stiffness, brush head design, and brushing kinematics may significantly influence abrasion patterns; thus, further research should evaluate different toothbrush types. Additionally, this study did not incorporate intraoral variables such as thermal fluctuations (hot–cold cycles), acidic or erosive challenges, or the lubricating and protective properties of saliva. Incorporating these dynamic oral conditions into future experimental designs would provide a more clinically relevant understanding of how whitening and conventional toothpastes affect the long-term surface integrity of contemporary restorative materials.

Within the limitations of this in-vitro study, brushing with whitening and conventional toothpastes produced material-dependent changes in the surface roughness of contemporary restorative materials. These findings indicate that the impact of dentifrices cannot be generalized across restorative materials, as their response is strongly influenced by filler composition, resin matrix characteristics, and the abrasive profile of the toothpaste. Clinically, the selection of toothpaste should consider the restorative material present in the oral cavity, especially in patients with extensive aesthetic or restorative treatments. Further studies incorporating longer brushing periods, varied polishing protocols, and more realistic intraoral conditions are warranted to better understand the long-term effects of whitening dentifrices on restorative surfaces.

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Research Article

Mukogingival Cerrahi Uygulanan Hastalarda Görsel veya Sözel Bilgilendirmenin Dental Anksiyete ve Ağrı Düzeylerine Etkisinin Değerlendirilmesi

Emre Durmuş[1*], Varol Çanakçı[1], Yunus Emre Güner[1], Oğuzcan Kaplan[1]

[1]Ordu Üniversitesi, Diş Hekimliği Fakültesi, Periodontoloji Anabilim Dalı, Ordu, Türkiye.

*Corresponding author: ynsgnr08@gmail.com

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Mukogingival Cerrahi Uygulanan Hastalarda Görsel veya Sözel Bilgilendirmenin Dental Anksiyete ve Ağrı Düzeylerine Etkisinin Değerlendirilmesi

Emre Durmuş, Varol Çanakçı, Yunus Emre Güner, Oğuzcan Kaplan

Özet

Amaç: Bu çalışmanın amacı, mukogingival cerrahi geçiren hastalarda cerrahi öncesi uygulanan görsel ve sözlü bilgilendirme yöntemlerinin dental anksiyete ve postoperatif ağrı düzeyleri üzerindeki etkilerini karşılaştırmaktır.

Gereç ve Yöntem: Mukogingival cerrahi endikasyonu bulunan toplam 80 birey rastgele olarak iki gruba ayrılmıştır: sözlü bilgilendirme grubu (n=40) ve görsel bilgilendirme grubu (n=40). Görsel bilgilendirme grubundaki hastalara, cerrahi işlemin tüm aşamalarını gösteren on adet yüksek çözünürlüklü fotoğraf cerrahi öncesinde standart koşullarda gösterilmiştir. Anksiyete ve ağrı düzeyleri, Modifiye Dental Anksiyete Skalası (MDAS), Durumluk-Sürekli Kaygı Envanteri (STAI-S, STAI-T) ve Vizüel Analog Skala (VAS) kullanılarak cerrahi öncesinde, hemen sonrasında ve postoperatif 10. günde değerlendirilmiştir. Veriler istatistiksel olarak Paired t-testi, Independent t-testi, Repeated Measures ANOVA ve Bonferroni düzeltmesi ile analiz edilmiştir ($p<0,05$).

Bulgular: Görsel bilgilendirme yapılan grupta postoperatif MDAS ve VAS skorları sözlü bilgilendirilen gruba kıyasla anlamlı düzeyde daha düşük bulunmuştur ($p<0,05$). Sürekli kaygı skorları (STAI-T) da görsel bilgilendirme grubunda anlamlı olarak daha düşüktür (34,0±8,62 vs. 39,6±9,98; $p=0,009$). Ayrıca tedavi sonrası oksijen satürasyonu değerleri görsel bilgilendirme yapılan hastalarda daha yüksek saptanmıştır ($p=0,010$). Ağrı düzeyleri ile nabız değerleri arasında tedavi öncesi ve sonrası dönemde pozitif korelasyon gözlenmiştir ($p<0,05$).

Sonuç: Görsel bilgilendirme, mukogingival cerrahi geçiren hastalarda dental anksiyete ve postoperatif ağrı düzeylerini azaltmada etkili bulunmuştur. Cerrahi öncesi bilgilendirme sürecine fotoğraf, video veya animasyon gibi görsel materyallerin eklenmesi; hastaların psikolojik rahatlığını artırarak tedaviye uyumunu güçlendirebilir ve periodontal cerrahilerde hasta memnuniyetini yükseltebilir.

Anahtar kelimeler: Ağrı algısı, Diş kaygısı, Görsel bilgiler, Hasta eğitimi, Mukogingival cerrahi.

Abstract

Objective: Dental anxiety is a prevalent psychosocial issue that can negatively affect patient cooperation and clinical outcomes during periodontal surgery. Visual educational methods have been proposed to enhance patient understanding and reduce anxiety levels before dental procedures. However, limited data exist regarding their influence on anxiety and pain perception in mucogingival surgeries. This study aimed to evaluate the effects of visual versus verbal preoperative information on dental anxiety and postoperative pain in patients undergoing mucogingival surgery.

Materials and Methods: Eighty patients requiring mucogingival surgery were randomly assigned to two groups: the verbal information group (n=40) and the visual information group (n=40). In the visual group, ten high-resolution photographs illustrating each step of the surgical procedure were shown prior to surgery. Anxiety and pain were assessed using the Modified Dental Anxiety Scale (MDAS), State-Trait Anxiety Inventory (STAI-S and STAI-T), and Visual Analog Scale (VAS) at baseline, immediately after surgery, and on postoperative day 10. Statistical analyses included paired and independent sample t-tests, repeated measures ANOVA, and Bonferroni correction ($p<0.05$).

Results: Postoperative MDAS and VAS scores were significantly lower in the visual information group compared with the verbal group ($p<0.05$). Trait anxiety scores (STAI-T) were also significantly lower in the visual group (34.0±8.62 vs. 39.6±9.98; $p=0.009$). Moreover, oxygen saturation levels measured after treatment were higher in patients receiving visual information ($p=0.010$). Positive correlations were found between pain intensity and heart rate values before and after surgery ($p<0.05$).

