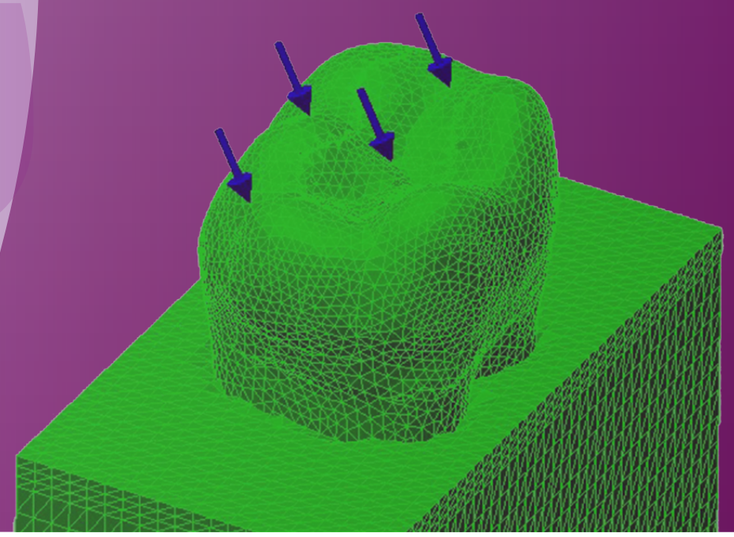
CUMHURIYET DENTAL JOURNAL

The Official Journal of Sivas Cumhuriyet University Faculty of Dentistry



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Cumhuriyet Dental Journal
The Official Journal of the Cumhuriyet University Faculty of Dentistry. The first issue was published in 1998 and journal's name was changed as Cumhuriyet Dental Journal in 2010. Issues are published quarterly since 2018.

Aims and Scope

Cumhuriyet Dental Journal (CDJ) is an international journal dedicated to the latest advancement of dentistry. The aim of this journal is to provide a platform for scientists and academicians all over the world to promote, share, and discuss various new issues and developments in different areas of dentistry.

CDJ publishes original research papers, reviews, and case reports within clinical dentistry, on all basic science aspects of structure, chemistry, developmental biology, physiology and pathology of relevant tissues, as well as on microbiology, biomaterials and the behavioral sciences as they relate to dentistry.

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INDEXING

CUMHURIYET DENTAL JOURNAL

AUTHOR GUIDELINE

Cumhuriyet Dental Journal (CDJ) is the Official Publication of the Cumhuriyet University, Faculty of Dentistry. CDJ accepts original experimental investigations and review articles concerning topics of clinical relevance to the general dental practitioner. Case reports and technique articles will be very critically reviewed in terms of interest to the general dental practitioner and the supporting data provided.

CDJ accepts articles in English. Submitting a paper to CDJ is free of charges. In addition, CDJ has not have article processing charges.

Frequency: Four times a year (March, June, September, and December)

CDJ is published using an open access publication model, meaning that all interested readers are able to freely access the journal online without the need for a subscription. Manuscripts will be reviewed by the editor, and at least two reviewers with expertise within the scope of the article.

Review Process

Double-Blind Peer Review Process

CDJ uses double-blind review, which means that both the reviewer and author identities are concealed from the reviewers, and vice versa, throughout the review process. Within this aim, the authors need to ensure that their manuscripts are prepared in a way that does not give away their identity. Editors will email selected Reviewers the title and abstract of the submission, as well as an invitation to log into the journal web site to complete the review. Reviewers enter the journal web site to agree to do the review, to download submissions, submit their comments, and select a recommendation.

The typical period of time allowed for reviews: 6 weeks which can be modified during the editorial process.

Reviewers will have access to the submission file only after agreeing to review it.

Language

The publication language is English. Authors whose native language is not English should obtain the assistance of an expert in English and scientific writing before submitting their manuscripts. Manuscripts that do not meet basic language standards will be returned pre-review. Authors are requested to submit their original manuscript and figures via the online submission and editorial system for Cumhuriyet Dental Journal. Using this online system, authors may submit manuscripts and track their progress through the system to publication. Reviewers can download manuscripts and submit their opinions to the editor. Editors can manage the whole submission/review/revise/publish process.

Manuscript Format and Style

General

Manuscript length depends on manuscript type. Paper dimensions should be 8.5 × 11 inches with 2.5 cm margins on all sides. Please use normal, plain font (12-point Times New Roman), justified and number all pages consecutively. Indent or space paragraphs.

Manuscript Types Accepted

Original Research Article: Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusions, Acknowledgements, References, Tables and Figure Legends

Review Articles: Although a Review article (particularly following a systematic review) may adhere to the format of the Original Research Article, both Review and Focus Articles need not contain Materials and Methods, Results or Discussion sections, and may instead employ other headings as relevant for the topic addressed.

Case Report: Title, Abstract, Introduction, Case Report, Discussion, Conclusions, Acknowledgements, References, Tables and Figure Legends

Manuscript Submission Procedure

Submission site

Manuscripts should be submitted online through http://dergipark.gov.tr/cumudj. Full instructions and support are available on the website, and a *user ID* and *password* can be obtained at the first visit. All parts of the manuscript (Main Document, Tables, Figures and Supplemental Information) must be available in an electronic format: Microsoft Word or generic RTF are recommended for text and tables; and TIFF or EPS for graphics (see under Figures).

ELEMENTS OF a MANUSCRIPT

1. Title Page

- ***Title page must be* uploaded apart from manuscript and should include;**
  - § -Title
  - § -Authors (first name, middle initial, surname) e.g. Burak Buldur, DDS, PhD,[a]
  - § -Authors' addresses (abbreviated) e.g.
- [a] Associate Professor Dr., Department of Pediatric Dentistry, Faculty of Dentistry, Cumhuriyet University, Sivas, Turkey.
- **ALL AUTHORS' ORCID NUMBERS** must be included
- **A running title**, not exceeding 50 letters and spaces
- Please write up to 5 keywords should be supplied according to **MESH**. (Turkish authors must add Turkish keywords via **http://www.bilimterimleri.com/**)
- Corresponding Author details including name, complete address, phone, fax, and e-mail must be added.

Main Document

The main document includes, in a single electronic file (Word/text file, not pdf).

2. Title and Abstract

- Should not exceed 300 words and should be presented under the following subheadings:
  Research Articles: Objectives, Materials and Methods; Results; Conclusions (Turkish authors should also add Turkish abstract as follows: Amaç, Gereç ve Yöntemler, Bulgular ve Sonuçlar)
  Reviews and Case Reports: Provide a short, nonstructured, 1-paragraph abstract that briefly summarizes the study.

3. Keywords

- Up to 5 keywords should be supplied according to **MESH**. (Turkish authors must also add Turkish keywords via **http://www.bilimterimleri.com/**)

4.Introduction

- This must be presented in a structured format, covering the following subjects, although not under subheadings: succinct statements of the issue in question; the essence of existing knowledge and understanding pertinent to the issue; and the aims and objectives of the research being reported.

5. Materials and methods

- The authors should describe the procedures and analytical techniques and identify names and sources of all commercial products e.g. magnetic attachment (Hyper Slim 5513, Hitachi Metals, Tokyo, Japan)
- Please add **ETHICS statement** and add decision number if any.

6. Results

- The authors should refer to appropriate tables and figures and report statistical findings.

7. Discussion

- The authors should discuss the results of the study also state the agreement with other studies and identify the limitations of the present study, and suggest areas for future research.

8. Conclusions

- The authors should concisely list conclusions that may be drawn from the research and do not simply restate the results.

9.Acknowledgements

- If the work was supported by a grant or any other kind of funding, supply the name of the supporting organization and the grant number.

11. Conflicts of Interest statement

- Specify any potential conflict of interests, or state no conflicts of interest.

11. References

- References must be identified in the body of the article with superscript Arabic numerals after punctuation marks. Please put reference number after in the case of " Author et al." in the main body of article instead of the end of the statement. (e.g. Author et al.[1])
- The complete reference list must be double spaced and in numerical order and should start on a separate page. Only references cited in the text should appear in the reference list.
- Unpublished data or personal communications are not accepted.

Examples for Journal reference style: (Author. Title. Journal Abbrev Year;Volume:Pages)

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

Examples for Book reference style:

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- All tables must be thoroughly discussed in the text of the manuscript.
- The authors should put one table to a page, each with a title and -number tables in order of mention using Arabic numerals.
- Tables must be uploaded at the end of the main text and for explanatory footnotes, symbols (*, #,**,##) must be used.

13. Figures

- The authors **must not** import the figures into the text and should be saved in jpeg format.
- All graphs, drawings, and photographs are considered Figures and should be numbered in sequence with Arabic numerals.
- Figures should be planned to fit the proportions of the printed page (width 17 cm) or one column (width 8 cm) and be legible at this size.

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- Colour and black-and-white photographs should be created and saved at a minimum of 300 dots per inch (dpi).
- Please name each electronic image file. For example, a Figure 1 in jpeg format should be named fig 1. Multipart figures must be clearly identifiable by the file names: fig 1A, fig 1B, fig 1C, etc.

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- The authors should list together on a separate page and include key for symbols or abbreviations used in Figures.