Conclusion: Visual preoperative information effectively reduced dental anxiety and postoperative pain in patients undergoing mucogingival surgery. Incorporating visual materials such as photographs, videos, or animations into routine patient education protocols may improve psychological comfort, enhance treatment compliance, and contribute to better overall clinical outcomes in periodontal surgery.

Keywords: Dental anxiety, Mucogingival surgery, Pain perception, Patient education, Visual information.

Giriş

Periodontal tedavi, yalnızca periodontal patojenlerin neden olduğu kronik hastalıkların kontrol altına alınmasını değil, aynı zamanda yumuşak doku deformitelerinin düzeltilmesini ve estetik kayıpların giderilmesini de amaçlamaktadır. Mukogingival cerrahinin temel hedefi, keratinize dişeti dokusunun bütünlüğünü korumak, kaybolan dokuyu yeniden oluşturmak ve ilerleyen dönemlerde ortaya çıkabilecek sert ve yumuşak doku kayıplarını önlemektir. Bu yaklaşımla hem periodontal sağlığın sürdürülmesi hem de estetik beklentilerin karşılanması sağlanmaktadır (1,2).

Günümüzde dişler veya implantlar etrafındaki marjinal yumuşak doku çekilmeleri, yalnızca periodontal ve peri-implant sağlığı açısından değil, estetik sonuçların iyileştirilmesi bakımından da kritik öneme sahiptir. Bu nedenle otojen, allojen veya sentetik greftlerle gerçekleştirilen yumuşak doku ogmentasyonları; doku hacmini artırmak, keratinize dişeti miktarını yükseltmek ve estetik sonuçları geliştirmek amacıyla yaygın olarak tercih edilmektedir (3,4). Bununla birlikte mukogingival cerrahi işlemler sırasında ve sonrasında hastaların sıklıkla ağrı hissettikleri, ayrıca dental korku ve anksiyetenin bu deneyimi olumsuz yönde etkileyerek ağrı algısını artırdığı bildirilmektedir (5–7).

Dental anksiyete, bireylerin tedaviyi ertelemelerine veya tamamen iptal etmelerine yol açabilen, tüm dünyada yaygın görülen önemli bir psikososyal sorundur. Uluslararası araştırmalarda hastaların %5,5–15,5'inin dental anksiyete nedeniyle tedavilerini aksattığı rapor edilirken (6), ülkemizde bu oran %21–23,5 gibi daha yüksek seviyelerdedir (8,9). Yüksek anksiyete düzeyine sahip bireylerde tedavi sırasında daha yoğun ve uzun süreli ağrı hissedildiği, oral sağlık durumlarının daha kötü olduğu ve yaşam kalitelerinin olumsuz etkilendiği gösterilmiştir (10–14).

Anksiyetenin değerlendirilmesinde öznel yöntemler (anksiyete ölçekleri, yarı yapılandırılmış görüşmeler) ve nesnel ölçümler (kalp atım hızı, kan basıncı gibi fizyolojik parametreler) kullanılmaktadır (15). Son yıllarda hastaların bilgi düzeyini artırmayı ve kontrol duygusunu geliştirmeyi hedefleyen görsel bilgilendirme yöntemleri (video, animasyon, modeller) öne çıkmıştır. Bu teknikler, bireylerin tedavi sürecini daha iyi anlamalarına, kaygılarını azaltmalarına ve iş birliklerini artırmalarına katkı sağlamaktadır (16,17).

Bununla birlikte literatürde, mukogingival cerrahi öncesi ve sonrasında görsel bilgilendirmenin dental anksiyete ve ağrı düzeyleri üzerindeki etkilerini değerlendiren sınırlı sayıda çalışma bulunmaktadır. Bu araştırma, görsel bilgilendirmenin bu cerrahi işlemlerde hasta deneyimine olan etkilerini inceleyerek literatüre katkı sunmayı amaçlamaktadır.

Son yıllarda yapılan çalışmalar, periodontal cerrahi öncesi uygulanan farklı bilgilendirme yöntemlerinin ve hastaların psikolojik durumlarının, postoperatif ağrı ve anksiyete düzeyleri üzerinde önemli etkileri olduğunu göstermektedir (32–34).

Gereç ve Yöntem

Bu çalışma, Ordu Üniversitesi Diş Hekimliği Fakültesi Periodontoloji Anabilim Dalı'na başvuran ve mukogingival sorunları bulunan toplam 80 birey üzerinde gerçekleştirildi. Araştırma protokolü, Ordu Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından onaylandı (Karar no: 2020/203; tarih: 01.10.2020). Tüm katılımcılara çalışma hakkında ayrıntılı bilgi verildi ve yazılı onamları alındı.

Çalışmaya dahil edilen hastalara, klinik endikasyonlarına göre vestibüloplasti, serbest diş eti grefti, koronale pozisyone flep, dişeti ogmentasyonu, kuron boyu uzatma, implant çevresi mukozal defektlerin düzeltilmesi ve frenektomi gibi mukogingival cerrahi işlemler uygulandı.

Dahil edilme kriterleri arasında 18–65 yaş arası, ASA I–II sınıflamasına uygun, okuryazar olan ve çalışmanın anket formlarını anlayıp doldurabilecek bireyler yer aldı. Hamile/emziren kadınlar, ciddi sistemik hastalığı bulunanlar (ASA ≥III), psikiyatrik tedavi görenler, görme problemi olanlar ve kötü dental deneyim öyküsü bulunanlar dışlandı.

Katılımcılar kapalı zarf yöntemi ile rastgele iki gruba ayrıldı. Birinci grupta (n=40) hastalara yapılacak cerrahi işlem sözlü olarak aktarıldı. İkinci grupta (n=40) ise cerrahi sürecin lokal anesteziden sütur atımına kadar olan aşamalarını içeren 10 adet fotoğraf kullanılarak görsel bilgilendirme yapıldı. Fotoğraflar Nikon D7500 dijital kamera ile çekilmiş olup, bilgisayar ekranında yüksek çözünürlükte ve standart koşullarda gösterildi. Tüm cerrahi işlemler ve anket uygulamaları aynı klinisyen tarafından gerçekleştirildi.

Anksiyete değerlendirmesi için Durumluk-Sürekli Kaygı Envanteri (STAI-S, STAI-T) [18], Modifiye Dental Anksiyete Skalası (MDAS) [19,20] ve Vizüel Analog Skala (VAS) kullanıldı. STAI ölçeği 20 maddelik iki alt formdan oluşmakta olup 20–80 arasında değişen puanlar yüksek kaygıyı yansıtmaktadır [18]. MDAS toplam 5 sorudan oluşmakta ve 5–25 arası skor

vermektedir; 19 ve üzeri değerler şiddetli anksiyeteyi göstermektedir [19,20]. VAS ise 10 cm'lik çizgi üzerinde 0="hiç ağrı yok" ve 10="dayanılmaz ağrı" ifadeleri ile ölçüm sağlamaktadır.

Tüm ölçekler üç zaman diliminde uygulandı: cerrahi öncesi (T0), cerrahi sonrası (T1) ve postoperatif 10. gün (T2). Ek olarak T0'da STAI-T formu da dolduruldu. Demografik bilgiler, vital parametreler (nabız, kan basıncı, oksijen satürasyonu) standart cihazlarla kaydedildi.

İstatistiksel Analiz

Örneklem büyüklüğü, G*Power (v3.1) programı kullanılarak, α=0,05, güç (1-β)=0,80 ve orta düzey etki büyüklüğü (d=0,5) varsayılarak hesaplanmış ve her grup için en az 34 birey gerekli bulundu.

Veriler SPSS 24.0 yazılımı ile analiz edildi. Tanımlayıcı istatistiklerin yanı sıra, ikili karşılaştırmalarda Paired Sample t testi, çoklu ölçümlerde Repeated Measures testi ve Bonferroni düzeltmesi kullanıldı. Gruplar arası karşılaştırmalarda Independent Samples t testi ve Pearson Ki-kare testi uygulandı. Anlamlılık düzeyi $p<0,05$ olarak kabul edildi.

Bulgular

Çalışmaya toplam 80 birey (24 erkek, %30; 56 kadın, %70) dahil edilmiştir. Katılımcıların yaşları 18 ile 65 arasında değişmekte olup ortalama yaş 39,51±13,78 yıl olarak saptanmıştır. Katılımcıların %25'i sigara, %12,5'i alkol kullanmakta; %21,2'si sistemik hastalık öyküsü, %23,8'i ise sürekli ilaç kullanımı bildirmiştir. En son diş hekimi ziyaret nedeni olarak en sık kontrol (%42,5) ve kanama (%21,3) bildirilmiştir. Hastaların %53,8'ine son işlem olarak diş taşı temizliği uygulanmış, %12,5'ine cerrahi girişim yapılmıştır.

Ağız sağlığı öz değerlendirme skorları incelendiğinde, katılımcıların kendi sağlıklarına verdikleri ortalama skor 6,41±1,48 olarak belirlenmiştir. Gruplar arasında bu değerler açısından istatistiksel olarak anlamlı farklılık bulunmamıştır ($p>0,05$).

Vital bulgular değerlendirildiğinde, her iki grupta da tedavi öncesi ve sonrası sistolik/diyastolik kan basınçları, nabız ve satürasyon değerlerinde anlamlı değişim izlenmemiştir ($p>0,05$). Ancak tedavi sonrası satürasyon ölçümleri görsel bilgilendirme yapılan grupta anlamlı olarak daha yüksek bulunmuştur ($p=0,010$).

Table 1.

	Görsel Bilgilendirme Yapılan Grup (n=40)		**Sözlü Bilgilendirme Yapılan Grup (n=40)**		
	Mean±SD	**Min-Max (Median)**	**Mean±SD**	**Min-Max (Median)**	**[b]p**
Tedavi Öncesi MDAS	8,58±3,37	5-19 (7)	10,08±3,52	5-16 (9)	**0,055**
Tedavi Sonrası MDAS	7,38±2,38	5-18 (7)	8,78±2,92	5-16 (9)	**0,021***
10.Gün MDAS	6,9±2,05	5-13 (6)	8,5±2,85	5-16 (8)	**0,005****
Tedavi Öncesi STAI-S	34,1±7,92	26-51 (31)	37,5±9,52	20-55 (38,5)	**0,086**
Tedavi Sonrası STAI-S	32,2±7,17	21-53 (31)	35±8,88	20-54 (34)	**0,124**
10.Gün STAI-S	31,03±6,05	20-52 (30)	33,7±9,96	20-54 (33,5)	**0,151**
STAI-T	34,00±8,62	23-58 (30,5)	39,6±9,98	24-70 (36,5)	**0,009****

[b]Indepedent Sample T Testi *p<0,05 **p<0,01

Anksiyete ölçekleri incelendiğinde, görsel bilgilendirme yapılan grupta MDAS değerleri tedavi sonrasında (7,38±2,38) ve 10. günde (6,9±2,05) anlamlı olarak daha düşük bulunmuştur (p=0,021 ve p=0,005). Benzer şekilde STAI-T skorları sözlü bilgilendirilen grupta daha yüksek saptanmıştır (39,6±9,98 vs. 34,0±8,62; p=0,009). STAI-S değerlerinde ise gruplar arasında anlamlı farklılık gözlenmemiştir (p>0,05).

Table 2.

	1.Gün		**3.Gün**		**10. Gün**		
	Mean ±SD	**Min-Max (Median)**	**Mean ±SD**	**Min-Max (Median)**	**Mean ±SD**	**Min-Max (Median)**	**[d]p**
Görsel Bilgilendirme Yapılan Grup VAS	4±1,66	0-9 (4)	1,73±1,47	0-9 (1)	0,18±0,45	0-2 (0)	**0,001****
Sözlü Bilgilendirme Yapılan Grup VAS	4±2,72	0-9 (4)	2,63±2,36	0-9 (2,5)	0,65±1,19	0-5 (0)	**0,001****

[d]Repetead Measure Test **p<0,01

Ağrı düzeyleri değerlendirildiğinde, başlangıçta VAS skorları benzer bulunmuştur (p>0,05). Üçüncü gün ağrı takibinde sözlü bilgilendirme yapılan grupta VAS değerleri anlamlı derecede yüksek saptanmıştır (2,63±2,36 vs. 1,73±1,47; p=0,044). Onuncu günde de sözlü bilgilendirilen grupta ağrı skorları daha yüksektir (0,65±1,19 vs. 0,18±0,45; p=0,020).