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OPEN ACCESS POLICY

An old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, for the sake of inquiry and knowledge. The new technology is the internet. The public good they make possible is the world-wide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students, and other curious minds. Removing access barriers to this literature will accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge.

For various reasons, this kind of free and unrestricted online availability, which we will call open access, has so far been limited to small portions of the journal literature. But even in these limited collections, many different initiatives have shown that open access is economically feasible, that it gives readers extraordinary power to find and make use of relevant literature, and that it gives authors and their works vast, readership and impact. To secure these benefits for all, we call on all interested institutions and individuals to help open up access to the rest of this literature and remove the barriers, especially the price barriers, that stand in the way. The more who join the effort to advance this cause, the sooner we will all enjoy the benefits of open access.

The literature that should be freely accessible online is that which scholars give to the world without expectation of payment. Primarily, this category encompasses their peer-reviewed journal articles, but it also includes any unreviewed preprints that they might wish to put online for comment or to alert colleagues to important research findings. There are many degrees and kinds of wider and easier access to this literature. By "open access" to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited.

While the peer-reviewed journal literature should be accessible online without cost to readers, it is not costless to produce. However, experiments show that the overall costs of providing open access to this literature are far lower than the costs of traditional forms of dissemination. With such an opportunity to save money and expand the scope of dissemination at the same time, there is today a strong incentive for professional associations, universities, libraries, foundations, and others to embrace open access as a means of advancing their missions. Achieving open access will require new cost recovery models and financing mechanisms, but the significantly lower overall cost of dissemination is a reason to be confident that the goal is attainable and not merely preferable or utopian.

To achieve open access to scholarly journal literature, we recommend two complementary strategies.

I. Self-Archiving: First, scholars need the tools and assistance to deposit their refereed journal articles in open electronic archives, a practice commonly called, self-archiving. When these archives conform to standards created by the Open Archives Initiative, then search engines and other tools can treat the separate archives as one. Users then need not know which archives exist or where they are located in order to find and make use of their contents.

II. Open-access Journals**:** Second, scholars need the means to launch a new generation of journals committed to open access, and to help existing journals that elect to make the transition to open access. Because journal articles should be disseminated as widely as possible, these new journals will no longer invoke copyright to restrict access to and use of the material they publish. Instead they will use copyright and other tools to ensure permanent open access to all the articles they publish. Because price is a barrier to access, these new journals will not charge subscription or access fees, and will turn to other methods for covering their expenses. There are many alternative sources of funds for this purpose, including the foundations and governments that fund research, the universities and laboratories that employ researchers, endowments set up by discipline or institution, friends of the cause of open access, profits from the sale of add-ons to the basic texts, funds freed up by the demise or cancellation of journals charging traditional subscription or access fees, or even contributions from the researchers themselves. There is no need to favor one of these solutions over the others for all disciplines or nations, and no need to stop looking for other.

Open access to peer-reviewed journal literature is the goal. Self-archiving (I.) and a new generation of open-access journals (II.) are the ways to attain this goal. They are not only direct and effective means to this end, they are within the reach of scholars themselves, immediately, and need not wait on changes brought about by markets or legislation. While we endorse the two strategies just outlined, we also encourage experimentation with further ways to make the transition from the present methods of dissemination to open access. Flexibility, experimentation, and adaptation to local circumstances are the best ways to assure that progress in diverse settings will be rapid, secure, and long-lived.

The Open Society Institute is committed to providing initial help and funding to realize this goal. It will use its resources and influence to extend and promote institutional self-archiving, to launch new open-access journals, and to help an open-access journal system become economically self-sustaining. While the Open Society Institute's commitment and resources are substantial, this initiative is very much in need of other organizations to lend their effort and resources.

We invite governments, universities, libraries, journal editors, publishers, foundations, learned societies, professional associations, and individual scholars who share our vision to join us in the task of removing the barriers to open access and building a future in which research and education in every part of the world are that much morefree to flourish. Submitting a paper to CDJ is free of charges. In addition, CDJ has not have article processing charges.

PLAGIARISM and ETHICS

CDJ aims to the highest standards with regard to research integrity and in particular the avoidance of plagiarism, including self-plagiarism. It is therefore essential that authors, before they submit a paper, particular attention should be paid When submitting a paper on CDJ, authors will be prompted as to whether they have read and agree to these guidelines before proceeding further with their submission. They will be asked specifically for an assurance that the paper contains no element of data fabrication, data falsification or plagiarism (including unacknowledged self-plagiarism). Authors are reminded that, where they draw upon material from another source, they must either put that material in the form of a quote, OR write it entirely in their own words (i.e. there is no 'middle way'). In both cases, they must explicitly cite the source, including the specific page number in the case of a quote or a particular point. **CDJ uses Ithenticate: Plagiarism Detection Software**

For the experimental, clinical and drug human studies, approval by ethical committee and statement on the adherence of the study protocol to the international agreements (Helsinki Declaration revised 2008) are required. In experimental animal studies, the authors should indicate that the procedures followed were in accordance with animal rights and they should obtain animal ethic committee approval. The Ethic Committee approval document should be submitted to the Cumhuriyet Dental Journal together with the manuscript.

The approval of the ethic committee, statement on the adherence to international guidelines mentioned above and that the patients' informed consent is obtained should be indicated in the "Materials and Methods" section and is required for case reports whenever data/media used could reveal identity of the patient. The declaration of the conflict of interest between authors, institutions, acknowledgement of any financial or material support, aid is mandatory for authors submitting manuscript and the statement should appear at the end of manuscript. Reviewers are required to report if any potential conflict of interest exists between reviewer and authors, institutions.

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2019; Volume:22 Issue:1

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Editorial

Cumhuriyet Dental Journal: A New Mission and Vision to Be a Global Journal

First issue of the Cumhuriyet Dental Journal (CDJ, formerly known as Journal of Cumhuriyet University Faculty of Dentistry) was published in 1998. It has been twenty years from the beginning of CDJ and the world and academia has changed during these years. We have made a very intense effort, especially in the last years, in order to follow the innovations and changes in the world and academia and to adapt them to CDJ. For this purpose, we have also made some changes in scope and vision of CDJ in the last year. CDJ currently aims to be an internationally known journal and makes every effort to achieve this aim.

As a result of our submissions, CDJ is currently indexed in internationally known SCOPUS, DOAJ and INDEX COPERNICUS and under evaluation for WEB of SCIENCE (ESCI). In 2018, the CDJ has received 172 submissions and has published 52 articles. These issues presented a wide range of high quality articles including original research articles, review and clinical case reports. CDJ has begun to publish quarterly since 2018. CDJ currently accepts articles in only English.

We hope all members of CDJ including Editors-in-Chief, Editorial Board members, authors, reviewers, and readers will help us consolidate the Cumhuriyet Dental Journal among our peers and spread it to the international community.

Editors-in-Chief, Prof. Ihsan Hubbezoglu and Assoc. Prof. Burak Buldur, would like to welcome our new prestigious Editorial Board members- Prof. John Nicholson from UK, Prof. Alessandro Leite Cavalcanti from Brasil, Prof. Zafer Cehreli from Turkey and USA, and Prof. Marco Tatullo from Italy.

We would like to thank all members of CDJ and wish Happy Readings and Happy New Year in 2019.

Editors-in-Chief

Prof. Ihsan Hubbezoglu

Assoc. Prof. Burak Buldur

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Editorial

The Editor-in-Chief's recommendation of this issue's article to readers;

INJURIES IN THE MAXILLOFACIAL COMPLEX AND ASSOCIATED FACTORS IN BRAZILIAN VICTIMS OF VIOLENCE: A CROSS-SECTIONAL STUDY

I am pleased to inform you that I have chosen this article by Laureno *et al.*[1] as Editor's Choice for first issue of 2019.

Violence is a major and ever-mounting problem throughout the world. The maxillofacial region is exposed to injuries due to its easily reachable, more prominent and unprotected location. Maxillofacial injuries can cause serious health problems, post-traumatic psychological effects or even death. To be informed about the prevalence of jaw-face injuries in victims of violence is important to evaluate the needs of health services and to minimize the consequences of aggression.

This article shows that physical aggression is the most frequent type of violence, with high occurrence of head and face injuries. Face injuries showed association with gender and number of lesions, both being more frequent among women.

Happy readings and have a great year with increasing academic interest in 2019!

Assoc. Prof. Burak Buldur

Editor-in-Chief

REFERENCE

1. Laureno ICC, Farias L, De Souza G, Alencar A, Cavalcanti AFC, De Alencar CRB, Cavalcanti AL. Injuries in The Maxillofacial Complex and Associated Factors in Brazilian Victims of Violence: A Cross-Sectional Study. Cumhuriyet Dent J 2019;22:1:3-10.

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Original research

INJURIES IN THE MAXILLOFACIAL COMPLEX AND ASSOCIATED FACTORS IN BRAZILIAN VICTIMS OF VIOLENCE: A CROSS-SECTIONAL STUDY

Isla Camilla Carvalho Laureano[1],
Lunna Farias[1],
Gláucia De Souza Abreu Alencar[2],
Alidianne Fábia Cabral Cavalcanti[1],
Catarina Ribeiro Barros De Alencar[3],
*Alessandro Leite Cavalcanti[4]

ORCID IDs of the authors:
I.C.C.L.0000-0002-6621-1834;
L.F. 0000-0002-4077-6706;
G.D.S.A.A. 0000-0003-3786-4067;
A.F.C.C. 0000-0002-7779-2478;
C.R.B.D.A. 0000-0002-8718-8311;
A.L.C. 0000-0003-3572-3332.

[1] Post-Graduate Program in Dentistry, State University of Paraíba, Campina Grande, PB, Brazil.
[2] Post-Graduate Program in Public Health, State University of Paraíba, Campina Grande, Paraíba, Brazil.
[3] School of Dentistry, Federal University of Campina Grande, Patos, PB, Brazil.
[4] Department of Dentistry, State University of Paraíba, Campina Grande, PB, Brazil.

ABSTRACT

Objectives: This cross-sectional study evaluated the prevalence of injuries in the maxillofacial complex of victims of violence attended by a Mobile Emergency Care Service in a municipality of Northeastern Brazil.

Materials and Methods: A total of 2,347 records were evaluated from February 2014 to December 2016, of which 337(14.3%) corresponded to victims of violence. Information related to sociodemographic profile, associated factors and violence was collected. Data were analyzed through descriptive and inferential statistics, with significance level of 5%.

Results: There was predominance of males (76.3%) and age group of 20-29 years (29.7%). Occurrences were more frequent at night (61.4%) and at the weekend (40.7%). Alcohol use was observed in 63.5% of victims and 16.0% reported illicit drug use, with predominance of crack (92.6%). The most prevalent type of aggression was physical violence (54.9%). The majority of victims presented a single lesion (72.7%) with predominance of laceration (80.4%). Cases of head and face injuries represented, respectively, 33.5% and 35.9% of aggressions. Face injuries showed association with gender (p=0.027) and number of injuries (p=0.042).

Conclusions: The main victims of violence are young men who have used alcohol and illicit drugs. Physical aggression is the most frequent type of violence, with high occurrence of head and face injuries. Face injuries showed association with gender and number of lesions, both being more frequent among women.

Keywords: Violencex physical abuse, maxillofacial injuriesx facial injuries.

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***Corresponding Author**
Universidade Estadual da Paraiba Programa de Pós-graduação em Odontologia Rua das Baraúnas, S/N – Bodocongo, Campina Grande, PB, Brazil. 58429-500
Phone: +55 83 3315-3326 **E-mail:** alessandrouepb@gmail.com

INTRODUCTION

Violence is an integral part of the human condition and shows its different aspects throughout the world.[1] The World Health Organization defines violence as: "the intentional use of physical force or power, threatened or actual against oneself, another person or against a group or community, which results in or is highly likely to cause injury, death and psychological harm".[2]

The global prevalence of self-inflicted and interpersonal violence in 2016 was approximately 230 million people.[3] More than 1.3 million people worldwide die each year as a result of violence in all its forms, accounting for 2.5% of global mortality.[4] In Brazil, the estimated mortality rate for all types of violence for the year 2016 was approximately 78,400 deaths.[5]

Recent studies have shown that interpersonal violence is one of the main etiological factors of maxillofacial lesions.[6,7] The maxillofacial region is the common target of injuries due to its more prominent, unprotected location and because it is a region that is easily reached upon aggression.[8-11] The epidemiological characteristics of maxillofacial lesions and their associated factors are influenced by demographic, socioeconomic, cultural and environmental variables.[8-11]

Maxillofacial injuries are often associated with morbidity and can cause functional deficiencies and / or deformities[12], resulting in severe pressure on the health, social services and economic systems, since the administration of the community economy is highly affected by the absenteeism of labor force and loss of productivity.[4] In 2004, in Brazil, the direct medical cost of injuries due to violence accounted for about 0.4% of the total health budget, while the loss of productivity related to violence corresponded to 12% of total health expenditure and 1.2% of the Brazilian Gross Domestic Product.[13]

Patients affected by maxillofacial lesions present high risk of developing post-traumatic psychological effects due to functional and aesthetic deficiencies.[14] Maxillofacial lesions have been associated with social issues, such as alcoholism or illicit drug use.[11] These violence-related injuries are often underreported and difficult to assess due to the common association with illegal activities (alcohol or drug abuse, firearms and acts of violence against women and children).[10,11]

Therefore, an in-depth knowledge of the characteristic pattern of victims of violence and the prevalence of maxillofacial injuries is essential both for the diagnosis and for the development of public health policies to assess the needs of health services and for the development of prevention programs in order to minimize the consequences of aggressions.[10,11,15]

In this context, this study aimed to characterize the profile, associated factors and to evaluate the prevalence of injuries in the maxillofacial complex of victims of violence attended by a Mobile Emergency Care Service (SAMU) in a municipality in Northeastern Brazil.

MATERIALS AND METHODS

Study Design

This is a retrospective and cross-sectional study carried out in the municipality of Cajazeiras, Paraíba, Brazil. The municipality has an estimated population of 61.776 inhabitants, Human Development Index (HDI) of 0.67 and Gini Coefficient of 0.56.[16]

Data Collection

A total of 2.347 records were evaluated from February 2014 to December 2016 by the Mobile Emergency Care Service (SAMU). SAMU is a pre-hospital care service offered by the Brazilian Unified Health System (SUS) and provides care to victims of trauma of any etiology.

The categories for the different mechanisms of injury due to violence were extracted from Chapter XX - External Causes of Morbidity and Mortality (V01-Y98), International Classification of Diseases (ICD 10). The analysis was restricted to victims of aggression (X85-Y09) and to the following groups: aggression by firearm (X93), aggression by means of a sharp or penetrating object (X99), aggression by blunt object Y00) and aggression by means of body force (Y04).[17]

Data collection was performed by three researchers, recording information about the socio-demographic profile (gender and age group), shift (daytime - between 06:00 a.m. and 05:59 p.m. - and night - between 06:00 p.m. to 05:59 a.m.) and weekday (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday), associated factors [use of alcohol and illicit drugs and type of drug (crack, cocaine, marijuana and other)] and variables related to violence [type (firearm, cold weapon and physical aggression); number of lesions (single and multiple); type of injury (laceration, abrasion, hematoma, and bone fracture); presence of head and face injury, and clinical outcome (released after care, refusal of care, death at the site / during care and referral to the hospital)].

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows Software, version 20 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to calculate the absolute and relative frequencies, mean, median and standard deviation. Chi-square test was used to compare frequencies between the variables. The significance level was set at $p<0.05$.

Ethical Aspects

This research project was approved by the Ethics Research Committee of the State University of Paraíba (Protocol No. CAAE 69253617.0.0000.5187).

RESULTS

The prevalence of violence was 14.3% (n = 337), and the mean age of victims was 33.4 ± 15.0 years, median age 31 years, minimum age 6 years and maximum age 94 years. Regarding the profile, there was predominance of male victims (76.3%), age between 20 and 29 years (29.7%), at night shift (61.4%) and at the weekend (40.7%). Alcohol use was observed in 63.5% of cases and 16.0% reported illicit drug use, with predominance of crack (92.6%) (Table 1). The male / female ratio was 3.2:1.

Table 1. Distribution of victims according to demographic and violence characteristics.

Variables	N	%
Gender		
Female	80	23.7
Male	257	76.3
Age Group (in years)		
6 to 19	55	16.3
20 to 29	100	29.7
30 to 39	98	29.1
40 to 49	44	13.0
50 to 59	15	4.4
60 or more	25	7.5
Period		
Daytime	130	38.6
Nighttime	207	61.4
Day of Week		
Sunday	82	24.3
Monday	41	12.2
Tuesday	40	11.9
Wednesday	36	10.7
Thursday	43	12.8
Friday	40	11.9
Saturday	55	16.3
Alcohol Abuse		
Yes	214	63.5
No	123	36.5
Illicit Drugs		
Yes	54	16.0
No	283	84.0
Type of Drug		
Crack	50	92.6
Cocaine	2	3.7
Marijuana	1	1.8
Other	1	1.8

The most prevalent type of violence was physical aggression (54.9%). Most victims presented a single injury (72.7%), with predominance of laceration (80.4%). The occurrence of head and face injuries was found in 33.5% and 35.9% of the sample, respectively, with the majority of victims being referred to the hospital (85.2%) (Table 2).

Table 2. Distribution of victims according to the type of violence and characteristics of injuries.

Variables	N	%
Type of Violence		
Firearm	46	13.6
Cold weapon	98	29.1
Physical aggression	185	54.9
Not Informed	8	2.4
Number of Injuries		
Single	245	72.7
Multiple	92	27.3
Laceration		
Yes	271	80.4
No	66	19.6
Abrasion		
Yes	8	2.4
No	329	97.6
Hematoma		
Yes	50	14.8
No	287	85.2
Bone Fracture		
Yes	16	4.7
No	321	95.3
Head Injury		
Yes	113	33.5
No	224	66.5
Face Injury		
Yes	121	35.9
No	216	64.1
Outcome		
Victim Released after Care	5	1.5
Refusal of Care	11	3.3
Death in the Site/ During Care	34	10.1
Referral to the Hospital	287	85.2

Table 3 shows the distribution of the occurrence of lesions in the maxillofacial complex according to variables related to the victim's gender, number of injuries and associated factors. Face injuries showed association with gender (p=0.027) and with the number of injuries (p=0.042), both of which being more frequent in women.