Korelasyon analizlerinde, tedavi öncesi VAS skorları ile nabız değerleri arasında (r=0,336; p<0,01) ve tedavi sonrası VAS skorları ile nabız değerleri arasında (r=0,236; p<0,05) pozitif ilişki saptanmıştır. Ayrıca tedavi öncesi VAS skorları ile 1., 3. ve 10. gün ağrı skorları arasında anlamlı pozitif korelasyon bulunmuştur.

Tartışma

Bu çalışmada mukogingival cerrahi öncesi farklı bilgilendirme yöntemlerinin hastaların anksiyete ve ağrı düzeyleri üzerindeki etkileri değerlendirildi. Güncel literatürde periodontal cerrahi öncesi anksiyete düzeyinin postoperatif ağrı ve hasta deneyimi ile yakından

ilişkili olduğu ve farklı bilgilendirme yaklaşımlarının bu süreci anlamlı şekilde etkileyebileceği bildirilmiştir (34,35). Elde edilen bulgular, görsel bilgilendirme yapılan grupta hem dental anksiyetenin hem de postoperatif ağrı skorlarının belirgin şekilde daha düşük olduğunu ortaya koymuştur. Özellikle MDAS değerlerinin tedavi sonrası ve 10. günde anlamlı olarak azalması, görsel bilgilendirmenin hastaların anksiyete yönetiminde önemli bir araç olabileceğini göstermektedir.

Literatürde dental anksiyetenin tedavi sürecine olumsuz etkileri iyi bilinmektedir. Yüksek anksiyeteye sahip hastaların tedavi uyumlarının düşük, ağrı algılarının ise daha yüksek olduğu pek çok araştırmada vurgulanmıştır [21–23]. Bizim çalışmamızda da benzer şekilde, sözlü bilgilendirme yapılan grupta hem STAI-T hem de postoperatif VAS değerleri daha yüksek bulunmuştur. Bu sonuç, anksiyetesi yüksek bireylerin cerrahi süreçte daha fazla ağrı hissettikleri yönündeki verilerle uyumludur [24,25].

Bilgilendirme yöntemlerinin hasta psikolojisi üzerindeki rolü çeşitli çalışmalarda tartışılmıştır. Kent [26], hastalara verilen bilgilendirmenin belirsizlik duygusunu azalttığını ve öngörülebilirliği artırarak kaygıyı düşürdüğünü belirtmiştir. Krouse [27] ve Gagliano [28] ise görsel bilgilendirmenin, özellikle video ve fotoğraf materyallerinin, hastaların bilgi düzeyini artırmada ve kaygıyı azaltmada etkili olduğunu göstermiştir. Bizim bulgularımız da bu sonuçları destekler niteliktedir; zira görsel bilgilendirme yapılan grupta hem kısa vadede hem de 10. gün takibinde anksiyete değerlerinin düşük kalması bu yöntemin kalıcı bir etki sağlayabileceğini düşündürmektedir.

Çalışmamızda ayrıca, vital bulgular açısından gruplar arasında anlamlı bir fark bulunmamakla birlikte, tedavi sonrası satürasyon düzeylerinin görsel bilgilendirme yapılan grupta daha yüksek olması dikkat çekicidir. Bu durum, anksiyetenin fizyolojik parametreler üzerindeki etkisini desteklemektedir. Önceki çalışmalar, dental anksiyetenin kalp atım hızı ve oksijen satürasyonu gibi parametrelerde dalgalanmalara yol açabileceğini bildirmiştir [29,30].

Bulgularımız, bilgilendirme yöntemlerinin yalnızca psikolojik değil, aynı zamanda fizyolojik iyileşme sürecine de katkı sağlayabileceğini göstermektedir. Özellikle 3. ve 10. gün VAS skorlarının görsel bilgilendirme yapılan grupta anlamlı şekilde düşük olması, hastaların postoperatif dönemde daha konforlu bir iyileşme süreci yaşadıklarını ortaya koymaktadır. Bu sonuç, Appukuttan [31] tarafından da vurgulandığı gibi, anksiyete kontrolünün postoperatif ağrı yönetiminde kritik rol oynadığını göstermektedir.

Çalışmamızın güçlü yönleri arasında randomizasyon yöntemi ile hasta dağılımının sağlanması ve geçerliliği kanıtlanmış ölçeklerin (MDAS, STAI, VAS) kullanılması sayılabilir. Bununla birlikte bazı sınırlılıklar da bulunmaktadır. Öncelikle örneklem sayısı nispeten sınırlıdır ve tek merkezde yürütülmüştür. Ayrıca yalnızca fotoğraf tabanlı görsel bilgilendirme yöntemi kullanılmış, video veya animasyon gibi alternatif görsellerin etkisi değerlendirilmemiştir. İleride yapılacak daha geniş örneklemli ve farklı görsel yöntemleri karşılaştıran çok merkezli çalışmalar, bu alanda daha kapsamlı sonuçlar ortaya koyacaktır.

Sonuç olarak, bu çalışma görsel bilgilendirmenin mukogingival cerrahi geçiren hastalarda hem anksiyete hem de postoperatif ağrı düzeylerini azaltmada etkili olduğunu göstermektedir. Bu bulgular, klinik uygulamalarda hasta bilgilendirme protokollerine görsel materyallerin eklenmesinin hasta konforunu artırabileceğini ve tedaviye uyumu güçlendirebileceğini düşündürmektedir.

Sonuç

Bu çalışma, mukogingival cerrahi geçiren hastalarda farklı bilgilendirme yöntemlerinin anksiyete ve ağrı düzeyleri üzerindeki etkilerini değerlendirmiştir. Bulgular, görsel bilgilendirme yönteminin sözlü bilgilendirmeye kıyasla dental anksiyete skorlarını anlamlı biçimde azalttığını ve postoperatif dönemde ağrı algısını düşürdüğünü göstermektedir. Özellikle MDAS skorlarının tedavi sonrası ve 10. günde daha düşük olması ile 3. ve 10. gün VAS değerlerindeki azalma, görsel bilgilendirmenin hasta konforu ve tedaviye uyum açısından önemli katkılar sağladığını ortaya koymuştur.