DISCUSSION

Violence is recognized as a major and growing public health problem for which no country, no city and no community are immune.[18] Several authors have shown that there is an increasing tendency of maxillofacial injuries to be related to violence.[1,6,7,9,11,19]

In the present study, men were the main victims of violence, confirming results obtained in studies conducted in Brazil[7,10,15,20-23], Italy[1], Greece[6], India[8,14], New Zealand[9], the United Arab Emirates[11], Australia[24,25] and Nigeria.[26] Among the factors that may explain these findings are the fact that men are exposed to risk factors, such as participation in events of violent nature (fights)[21], alcohol consumption[9,24-27] and drugs.[28] In contrast, some authors have found an increase in the incidence of aggression-related injuries among women.[29] A possible explanation for this increase is the fact that in the past, some women referred to health services may not have revealed the actual cause of the injury, such as aggression or domestic violence, and reported falls or traffic accidents as the cause of injury.[30]

The occurrence of aggressions was greater in individuals in the third and fourth decades of life. This finding, involving young adults, corroborates other studies conducted in Brazil[7,15,21,22], Australia[24,25], Nigeria[26] and India.[30] Individuals in this age group are regular visitors of bars and parties, have greater social interaction and are more likely to suffer aggression due to their physical vigor.[15,21,25] Other factors that may contribute to the occurrence of aggressions in young people include social, economic and emotional conflicts.[6,11,31]

In this study, the frequency of violence in individuals aged 60 years and over was only 7.5%. However, other studies have found that the

Table 3. Distribution of the occurrence of head and face injuries according to the gender of the victim, number of injuries and use of alcohol and drugs.

	Body Region					
	Head			Face		
Variables	Yes N (%)	No N (%)	p-value	Yes N (%)	No N (%)	p-value
Gender						
Male	88 (34.2)	169 (65.8)	0.621	84 (32.7)	173 (67.3)	0.027*
Female	25 (31.2)	55 (68.8)		37 (46.2)	43 (53.8)	
Number of Injuries						
Single	77 (31.4)	168 (68.6)	0.182	80 (32.6)	165 (67.4)	0.042*
Multiple	36 (39.1)	56 (60.9)		41 (44.6)	51 (55.4)	
Alcohol Use						
Yes	75 (35.0)	139 (65.0)	0.437	82 (38.3)	132 (61.7)	0.223
No	38 (30.9)	85 (69.1)		39 (31.7)	84 (68.3)	
Illicit Drugs						
Yes	14 (25.9)	40 (74.1)	0.196	19 (35.2)	35 (64.8)	0.904
No	99 (35.0)	184 (65.0)		102 (36.0)	181 (64.0)	

proportion of maxillofacial injuries due to violence against older adults is increasing.[23,27] Therefore, it should be considered that the reduced number of cases of violence against older adults may be related to their greater difficulty in making a formal complaint or notification due to their debilitating physical and/or psychological conditions[23,27], thus increasing underreported cases.

Regarding the distribution of victims according to the day shift and weekday, the nocturnal period and the concentration of occurrences on Sunday corroborate other findings.[1,21,31] Research developed in Brazil has shown that violent crimes committed against men are associated with night time and weekends.[22] This can probably be explained by the fact that during this time, individuals often go to places in search of fun and leisure, with large concentrations of people and frequent exposure to alcohol and drugs.[9,22]

Alcohol use among victims was high, corresponding to almost two-thirds of the sample. This finding corroborates previous studies that found that injuries in the maxillofacial complex are frequently associated with alcohol intoxication.[24-26] Recent studies in Australia have found that facial fractures occurred in 17.6%[24] and 7.9%[25] of individuals who consumed alcohol. Underreporting regarding alcohol consumption is possible because patients may not reveal their actual state of intoxication at the time of care.[25]

In this research, the use of illicit drugs was high. The involvement of individuals with illicit drugs can increase the risk of being a victim and / or aggressor, while violence may increase the risk of consuming illicit drugs[32], and as a consequence, in both cases, they can increase the number of maxillofacial injuries. Approximately 9.3% of the Brazilian population was victims of at least one form of urban violence in 2012, but this proportion increases to 19.7% among cocaine users and to 18.1% among individuals who consume alcohol.[33] The consumption of alcohol and illicit drugs can lead to reduction of inhibitions, impulsive and aggressive behaviors.[21] These effects are amplified by the combination of these two substances, which commonly occurs among users.[28]

The most common type of aggression was physical violence, with the majority of victims presenting a single lesion and involvement of soft tissues (lesions of a mild nature), which is in agreement with other studies.[1,7,11,22,31] Previous study revealed that bruises were higher among females, while fractures and injuries predominated among males.[7] The literature shows that in relation to maxillofacial trauma, men are associated with aggressions that result in severe trauma, facial bone fracture or dentoalveolar fracture.[22] Minor injuries in women may possibly go unnoticed by persons close to the victims.[34] Thus, when traces of aggression are reduced, they allow violent acts to remain hidden, which make perpetuation of aggressions possible.[34] Cases of head and face injury were high, accounting for more than one third of victims. The face is the most singular area of the body of individuals and

represents their identity, so that aggressions in this region aim to disqualify the victim's identity, acting as a factor of intimidation.[34,35,36]

This study has some limitations. Due to its cross-sectional design, the findings only demonstrate associations and not causality. One of the difficulties of working with secondary data lies in the fact that, in many situations, the incomplete recording of information prevents the faithful transcription of findings.[26,37,38] This condition was observed in this study, since some records were not properly filled.

CONCLUSION

The main victims of violence are young men who have used alcohol and illicit drugs. Physical aggression is the most frequent type of violence, with high occurrence of head and face injuries. Face injuries showed association with gender and number of lesions, both being more frequent among women.

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CONFLICTS OF INTEREST

No competing financial interests exist.

Brezilyalı Şiddet Mağdurlarında Orofasiyal Yaralanmalar ve İlişkili Faktörler:Kesitsel Çalışma

ÖZ

Amaç: *Bu kesitsel çalışma, Kuzeydoğu Brezilya'da bir belediyede Mobil Acil Bakım Servisne başvuran şidddet mağdurlarının orofasiyal bölgede meydana gelen yaralanmaların yaygınlığını değerlendirdi.* ***Gereç ve Yöntemler:*** *Şubat 2014'ten Aralık 2016'ya kadar toplam 2.347 kayıt değerlendirildi. Bunların 337'si (%14,3) şiddet mağduru olduğu bulundu. Sosyodemografik profil, ilişkili faktörler ve şiddet ile ilgili bilgiler toplanmıştır. Veriler, %5'lik anlamlılık düzeyinde, tanımlayıcı ve çıkarımsal istatistikler yoluyla analiz edilmiştir.* ***Bulgular:*** *Erkeklerin ağırlık yüzdesi (%76,3) ve yaş grubu 20-29 (%29,7) idi. Olaylar gece (%61,4) ve haftasonu (%40,7) daha sıktı. Alkol kullanımı, mağdurların %63,5'inde, %16,0'ında ise yasa dışı uyuşturucu kullanımı, %92,6'sında çatlak hakimiyeti gözlenmiştir. En sık görülen saldırganlık türü fiziksel şiddet (%54,9) idi. Kurbanların çoğunluğu, laserasyonun baskın olduğu (%80,4) tek bir lezyon (%72,7) sundular. Kafa ve yüz yaralanması vakaları sırasıyla %33,5 ve %35,9 oranında saldırganlık göstermektedir. Yüz yaralanmaları cinsiyetle ilişki (p=0,027) ve yaralanma sayısı (p=0,042) gösterdi.* ***Sonuçlar:*** *Şiddetin ana mağdurları, alkol ve yasadışı uyuşturucu kullanan genç erkeklerdir. Fiziksel saldırganlık, en sık görülen tipte şiddet ve kafa ve yüz yaralanmalarıdır. Yüz yaralanmalarının, her ikisi de kadınlarda daha sık görülmekle beraber, cinsiyet ve lezyon sayısı ile ilişkili olduğunu göstermiştir.* ***Anahtar Kelimeler:*** *Şiddet, fiziksel suistimal, maksillofasiyal yaralanmalar, yüz yaralanmaları.*

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Original research

EVALUTION OF THE PATIENS ORAL HEALTH RELATED QUALITY OF LIFE AFTER HARVESTING FREE GINGIVAL GRAFT

*Sıla Çağrı İşler[1],
Ahu Uraz[1],
Janset Şengül[1],
Miray Çakıroğlu[1],
Batuhan Bakırarar[2],
Deniz Çetiner[1]

ORCID IDs of the authors:
S.Ç.İ.0000-0001-5419-9658
A.U.0000-0001-6281-6855
J.Ş.0000-0001-5699-6781
M.Ç.0000-0002-6919-7986
B.B.0000-0002-5662-8193
D.Ç.0000-0002-1903-2999

[1]Department of Periodontology, Faculty of Dentistry, Gazi University, Ankara, Turkey.
[2] Department of Biostatistics, Faculty of Medicine, Ankara University, Ankara, Turkey.