Bununla birlikte, vital bulgular açısından anlamlı farklılık gözlenmemiştir. Ancak tedavi sonrası oksijen satürasyonu değerlerinin görsel bilgilendirme grubunda daha yüksek bulunması, bu yöntemin fizyolojik yanıtlar üzerinde de dolaylı bir etki yaratabileceğini düşündürmektedir.

Sonuç olarak, mukogingival cerrahi öncesi bilgilendirme sürecinde görsel materyallerin (fotoğraf, video, animasyon) kullanılması, hastaların kaygılarını azaltarak daha konforlu bir cerrahi deneyim yaşamalarına katkıda bulunabilir. Klinik uygulamalarda rutin hasta bilgilendirme protokollerine görsel materyallerin eklenmesi, periodontal cerrahi tedavilerde hem hasta memnuniyetini hem de tedavi başarısını artırabilecek değerli bir yaklaşımdır.

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Research Article

Evaluation of Information, Content, Quality and Readability of Information on the Internet About Dental Implants

İpek Alazcıoğlu[1], Figen Öngöz Dede[1*], Süleyman Kutalmış Büyük[2], Varol Çanakçı[1]

[1]Ordu University, Faculty of Dentistry, Department of Periodontology, Ordu, Turkey
[2]Ordu University, Faculty of Dentistry, Department of Orthodontics, Ordu, Turkey.

*Corresponding author: figen_ongoz@hotmail.com

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İpek Alazcıoğlu, Figen Öngöz Dede, Süleyman Kutalmış Büyük, Varol Çanakçı

Abstract

Objective: The aim of this study was to evaluate the quality, reliability and readability of the information and content about dental implants on the Internet.

Material and Methods: The most searched terms on the internet were determined as "dental implant" and "tooth implant" using the Google Trends application. A total of 220 websites were scanned according to search terms using Google and Yahoo search engines, and 45 websites matching the criteria were included in the study. These websites were evaluated according to the DISCERN questionnaire, JAMA criteria, and the FRES and FKGL readability formula. ANOVA, Kruskal Wallis, Mann-Whitney U and Fischer's exact tests were used for comparisons between data. $P<0.05$ was considered to be statistically significant.

Results: It was determined that 47%(n=21) by private dental clinics, 33%(n=15) by health sites, and 20%(n=9) by dentists of the 45 websites were shared. Health websites had significantly higher DISCERN scores than other websites($P\leq0.05$). When evaluated according to JAMA criteria, it was determined that the freshness criteria of the websites were the least (42%, n=19) and the patent rights criteria were the most(82%, n=37). Only seven websites had the HONcode seal detected. The average FRES and FKGL were 55.94 and 10.09, respectively, There was no statistically significant difference related to FRES and FKGL scores between groups ($P>0.05$).

Conclusions: The quality and readability of web-based information about dental implants were poor and insufficient. There is a need for websites that offer high-quality data with better readability for dental implant patients.

Keywords: Content, Dental implant, Information quality, Internet, Readability.

Özet

Amaç: Bu çalışmanın amacı internetteki diş implantları ile ilgili bilgi ve içeriklerin kalitesini, güvenilirliğini ve okunabilirliğini değerlendirmektir.

Gereç ve Yöntemler: İnternette en çok aranan terimler Google Trends uygulaması kullanılarak "dental implantı" ve "tooth implantı" olarak belirlendi. Google ve Yahoo arama motorları kullanılarak toplam 220 web sitesi arama terimlerine göre tarandı ve kriterlere uyan 45 web sitesi çalışmaya dahil edildi. Bu web siteleri DISCERN anketi, JAMA kriterleri ve FRES ve FKGL okunabilirlik formülüne göre değerlendirildi. Veriler arasındaki karşılaştırmalarda ANOVA, Kruskal Wallis, Mann-Whitney U ve Fischer'in kesin testleri kullanıldı. $P<0.05$ istatistiksel olarak anlamlı kabul edildi.

Bulgular: 45 sitenin %47'sinin (n=21) özel diş klinikleri, %33'ünün (n=15) sağlık siteleri ve %20'sinin (n=9) diş hekimleri tarafından paylaşıldığı belirlendi. Sağlık web sitelerinin DISCERN puanları diğer web sitelerine göre anlamlı derecede yüksekti ($P\leq0.05$). JAMA kriterlerine göre değerlendirildiğinde web sitelerinin güncellik kriterlerinin en az (%42, n=19), en fazla ise patent hakları kriterlerinin (%82, n=37) olduğu belirlendi. Yalnızca yedi web sitesinde HONcode mührü tespit edildi. Ortalama FRES ve FKGL sırasıyla 55.94 ve 10.09 idi. Gruplar arasında FRES ve FKGL skorları açısından istatistiksel olarak anlamlı fark yoktu ($P>0.05$).

Sonuç: Dental implantlara ilişkin web tabanlı bilgilerin kalitesi ve okunabilirliği zayıf ve yetersizdi. Diş implantı hastaları için daha iyi okunabilir, yüksek kaliteli veriler sunan web sitelerine ihtiyaç vardır.

Anahtar Kelimeler: İçerik, Diş implantı, Bilgi kalitesi, İnternet, Okunabilirlik.

Introduction

With the increasing access opportunities in today's global world, the internet has become one of the most important and frequently used information sources about health (1,2). In the USA, internet-based health information has become the source where patients get information about treatments after receiving doctor's recommendations (2). When patients search for information about dental health or treatment on the Internet, they primarily use websites and see the Internet as a reliable source for patient information about dental practices, treatment procedures, risks, benefits, and alternatives (3). Due to the uncontrollable nature of the

Internet, the accuracy of the data available on the Internet is still debated (4). In addition, the accuracy and quality of health information on the internet also affects patients' compliance with treatment and their communication with their doctors (5). Several methods have been developed to objectively evaluate the quality of health information to minimize the possible disadvantages of the use of the Internet for informational purposes (6). A study evaluating the readability of internet-based health information noted that poor readability can limit the usability of websites (7).

Tooth loss is one of the most important problems with a high incidence in many countries, and it also, partial or complete tooth loss affects the quality of life by negatively affecting the physiological, biological and social status of the person (8,9). Today, dental implants with clinically proven long-term success are seen as the most popular treatment option preferred to replace lost teeth (10–12). Moreover, Chestnutt and Reynolds (13) determined that dental implants were the third most common topic in dentistry on the Internet.