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ABSTRACT

Objectives: Oral Health Related Quality of Life is the individual's perception of how oral health affects the quality of life and general health. Periodontal plastic surgery procedures have been reported to negatively affect the quality of life of patients after the operations. The aim of this study was to evaluate the effects of different treatment procedures applied for wound healing of the donor palate site after free gingival graft (FGG) operations on the quality of life.

Materials and Methods: After FGG harvesting, 60 patients' palatal donor sites were randomly assigned one of the six groups, giving 10 participants per group. Palatal wounds were treated with platelet-rich fibrin (PRF), essix retainer, ozone therapy, low-level laser therapy (LLLT) or collagen fleece. As a control group, palatal donor sites were left to secondary healing without any of the treatment procedures. After the postoperative procedures, The Oral Health Impact Profile (OHIP-14) questions were asked to patients to evaluate their quality of life, whereas parameters in relation to postoperative morbidity were analyzed by using Visual Analogue Scale (VAS).

Results: Regarding to the questions belonging Turkish version of OHIP-14 (OHIP-14 TR), there were statistically significant relationships between the group categorical variables and the categorical results of question 7 and 10 (p=0.002 and p=0.015). For these questions, the lowest scores were mostly given in the LLLT group. No statistically significant difference was observed between the study groups and total OHIP scores (TOHIP) and the means of 7 subscales of OHIP-14 (p>0.05). Significant differences were found between PRF-ozone groups on the 5th day (p=0.011) for mean VAS scores exhibiting postoperative pain.

Conclusions: It has been observed that applying LLLT procedures to the donor wound area following FGG operations may have positive effects on the quality of life and PRF treatments may be more effective in terms of patient comfort after operation.

Key Words: Temostatic technics, laser therapy, oral surgical procedures, quality of life

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*** Corresponding Author**
Gazi University Faculty of Dentistry Department of Periodontology, 8. Cadde 82. Sokak Emek, 06510 Ankara Turkey,
Phone: +90 312 203 42 43 **Fax:** +90 312 203 60 20 **E-mail:** silaisler@gazi.edu.tr

INTRODUCTION

Defined by the World Health Organization (WHO) as the individuals' perception of their positions in life with regard to their purposes, expectations, standards and concerns in the context of their respective culture and system of values, "quality of life" has gained importance by social studies since 1970s.[1] While "health-related quality of life" is defined in connection with health and physical functions, emotional well-being, general perception of wellness and social functions[2,3], Oral Health Related Quality of Life (OHRQoL) characterizes an individual's perception based on how their oral health affects their life standards and overall well-being.[4-6] In other words, OHRQoL is a multidimensional concept that covers the variables that affect an individual's nutrition, sleep, communication with other individuals, their self-confidence, and their satisfaction with their oral health.[4] The factors that affect "quality of life" and OHRQoL include the psychological state, social-demographic factors, life-style factors and the judgments of one's social circle.[5]

Until the last 30 years, physiological and psycho-social implications of oral health attracted less attention since they were not considered to have a major effect on the lives of individuals or cause a vital threat. However, it is a proven fact that oral health plays a major role in comfort, sleep, social life, aesthetic appearance, and consequently the quality of life.[7] Even though periodontal diseases are not life-threatening conditions, they may not only affect eating, speaking and socializing but also interpersonal relationships, daily activities, hence "well-being" or "quality of life".[8] Today, many studies have showed that just like other diseases, periodontal diseases have emotional and psycho-social implications.[9-11] Oral Health Impact Profile-14 (OHIP-14)[12] is a type of measurement that was designed to thoroughly identify the dysfunction, discomfort and injuries that are related to oral conditions. The questions in OHIP cover 7 dimensions, namely functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap, which are rooted and formulated in the theoretical model of oral health.[12]

An adequate width of attached gingiva is critical for maintaining periodontal/periimplant health. In case of a lack of adequate keratinized and attached gingiva, optimal plaque control cannot be achieved, and mucogingival stress in the relevant zone may cause gingival inflammation and recession.[13]

Several periodontal surgery techniques such as autogenous pedicle grafts, free gingival graft (FGG), connective tissue graft (CTG), epithelial connective tissue graft (ECTG) and guided tissue regeneration have been developed to increase the amount of keratinized attached gingiva and/or treat gingival recession.[14]

FGG is a predictable and successful technique in treating mucogingival problems such as insufficient attached gingiva and also gingival recession. While the palatal zone is usually chosen as the donor site, the palatal donor site heals by secondary intention after FGG operations, and the healing process may take a few weeks.[15] Post-operative complaints continue until the epithelization is completed within 2 to 4 weeks.[16] The most frequent complications after FGG applications are hemorrhage, pain, burning sensation, sensitivity, paresthesia, mucocele, herpetic lesion in the palate, and the delay in wound healing.[17,18] Such problems may restrict patients' daily activities such as eating, drinking, brushing teeth or speaking, and affect their quality of life. A lot of methods including the implementation of hemostatic agents, bioactive materials, antibacterial and antiseptic agents, herbal products, platelet-rich fibrin (PRF) and low-level laser treatment (LLLT) have been used to minimize the discomfort and accelerate wound healing in this recovery process.[19-23] Therefore, the purpose of this study was to assess the effects of different treatment procedures applied for wound healing of the donor palate site after the FGG operation on the oral health and quality of life.

MATERIALS AND METHODS

Selection of Patients and Study Protocols

The research protocol was approved by the Clinical Research Ethics Committee of Ankara University, Faculty of Dentistry (36290600/114). A total of 60 patients aged between 18 and 65, who admitted to Gazi University, Faculty of Dentistry, had shallow vestibule along with the inadequate width of attached gingiva and were indicated with FGG procedure for isolated gingival recession defects on mandibular and maxillary anterior teeth, were included in the present study. Informed written consent forms were obtained for all participants before their participation.

The patients who were included in the study were non-smokers, did not have any systemic condition that may affect wound healing, did have a full mouth plaque scores (FMPS) and full mouth bleeding scores (FMBS) of less than 20%, did not undergo any periodontal treatment in the previous 6 months, did not use any antibiotics in the previous 3 months, were not in the lactation period, and did not undergo any surgical intervention for their operation area. The patients who failed to fulfill these criteria were excluded from the study.

Before the surgery, all patients received oral hygiene instructions and the Phase I periodontal treatment including scaling and root planning and polishing of the teeth. All patients were recommended to use a standardized soft toothbrush according to a standardized method of brushing (the modified Stillman technique).

Four weeks after the initial therapy, FGG procedures were performed by the same periodontist as described by Sullivan and Atkins[24] and modified by Miller[25]. To prepare the donor area, a rectangular-shape incision with 1–1.5 mm thickness was made, and care was taken to place most of the coronal part of the incision at least 2 mm apical from gingival margins of the upper teeth. The apical coronal dimension of the graft was standardized (9x11 mm) using a sterile aluminum foil template due to the selection of the recessions on the mandibular and maxillary anterior teeth. After removing the FGG, two vertical mattress sutures were made mesial and distal to the tissue-harvesting site to prevent immediate and/or delayed bleeding using 3/0 resorbable sutures (Pegesorb, Doğsan, Istanbul, Turkey).

60 patients were randomly allocated into one of the six study groups, using a computer-generated randomization table, based on the applications of treatment methods on the palatal donor site following FGG procedures.

a) Group 1 (Control) (n=10): The palatal donor site was left spontaneously for secondary healing.

b) Group 2 (PRF) (n=10): PRF membranes prepared as described in the method developed by Choukroun[26] were applied to the palatal donor site by vertical mattress sutures using 3/0 resorbed sutures (Pegesorb, Doğsan, İstanbul, Turkey).

c) Group 3 (Essix retainer) (n=10): 1-mm-thick Essix retainer (Clear Advantages Series, Ortho Technology, Florida, United States) prepared pre-operatively to cover the palatal donor site was used.

d) Group 4 (Ozone) (n=10): Topical gaseous ozone (Ozone DTA Ozone Generator, DentaTec Dental AS, Hov, Norway) with an oxygen power of 80% and a concentration of 2100 ppm was administered to the palatal donor site for 30 seconds on the day 1, 3, and 7 after the operation.

e) Group 5 (LLLT) (n=10): LLLT was applied to the palatal donor site for 30 seconds using a diode laser ($\lambda = 970 \pm 15$ nm) (SIROLaser Xtend, Sirona Dental Systems GmbH, Bensheim, Germany) (tissue dose: 5.25 J/cm^2 and power: 2W) on the day 1, 3, and 7 after the operation.

f) Group 6 (Collagen fleece) (n=10): The palatal donor site was covered with a collagen sponge (Bego Collagen Fleece, Bremen, Germany) and immobilized using a 3/0 resorbed suture (Pegasorb) and a vertical mattress suture.

Postoperative care was aimed at maintaining wound stability. In order to control for postoperative infections, the patients were asked to use a 0.12% chlorhexidine mouth rinse (Kloroben, Drogsan, Istanbul, Turkey) twice a day for three weeks, postoperatively. Patients were prescribed 100 mg flurbiprofen tablets (Majezik, Sanovel,

Istanbul, Turkey) to take systemically up to three times/day for a week, in case of pain.

Clinical Evaluations

The Plaque index (PI),[27] Gingival index (GI),[28] Bleeding on probing (BOP) and Probing depth (PD) measurements were taken pre-operatively to identify the periodontal health of patients. The measurements were obtained from four aspects of the teeth-mesial, distal, buccal, and lingual/palatinal surfaces-using a Williams periodontal probe (Hu-Friedy, Chicago, IL, Amerika) by the same study examiner.

Furthermore, the periodontal probe was used to measure the distance from the gingival margin to the cemento-enamel junction (CEJ) which was identified as the Recession depth (RD) and Recession width (RW) was measured as the distance from one border of the recession to another in mesiodistal direction at 1 mm apical of the CEJ. Palatal tissue thickness (PTT) and the size and thickness of the grafts were also recorded during the surgical procedure.

Postoperative instructions included to discontinue toothbrushing and flossing around the surgical sites during the first 14 days after surgery. During this period, patients were instructed to rinse with a 0.12% chlorhexidine gluconate solution (Kloroben, Drogsan, Ankara, Turkey) two times a day. Patients were also prescribed 100 mg flurbiprofen tablets (Majezik, Sanovel, Istanbul, Turkey) to take systemically up to three times/day for a week, in case of pain.

OHRQoL was evaluated using the Turkish version of OHIP-14 (OHIP-14 TR) scale[29] which consists of 14 items and 7 sub-scales (1) functional limitation, 2) physical pain, 3) psychological discomfort, 4) physical disability, 5) psychological disability, 6) social disability and 7) handicap. The Likert-type scale (0="Never", 1="Rarely", 2="Sometimes", 3="Often", 4="Very Often") was used. OHIP-14 TR scale was implemented face-to-face by the same researcher on the 14th day postoperatively.

Post-operative pain was also assessed using a questionnaire showing the intensity of the given event on a visual analogic scale (VAS). VAS is a scale by which the severity of the measured values is rated on a 10-cm scale (0: no pain, 1: minimal pain, 10: severe pain). This assessment was made every day for the first 7 days and on the 14th day following the FGG operation.

Statistical Analysis

The data was analyzed using the statistics packages SPSS 20 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) and R (Version 3.0.2). As descriptive statistics mean ± standard deviation and median (minimum-maximum) was used for quantitative variables, and numbers (percentage) were used for qualitative variables. For quantitative variables, whether there was a statistically significant difference among the categories of qualitative variables which have more than two categories was decided using One-Way Analysis of Variance (ANOVA) where normal distribution assumptions were established, and Kruskal Wallis H test where it they were not established. Chi-square test was used to examine the relation between the two qualitative variables. The level of statistical significance was 0.05.

RESULTS

60 patients aged 18 to 65 (39.5±12.7) were included in our study. 44 of them (73.3%) were female, and 16 (26.7%) were male. All patients regularly attended the examinations, and none of them left the study. No postoperative complications were reported by the patients in terms of delayed bleeding. The presence of partial necrosis was observed in one patient from control group and one patient from collagen fleece group.

The demographic data and clinical periodontal parameters of the patients are shown in Table 1. No statistically significant difference was found in terms of age and gender of the patients in comparison among the groups (p=0.993 and p=0.325). No statistically significant difference was seen in the measurements of PI, GI, PD, BOP, RD, RW, and PTT with regard to clinical parameters (p>0.05) (Table 1).

Table 1. Patients' Demographic Data and Clinical Periodontal Parameters

Parameters		Group 1 Control	Group 2 PRF	Group 3 Essix retainer	Group 4 Ozone	Group 5 LLLT	Group 6 Collagen fleece	*P* value
Age	Mean±SD	40.0±15.7	40.4±16.0	39.6±6.2	37.0±11.3	40.3±11.3	39.7±15.8	0.993*
	Median (Min.-Max.)	33.0 (18.0-65.0)	44.0 (18.0-63.0)	37.5 (31.0-51.0)	37.5 (31.0-51.0)	39.0 (21.0-56.0)	42.0 (22.0-65.0)	
Gender	Female	9 (90.0)	6 (60.0)	9 (90.0)	7 (70.0)	5 (50.0)	8 (80.0)	0.325**
	Male	1 (10.0)	4 (40.0)	1 (10.0)	3 (30.0)	5 (50.0)	2 (20.0)	
PI	Mean±SD	10.5±4.5	9.5±6.4	9.0±5.2	9.6±4.6	8.2±6.3	7.3±6.9	0.494#
	Median (Min.-Max.)	10.3 (4.8-21.3)	8.1 (2.1-21.3)	7.7 (3.6-20.0)	9.8 (3.6-19.2)	7.3 (0.0-18.2)	5.5 (0.0-25.0)	
GI	Mean±SD	0.2±0.2	0.2±0.1	0.2±0.2	0.1±0.1	0.1±0.1	0.1±0.1	0.541#
	Median (Min.-Max.)	0.2 (0.0-0.5)	0.1 (0.1-0.3)	0.1 (0.0-0.6)	0.1 (0.0-0.3)	0.1 (0.0-0.3)	0.1 (0.0-0.2)	
PD mm	Mean±SD	1.9±0.7	1.9±0.2	1.9±0.2	1.9±0.2	1.8±0.4	1.7±0.6	0.223#
	Median (Min.-Max.)	2.1 (0.0-2.6)	1.9 (1.6-2.2)	1.9 (1.6-2.1)	1.9 (1.6-2.4)	1.8 (1.5-2.9)	1.8 (0.0-2.4)	
BOP %	Mean±SD	11.1±5.2	9.3±4.3	7.6±5.0	9.8±5.5	9.0±6.6	8.2±5.6	0.394#
	Median (Min.-Max.)	11.5 (1.7-22.2)	9.1 (4.3-17.6)	7.5 (2.0-19.4)	8.5 (4.5-22.8)	7.4 (2.9-25.9)	7.7 (1.9-22.2)	
RD mm	Mean±SD	4.0±1.8	3.9±1.6	4.2±1.8	4.5±1.9	4.8±1.9	2.6±1.3	0.120#
	Median (Min.-Max.)	4.0 (1.5-7.0)	3.5 (1.0-7.0)	3.8 (2.0-7.0)	5.0 (1.0-8.0)	5.0 (2.0-9.0)	3.0 (0.0-4.0)	
RW mm	Mean±SD	3.1±0.9	3.1±0.7	3.1±1.4	3.9±1.4	3.2±0.9	2.3±1.2	0.097#
	Median (Min.-Max.)	3.0 (2.0-5.0)	3,0 (2.0-4.0)	3.0 (2.0-7.0)	3.0 (3.0-7.0)	3.0 (2.0-5.0)	3.0 (0.0-3.0)	
PTT mm	Mean±SD	3.9±0.6	3.9±0.7	3.4±0.4	3.2±0.7	3.4±0.3	3.9±0.9	0.051#
	Median (Min.-Max.)	4.2 (3.0-5.0)	4.0 (2.5-5.0)	3.3 (3.0-4.0)	3.0 (2.0-4.0)	3.2 (3.1-4.1)	3.5 (3.0-5.5)	

*: One-way ANOVA, #:Kruskal Wallis H test, **: Chi-square test. SD: Standard deviation; PRF: Platelet-rich fibrin; LLLT: Low-level laser therapy; PI: Plaque index; GI: Gingival index; PD: Probing depth; BOP: Bleeding on probing; RD: Recession depth; RW: Recession width; PTT: Palatal tissue thickness.