The Internet is seen as a reliable source for informing patients about dental practices, treatment procedures, risks, benefits and alternatives (3). However, despite the increasing on the Internet, clear information about the reliability, readability and quality of information about dental implants is not available on websites. Therefore, this study aimed to evaluate the quality, reliability and readability of the information and content available about dental implants on the Internet.

Materials and Methods

Since our study consists of publicly available data that does not contain any personal data, as in similar studies, ethics committee approval and informed consent form are not required. This study was conducted in full compliance with the World Medical Association Declaration of Helsinki.

The search terms for this study were determined using Google Trends (14). Google Trends was used to define the most popular terms about dental implants during the past 12 months (July 2021 to July 2022). The top two search terms related to the dental implant ("Dental implant", and "Tooth implant" were further analyzed. The related terms were searched in two widely used search engines: Google (Google LLC, Mountain View, CA, USA), and Yahoo (Yahoo, Sunnyvale, CA, USA). The search was performed in July 2022 by the virtual private network (VPN) in the USA by a single researcher (IA). VPN extends a private network across

a public network, allowing users to send and receive data over shared or public networks as if their devices were directly connected to the private network. Since this data is not based in the US, the search was performed using a suitable VPN to simulate the virtual environment of US citizens. The top 50 websites for each keyword from each search engine were evaluated.

The links to scientific articles, video links, book links, social media posts, advertisement links, and irrelevant website links were excluded from the study. Only websites in English were analyzed.

Quality Evaluation

Websites were evaluated using the DISCERN tool, Journal of the American Medical Association (JAMA), and Health on the Net code (HONcode) criteria.

The DISCERN instrument is the first standard index to evaluate the quality and reliability of written health information 15. The instrument consists of 16 questions each of which is rated on a five-point scale from 1 (low quality) to 5 (absolute agreement). The first eight questions are designed to evaluate reliability, the next seven questions assess treatment options, and the last question is designed to evaluate the overall quality of the website based on the answers to the first 15 questions (Table 1). The total DISCERN scores are classified as 16–26 very poor, 27–38 poor, 39–50 fair, 51–62 good, and >63 excellent (16).

JAMA benchmark criteria are used to evaluate the reliability and accuracy of information on the Internet. The benchmark consists of four parts, of which the first is Authorship; the identification of the information of the contributors and authors, second is Attribution; the existence of all reference sources cited, third is Disclosure; website ownership, financing, advertising, and conflicts of interest, and the fourth is Currency; the existence and timeliness of the websites (17). The scoring system ranges from 0 to 4. Evaluations are made by giving 1 point to each item that meets the criteria.

HONcode is the most commonly used trust seal signifying quality health information on the Internet. This organization evaluates health-related websites against appropriate and transparent information standards using eight criteria. If the website meets these standards, it is eligible to receive HONcode certification for one year (18).

Table 1. DISCERN instrument questions with the mean (standard deviation [SD]) score of each question

Each question is rated accordingly **1 2 3 4 5** **No Partially Yes**	**Private dental clinics (n=21)**	**Health sites (n=15)**	**Dentists (n=9)**	**Total (n=45)**
Section 1 (questions 1–8): *The reliability of the publication*				
1. Are the aims clear?	4.02(0.93)	4.02(0.93)	3.97(0.95)	4.02(0.91)
2. Does it achieve its aims?	3.91(0.98)	3.91(0.98)	3.83(1.01)	3.91(0.97)
3. Is it relevant?	4.00(0.91)	4.00(0.91)	3.94(0.94)	4.00(0.90)
4. Is it clear what sources of information were used to compile the publication (other than author/producer)?	2.64(1.66)	2.73(1.68)	2.57(1.67)	2.68(1.67)
5. Is it clear when the information used or reported in the publication was produced?	2.66(1.72)	2.75(1.74)	2.63(1.73)	2.71(1.74)
6. Is it balanced or unbiased?	2.68(1.00)	2.70(1.02)	2.63(1.00)	2.71(1.01)
7. Does it provide details of additional sources of support and information?	2.20(1.44)	2.25(1.43)	2.08(1.38)	2.22(1.42)
8. Does it refer to areas of uncertainty?	2.25(1.10)	2.22(1.10)	2.23(1.11)	2.24(1.09)
Section 2 (questions 9–15): *The quality of the information on treatment choices*				
9. Does it describe how each treatment works?	3.86(1.15)	3.86(1.15)	3.74(1.22)	3.88(1.15)
10. Does it describe the benefits of each treatment?	3.98(1.15)	3.98(1.15)	3.89(1.20)	4.00(1.14)
11. Does it describe the risks of each treatment?	3.41(1.45)	3.38(1.43)	3.37(1.46)	3.42(1.43)
12. Does it describe what would happen if no treatment is used?	3.16(1.18)	3.11(1.19)	3.11(1.16)	3.13(1.17)
13. Does it describe how treatment choices affect the overall quality of life?	3.36(1.08)	3.30(1.07)	3.26(1.07)	3.33(1.08)
14. Is it clear that there may be more than one possible choice of treatment?	2.98(1.32)	2.93(1.32)	2.97(1.34)	2.95(1.31)
15. Does it provide support for shared decision-making?	3.25(1.01)	3.23(1.00)	3.23(1.09)	3.24(1.00)
Section 3 (question 16): *Overall quality rating of the publication*				
16. This question is rated accordingly: 1 2 3 4 5 Low Moderate High Serious or extensive shortcomings Potentially important but no serious shortcomings Minimals shortcomings	3.02(1.19)	3.00(1.18)	2.97(1.25)	3.02(1.17)

Data are expressed as the mean ± standard deviation.

Evaluation of Readability Level

The readability levels of the websites were evaluated with Flesch Reading Ease Score (FRES) and Flesch–Kincaid Grade Level (FKGL) scores (19). A 200–500 word summary taken from a text is transferred to an online FRES calculator (www.readabilityformulas.com). The maximum score achievable is 100. Scores between 90 and 100 reflect data that people aged 10-11 can easily understand. Score scales range from 80 to 89 for easy, 70 to 79 for medium, 60 to 69 for standard, 50 to 59 for quite difficult, 30 to 49 for difficult, and 0 to 29 for very confusing 19. The FGKL scores have been determined using the same application calculator. FKGL represents the years of education required to understand text context and reflects a readability score corresponding to the US education grade level (20).

Statistical Analysis

Statistical analysis program (SPSS Inc., version 20 for Windows; Chicago, IL, USA) was used to analyze all data. All data are expressed as mean ± standard deviation (SD), median (minimum-maximum) and frequencies (percentages). Intergroup comparisons analysing the effect of authorship were performed by one-way analysis of variance (ANOVA) for normally distributed data, and by the Kruskal–Wallis test for non-normally distributed data. Fischer's exact test was used to compare JAMA benchmarks between the groups.

Table 2. Comparison of DISCERN, FRES, FKGL scores among the groups.

Parameters	Private dental clinics (n=21)	Health sites (n=15)	Dentists (n=9)	*p*	Post-hoc test		
					1	2	3
DISCERN Scores							
Section 1	20.76±5.74	31.00±7.16	22.44±9.19	**0.003***,¶	**0.000***,†	0.073†	0.928†
Section 2	23.14±7.25	26.13±5.38	22.3±7.48	0.312‡	0.196§	0.188§	0.764§
Total Mean (Section1& 2)	43.90±1.10	57.13±11.52	44.78±16.21	**0.010***,‡	**0.004***,§	**0.027***,§	0.865§
Section 3 (Q16)	2.81±1.25	3.40±0.91	2.89±1.36	0.316‡	0.144§	0.307§	0.866§
FRES	54.08±10.38	57.16±11.22	58.28±6.19	0.494‡	0.368§	0.793§	0.299§
FKGL	10.30±2.41	10.01±2.72	9.72±1.60	0.821‡	0.720§	0.774§	0.544§

Data are expressed as the mean ± standard deviation. **P*<0.05 was considered to be statistically significant.
FRES, Flesch Reading Ease Score; FKGL, Flesch–Kincaid Grade Level.
† Mann-Whitney U test; ‡ ANOVA test; § LSD test;¶ Kruskal Wallis test.
1; Comparison of Health Websites and Private Dental Clinics
2; Comparison of Health Webites and Dental Professionals
3; Comparison of Dental Professionals and Private Dental Clinics

Table 3. Comparison of JAMA benchmark scores among the groups

JAMA benchmarks	Private dental clinics (n=21)	Health sites (n=15)	Dentists (n=9)	*p*
Authorship				
Yes	8	7	6	NS
No	13	8	3	
Attribution				
Yes	10	7	4	NS
No	11	8	5	
Disclosure				
Yes	19	10	8	NS
No	2	5	1	
Currency				
Yes	11	3	5	NS
No	10	12	4	

Abbreviations: NS, not significant; *p*, p-value (Fisher exact test)

Results

After applying exclusion and inclusion criteria, a total of 45 websites were eventually identified (Figure 1). According to the distribution of sources of the websites included in the study, 45 websites were divided into 3 groups; 21 from private dental clinics (47%), 15 from health sites (33%), and 9 from dentists (20%). Among all websites, only seven had the HONcode seal (15.5%).

Regardless of authorship and ownership, 44.3% (n = 20) of the websites had very poor or poor quality, whereas only 13.3% (n = 6) were excellent according to DISCERN criteria (Figure 2).

The overall scores of each instrument are shown in Table 2. The health websites (57.13±11.52) had significantly higher DISCERN scores than those of private dental clinics (43.90±1.10) and dental professionals (44.78±16.21) ($P < 0.05$). Among the scores for each DISCERN item, professional organization websites obtained the highest scores in all questions. Health websites had significantly higher DISCERN (section 1) and total mean DISCERN (section 1 + section 2) scores ($P<0.05$).

When we examined the pairwise comparisons of DISCERN (section 1), it was found that health websites were statistically significantly higher than private dental clinics ($P<0.05$). When we analyzed the total DISCERN (section 1+ section 2) pairwise comparisons, it was determined that health websites were statistically significantly higher than private dental clinics and dental professionals ($P<0.05$).

While the average FRES and FKGL scores of all websites were 55.94 and 10.09, respectively, the websites were found to be at the standard and very difficult readability level according to the FRES score (Figures 3,4). There was no statistically significant difference in FRES and FKGL scores between groups ($P>0.05$) (Table 2).

Table 3 shows the JAMA benchmark scores between the groups. There was no statistically significant difference between various Authorships, Attribution, Disclosure, and Currency categories between all groups ($P<0.05$). It was determined that the internet sites evaluated according to JAMA criteria had the least up-to-dateness criteria (n=19; 42%) and the highest number of patent rights criteria (n=37; 82%) (Figure 5).