Table 2. Intergroup analysis of OHIP-14 TR questionnaires

OHIP-14	Group 1 Control					Group 2 PRF					Group 3 Essix retainer					Group 4 Ozone					Group 5 LLLT					Group 6 Collagen fleece					*P* value
Items / Questions	%					%					%					%					%					%					
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	
OH-1 / Trouble pronouncing words	60	30	10	0	0	40	30	10	10	10	30	30	30	10	0	20	30	20	20	10	30	20	40	10	0	20	30	30	20	0	0.916
OH-2 / Sense of taste worse	40	20	40	0	0	50	20	20	0	10	20	50	30	0	0	30	10	40	10	10	40	20	30	0	10	40	10	20	30	0	0.637
OH-3 / Painful aching in the mouth?	50	30	20	0	0	50	30	20	0	0	60	30	10	0	0	20	40	40	0	0	60	20	20	0	0	60	0	30	10	0	0.511
OH- 4 / Uncomfortable to eat	40	40	20	0	0	60	30	10	0	0	50	10	30	10	0	40	30	20	0	10	80	20	20	0	0	50	0	20	20	10	0.362
OH-5 / Self-conscious	40	40	20	0	0	40	40	20	0	0	60	10	20	0	10	50	10	30	10	0	60	30	0	10	0	70	10	10	10	0	0.774
OH-6 / Felt tense	40	40	20	0	0	80	10	10	0	0	40	0	40	10	10	50	0	40	0	10	70	20	10	0	0	60	0	20	10	10	0.200
OH-7 / Unsatisfactory diet	40	30	30	0	0	20	60	20	0	0	20	60	20	0	0	50	10	20	20	0	80	0	20	0	0	20	0	40	40	0	0.002*
OH-8 / Had to interrupt meals	40	40	10	10	0	60	20	20	0	0	50	10	40	0	0	50	10	30	0	10	20	40	40	0	0	40	30	10	20	0	0.446
OH-9 / Difficult to relax	70	20	10	0	0	70	20	0	10	0	70	10	10	0	10	70	10	10	0	10	50	20	30	0	0	50	10	30	0	10	0.590
OH-10 / Embarrassed	40	40	20	0	0	90	0	10	0	0	90	10	0	0	0	90	10	0	0	0	100	0	0	0	0	60	10	30	0	0	0.015*
OH-11 / Irritability with other people	60	20	20	0	0	70	30	0	0	0	90	10	0	0	0	90	0	0	10	0	80	0	20	0	0	80	0	20	0	0	0.229
OH-12 / Difficulty doing your usual jobs	70	20	10	0	0	60	40	0	0	0	80	10	0	10	0	80	10	0	10	0	90	0	10	0	0	50	10	10	30	0	0.225
OH-13 / Felt life less satisfying	60	30	10	0	0	100	0	0	0	0	90	10	0	0	0	90	10	0	0	0	70	30	0	0	0	70	10	10	10	0	0.349
OH-14 / Totally unable to function	60	30	10	0	0	90	10	0	0	0	80	20	0	0	0	80	10	10	0	0	80	0	20	0	0	80	0	20	0	0	0.681

*: p<0.05, Chi-square test. PRF: Platelet-rich fibrin; LLLT: Low-level laser therapy; OHIP-14: Oral Health Impact Profile-14.

A statistically significant relation was found between the qualitative variables of the group and the qualitative variables of the question 7 and question 10 related to the OHIP-14 TR scale (p=0.002 and p=0.015). For all groups, no patient chose "4" for the question 7. The highest number of patients who chose the rating "3" was in the group which was administered collagen fleece (40%). The highest number of patients who chose the rating "0", which was the lowest rating, was in the LLLT group (80%) for the question 7. All patients in the LLLT group chose "0" for the question 10 (Table 2).

The 14th-day the mean of Total OHIP (TOHIP) scores varied between 6.70±4.4 and 14.80±9.0 for the study groups (Table 3).

Table 3. Intergroup evaluations of the mean of the seven major subscales of the OHIP-14 TR scale

OHIP-14	Groups	N	Mean±SD	Median (Min.Max.)	*P* value
Functional limitation	Control	10	1.5±1.1	1.5 (0.0-3.0)	0.538
	PRF	10	2.2±2.3	1.0 (0.0-6.0)	
	Essix retainer	10	2.3±1.4	2.0 (0.0-5.0)	
	Ozone	10	3.3±2.5	3.0 (0.0-8.0)	
	LLLT	10	2.5±2.2	2.0 (0.0-6.0)	
	Collagen fleece	10	2.9±2.0	3.0 (0.0-5.0)	
Physical pain	Control	10	1.5±1.4	1.0 (0.0-3.0)	0.376
	PRF	10	1.2±1.1	1.0 (0.0-3.0)	
	Essix retainer	10	1.5±1.6	1.0 (0.0-4.0)	
	Ozone	10	2.3±1.7	2.0 (0.0-6.0)	
	LLLT	10	0.8±1.0	0.5 (0.0-3.0)	
	Collagen fleece	10	2.3±2.5	2.0 (0.0-7.0)	
Psychological discomfort	Control	10	1.6±1.3	1.5 (0.0-4.0)	0.507
	PRF	10	1.1±2.0	0.0 (0.0-6.0)	
	Essix retainer	10	2.4±2.6	2.5 (0.0-8.0)	
	Ozone	10	2.2±2.0	2.0 (0.0-6.0)	
	LLLT	10	1.0±1.3	0.5 (0.0-4.0)	
	Collagen fleece	10	1.7±2.5	0.0 (0.0-6.0)	
Physical disability	Control	10	1.8±1.7	1.5 (0.0-5.0)	0.540
	PRF	10	1.6±1.3	1.5 (0.0-4.0)	
	Essix retainer	10	1.9±0.9	2.0 (1.0-3.0)	
	Ozone	10	2.2±2.6	1.0 (0.0-7.0)	
	LLLT	10	1.6±1.4	1.0 (0.0-4.0)	
	Collagen fleece	10	3.1±2.1	3.0 (0.0-6.0)	
Functional limitation	Control	10	1.5±1.1	1.5 (0.0-3.0)	0.538
	PRF	10	2.2±2.3	1.0 (0.0-6.0)	
	Essix retainer	10	2.3±1.4	2.0 (0.0-5.0)	
	Ozone	10	3.3±2.5	3.0 (0.0-8.0)	
	LLLT	10	2.5±2.2	2.0 (0.0-6.0)	
	Collagen fleece	10	2.9±2.0	3.0 (0.0-5.0)	
Physical pain	Control	10	1.5±1.4	1.0 (0.0-3.0)	0.376
	PRF	10	1.2±1.1	1.0 (0.0-3.0)	
	Essix retainer	10	1.5±1.6	1.0 (0.0-4.0)	
	Ozone	10	2.3±1.7	2.0 (0.0-6.0)	
	LLLT	10	0.8±1.0	0.5 (0.0-3.0)	
	Collagen fleece	10	2.3±2.5	2.0 (0.0-7.0)	
Psychological discomfort	Control	10	1.6±1.3	1.5 (0.0-4.0)	0.507
	PRF	10	1.1±2.0	0.0 (0.0-6.0)	
	Essix retainer	10	2.4±2.6	2.5 (0.0-8.0)	
	Ozone	10	2.2±2.0	2.0 (0.0-6.0)	
	LLLT	10	1.0±1.3	0.5 (0.0-4.0)	
	Collagen fleece	10	1.7±2.5	0.0 (0.0-6.0)	
Physical disability	Control	10	1.8±1.7	1.5 (0.0-5.0)	0.540
	PRF	10	1.6±1.3	1.5 (0.0-4.0)	
	Essix retainer	10	1.9±0.9	2.0 (1.0-3.0)	
	Ozone	10	2.2±2.6	1.0 (0.0-7.0)	
	LLLT	10	1.6±1.4	1.0 (0.0-4.0)	
	Collagen fleece	10	3.1±2.1	3.0 (0.0-6.0)	

*: p<0.05, Kruskal Wallis H test.

SD: Standard deviation; PRF: Platelet-rich fibrin; LLLT: Low-level laser therapy; OHIP-14: Oral Health Impact Profile-14; TOHIP: Total OHIP scores

Seven sub-scale values of the OHIP-14 questionnaire did not show any statistically significant difference among the groups ($p>0.05$). It was found that the mean functional limitation score was highest (3.3±2.5) in the ozone group and lowest (1.5±1.1) in the control group. The mean physical pain score was highest (2.3±2.5) in the collagen fleece group and lowest (0.8±1.0) in the LLLT group. The mean psychological discomfort score was highest in the essix group (2.4±2.6) and lowest in the LLLT group (1.0±1.3). While in terms of physical and psychological disability had higher values in the collagen fleece group compared to the other groups, the mean physical disability scores were lowest in the PRF and LLLT groups, and the mean psychological disability score was lowest in the essix retainer group. While handicap disturbed the patients in the collagen fleece group the most, it disturbed the patients in the PRF group the least.

The statistically significant difference was observed between PRF and ozone groups for the mean VAS values regarding postoperative pain only on day 5 ($p=0.011$). Although there was a tendency towards a lower VAS value in the PRF group compared to other groups for all study follow-up periods, all inter-group comparisons did not show any statistical significance on the other postoperative days ($p>0.05$) (Table 4). At the 14-day follow-up, the patients for all the groups reported no postoperative pain**.**

Table 4. Comparison of the mean VAS values regarding postoperative pain between the groups