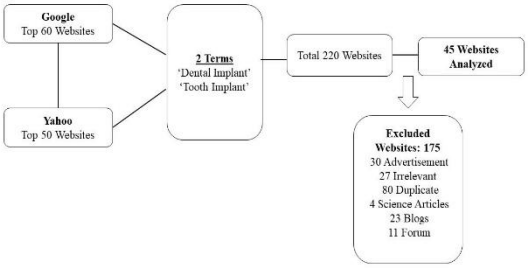

Figure 1. Flowchart diagram of Internet search

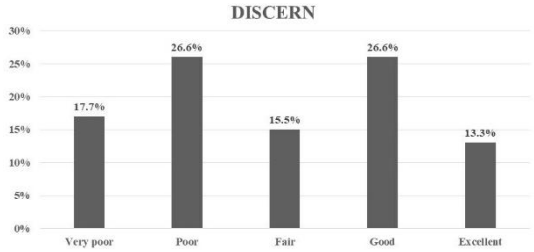

Figure 2: Distribution of DISCERN scores of analyzed websites

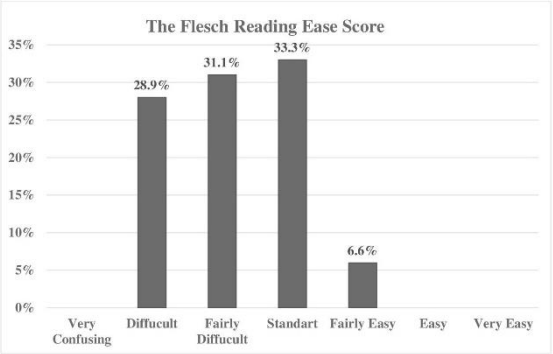

Figure 3: Flesch Reading Ease Score (FRES) of analyzed websites

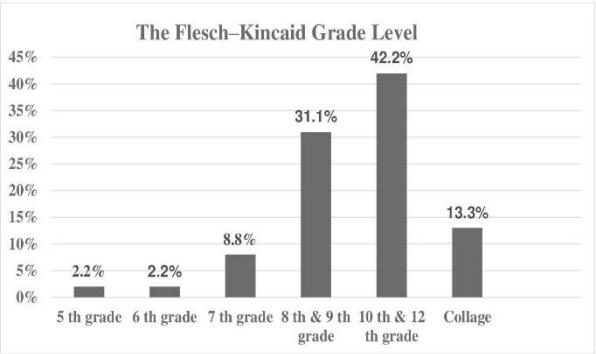

Figure 4: Flesch–Kincaid Grade Level (FKGL) of analyzed websites

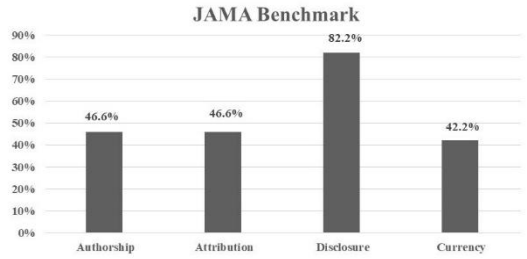

Figure 5: JAMA benchmark scores of analyzed websites

Discussion

Missing teeth can affect the quality of life of the individual and cause functional deterioration related to chewing and aesthetics (21). Nowadays, the treatment of missing teeth with implant-supported restorations is becoming a widely accepted treatment approach (22). The fact that a large part of the world's population now has internet access and with the developing

technology, the Internet is becoming the primary source of information that patients commonly use to learn more about health (23). However, despite the increasing data on the Internet, no study has been found that researches the accuracy, reliability, readability and general quality of the information on the websites that provide information about dental implants. This is the first study to evaluate the reliability, quality, and readability of websites describing dental implants.

The Internet is an easy-to-access information platform that people use to access information. It has been observed that search engines such as Yahoo and Bing are used together with Google in studies conducted to evaluate the quality of Internet information (24,26). As of 2022, it has been determined that the most used search engine in the United States and the world is Google in the 1st place and Yahoo in the 9th place (Similarweb, 2022). Based on these data, we used Google and Yahoo search engines in our study. Two search terms were defined with the help of Google Trends, which shows the most used keywords in online searches related to dental implants. For each keyword, Google (60) and Yahoo (50) websites were evaluated for each search engine. Our search strategy including exclusion criteria, was applied similarly to previous studies (14,16).

Tools such as DISCERN and JAMA, which measure the reliability and quality of internet information, have been developed to distinguish between sites that offer quality and reliable content and sites that provide low-quality and false information (28,30). The DISCERN questionnaire is one of the most commonly used tools whose validity and reliability have been accepted nowadays (15).

Health websites performed best in DISCERN scores. While there was a difference in quality between DISCERN scores and resource groups, it was seen that health sites received significantly higher scores (57.13) than private dental clinics and dentists, especially according to the results of the total DISCERN questions. Similarly, Meade and Dreyer reported in a recent study that health sites get the highest DISCERN scores (16). This may be due to the fact that these websites are probably less biased and receive professional support.

Displaying the HONcode seal on a medical website means it provides clear, accessible and reliable information. However, it does not give clear information about the accuracy of

the information (24). In our study, only 7 of the 45 websites showed the HONcode seal. Likewise, in their study of Riordain and Hodgson evaluating the content and quality of website information on the treatment of oral ulcers, they found that only 4 of 54 websites contained the HONcode seal 31. A lack of widespread display of the HONcode seal may be due to the license renewal fee for the HONcode certificate since 2014 and the lack of awareness of the health-related website designers about the application process (24).

Only ten websites met all four JAMA criteria. The highest-rated JAMA criterion is disclosure (82.2%), while the lowest JAMA criterion is currency (42.2%). Similarly, in a recent study by Haque et al. on rheumatic disease, it was stated that the patent right criterion was high with 88% points. On the other hand, McMorrow and Millett, in their study on adult orthodontics, found that the patent right criterion got the lowest score with 31% points 24. The fact that the JAMA criteria got different scores in the studies may be due to the variability of the quality of the websites that share information on various subjects.

Text readability is an important criterion when assessing the quality of health information. In our study, the mean FRES score of all websites was found to be 55.94. The results of this study show that the readability of the content is 'fairly difficult'. The online information about the dental implant is beyond the recommended reading level for understanding. Also, the average FKGL score of all websites was 10.09. While our study showed that approximately 10 years of USA school education is required to properly understand the information provided, most patient-focused studies have emphasized the need for a grade 6 reading level (32,33).

The Internet is an important means of obtaining information that can strengthen communication between patients and physicians 34. A well-informed patient is more likely to comply with treatment (35). Chestnutt and Reynolds (2006) found that healthcare professionals are unsure of where to direct people for high-quality and reliable information. Fox and Duggan (2013) also found that people use a health-specific websites such as WebMD, as well as search engines such as Google, to obtain information. These data show that health professionals should be made aware of directing people to quality websites, and the number of health-specific websites should also be increased (36).

This study has several limitations. The limitations of this study are that the results are only valid for a limited population due to the evaluation of websites in English-only websites in the USA and that websites are evaluated by one researcher at a time. With the changes in the ranking and content of websites over time, the evaluation of quality and readability tools may also differ. As in other studies evaluating the reliability of the information on the Internet, this study also deals with current conditions at a time. But since the nature of the internet is dynamic, the level of data and information is constantly changing.

Conclusions

Our study shows that internet-based information in English about the dental implant is of poor quality and difficult to read. Dental professionals can prevent this negative situation by directing patients to websites shared by experts in the field, consisting of clear, short and clear words and sentences that comply with international quality standards. We also believe that it would be beneficial for healthcare professionals to create websites that contain clear, reliable and high-quality information about dental implants that are both independent of commercial interests and easy to understand by a patient.

Author Contributions

IA and FOD were responsible for study conception, design, drafted and critically revised the manuscript. IA and SKB were responsible for data management. The authors gave final approval and agreed to be accountable for all aspect of the work.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts Of Interest

The authors report no conflicts of interest related to this study.

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