VAS	Groups	N	Mean±SD	Median (Min.-Max.)	*P* values
Day 1	Control	10	2.2±3.4	0.0 (0.0-10.0)	0.578
	PRF	10	0.7±1.5	0.0 (0.0-4.0)	
	Essix retainer	10	0.9±2.0	0.0 (0.0-6.0)	
	Ozone	10	0.9±1.7	0.0 (0.0-5.0)	
	LLLT	10	1.9±2.7	1.5 (0.0-9.0)	
	Collagen fleece	10	1.3±2.7	0.0 (0.0-8.0)	
Day 2	Control	10	2.1±3.0	1.0 (0.0-10.0)	0.378
	PRF	10	0.3±0.5	0.0 (0.0-1.0)	
	Essix retainer	10	0.6±1.0	0.0 (0.0-3.0)	
	Ozone	10	1.3±1.9	0.0 (0.0-5.0)	
	LLLT	10	0.9±1.4	0.0 (0.0-4.0)	
	Collagen fleece	10	2.1±2.9	1.0 (0.0-9.0)	
Day 3	Control	10	0.3±0.5	0.0 (0.0-1.0)	0.086
	PRF	10	0.0±0.0	0.0 (0.0-0.0)	
	Essix retainer	10	0.0±0.0	0.0 (0.0-0.0)	
	Ozone	10	0.9±1.2	0.0 (0.0-3.0)	
	LLLT	10	1.1±1.9	0.0 (0.0-5.0)	
	Collagen fleece	10	0.7±1.5	0.0 (0.0-4.0)	
Day 4	Control	10	2.4±2.8	1.5 (0.0-9.0)	0.105
	PRF	10	0.1±0.3	0.0 (0.0-1.0)	
	Essix retainer	10	1.0±2.2	0.0 (0.0-6.0)	
	Ozone	10	2.4±3.0	0.5 (0.0-7.0)	
	LLLT	10	1.9±2.8	0.5 (0.0-8.0)	
	Collagen fleece	10	2.4±3.1	1.0 (0.0-9.0)	
Day 5	Control	10	3.9±3.1	4.0 (0.0-9.0)	**0.011***
	PRF	10	0.3±0.7	0.0 (0.0-2.0)	
	Essix retainer	10	1.1±2.1	0.0 (0.0-5.0)	
	Ozone	10	4.0±2.8	4.0 (0.0-9.0)	
	LLLT	10	1.5±2.6	0.5 (0.0-8.0)	
	Collagen fleece	10	2.8±3.8	1.0 (0.0-9.0)	
Day 6	Control	10	2.4±3.2	1.0 (0.0-8.0)	0.223
	PRF	10	0.1±0.3	0.0 (0.0-1.0)	
	Essix retainer	10	1.1±2.1	0.0 (0.0-5.0)	
	Ozone	10	1.7±1.9	1.0 (0.0-5.0)	
	LLLT	10	1.1±2.8	0.0 (0.0-9.0)	
	Collagen fleece	10	1.6±2.9	0.0 (0.0-9.0)	
Day 7	Control	10	1.9±2.0	1.5 (0.0-5.0)	0.186
	PRF	10	0.4±1.0	0.0 (0.0-3.0)	
	Essix retainer	10	0.6±1.6	0.0 (0.0-5.0)	
	Ozone	10	0.6±1.1	0.0 (0.0-3.0)	
	LLLT	10	0.6±1.6	0.0 (0.0-5.0)	
	Collagen fleece	10	1.6±2.2	0.5 (0.0-5.0)	

*: $p<0.05$, Kruskal Wallis H test, SD: Standard deviation; PRF: Platelet-rich fibrin; LLLT: Low-level laser therapy. VAS: Visual Analogue Scale

DISCUSSION

The definition of the quality of life is "a life without diseases from the perspective of patients". The purpose of this concept is to ensure that people achieve their objectives and choose an ideal lifestyle. A patient-based assessment of the condition of health is essential for measuring well-being. Recently, patient-based assessments are considered critical endpoints in assessment of treatment outcomes, and the need for such assessments has led to development of the methods for quality of life scales related to oral health.[30] OHIP-49[31] and its shorter version OHIP-14[12] are the ones that are most comprehensive, accessible and most frequently used among those scales. OHIP measures the social impact of oral diseases on overall health as perceived by individuals, and it is used worldwide. Although it is a physiometric principle that reliability of an index decreases statistically in proportion to the number of questions, it is necessary for a pragmatic scale system to be easy and simple to implement. Therefore, in the present study, Turkish version of the OHIP-14 scale was used to identify the life quality of patients had FGG procedures with regard to post-operative palatal wound healing and their levels of perception of post-operative symptoms, and to compare the effects of different treatment methods on palatal wound area.

FGG is an approach that is considered gold standard with a proven success in treatment of mucogingival deformities and increasing the amount of attached gingiva.[22] Since the palatal donor site is left for secondary healing, the bleeding, pain, edema and infection observed after the harvesting of FGG are among the complications that appear at the first week after the operation.[20] Various treatment approaches are utilized on the donor site in order to reduce bacterial contamination and accelerate wound healing so that such complications are minimized and better conditions of post-operative wound care are provided.[20]

Recent studies have examined the post-operative morbidity of periodontal surgery and its effects on the quality of life.[32,33] A recent study reported by McGuire *et al.*[34] highlighted to raise awareness about the reliability, validity, sensitivity and clinical applicability of the use of current approaches for examination of post-operative morbidity and healing in periodontal surgery. Tonetti *et al.*[35] reported in their study which evaluated the post-operative healing period of periodontal plastic surgery using the scores obtained with OHIP-14 scale and showed a tendency to return to the patients' pre-operative scores at a 14-day follow-up period after the operation despite the initial increase.

The findings of our study showed that FGG operation had a negative effect on the patients' quality of life in the early postoperative healing period. In consisted with, Taşdemir *et al.*[36] showed that harvesting deepithelialized gingival graft affected the patients' quality of life in the early healing period. That study indicated that a statistically significant increase was observed in the OHIP-14 scores on day 6 after the operation, compared to the baseline condition, and that this effect started to decrease at week 2 postoperatively. It was also stated that the test group showed a better quality of life compared to spontaneous healing on day 6 after the operation, in parallel with the VAS values. It was particularly consistent with our study findings that the control group (spontaneous healing) showed higher VAS values regarding postoperative pain on days 1, 6 and 7 after the operation. These findings could be attributed to the fact that donor sites of the patients in the control group are more sensitive to stimulation since they are left for secondary healing.

The previous study reported by Özçelik *et al.*[37] which treated gingival recession using deepithelialized palatal graft, measured the patients' quality of life by OHQoL scale and showed that the values in the quality of life scale tended to return to the baseline values at week 1 after the operation. They pointed out in their study that VAS scores and OHQoL scale values of the test group were in correlation after the biostimulation of the operated area by using a diode laser and discussed that this difference may be attributed to the analgesic impact of laser therapy which accelerated the wound healing. In our study, the LLLT group had the lowest scores for the

physical pain, psychological discomfort and physical disability sub-scales of the OHIP-14 on day 14 after the operation. Furthermore, it was found statistically significant that application of LLLT had a positive effect with regard to the matters of diet and embarrassment expressed by the question 7 and 10 of the OHIP-14 scale. It was observed that the patients in the collagen group were disturbed the most by the sub-scales of physical pain, physical disability, social disability and handicap. This result could be explained by the potential disturbance caused by the sutures that was used to immobilize the collagen fleece or the potential allergenic characteristics of collagen.

Femminella *et al.*[21] assessed the post-operative wound healing and morbidity by applying PRF and gelatin sponge on the palatal wound area following the harvesting of epithelialized FGG. It was reported in the study that PRF provided a significant clinical benefit in accelerating the healing of palatal wounds and reducing post-operative morbidity by stimulating angiogenesis and epithelialization by the cytokines, glycoproteins and growth factors that it contains. In parallel with the results, PRF group showed significantly successful outcomes particularly in terms of post-operative pain in the VAS scale, moreover, the PRF group had lower scores compared to other groups for the sub-scales of physical disability and handicap with regard to the sub-scales of the OHIP-14 questionnaire.

Oliveira *et al.*[38] used the OHIP-14 questionnaire in their study to assess the impact of oral conditions on the quality of life. The ROC curve had a 82.7% accuracy in that study. They noted that OHIP-14 had a high sensitivity in indicating the impact of gingival recession and cervical dentin on the patients' quality of life, and reported that this was, above all, related to the conditions of physical pain, and physical and psychological disability which are defined as the sub-scales of OHIP-14. In our study, we believe that the fact that the outcomes related to the post-operative physical pain in the OHIP-14 TR scale are observed with lowest scores in the LLLT group in contrast with the results of the VAS scale may be associated with a decrease in cervical dentin sensitivity in connection with the amount of root coverage on the recipient site on day 14 in addition to the treatments procedures on the donor site. On the other hand, the fact that essix retainer group had the highest psychological discomfort score may be attributed to the obligation of the patients to use this retainer perpetually after the operation and the difficulty of the patients to tolerate the retainer. In addition, the fact that the control group had the highest mean of psychological disability values may be explained by leaving the wound for spontaneous healing without applying any treatment modalities on the donor site.

The previous studies which examined the wound healing of the palatal donor site after harvesting autogenous grafts, noted that the graft sizes might be related to post-operative morbidity.[39,40] In this sense, we aimed to standardize the size of the FGG for treatment of the deformities related to a single tooth zone in an effort to eliminate the potential differences. It should be considered that the differences of data among different groups arise from the patient's experience, duration of treatment, patient's reaction to anxiety/discomfort/pain, healing period and compliance with post-operative recommendation both during the treatment and post-operative healing period. In addition, it should take into account that different periodontal surgery procedures may affect the quality of life in different ways depending on the types of wound healing, i.e. primary or secondary healing of wound.

One limitation of the present study is that the study included a small study population and that no pre-study power analysis was possible to perform. However, as may be approved by many clinicians, the requirement to monitor the patients in defined time points frequently is the major challenge to increasing the patient population, and it is difficult to ensure maintenance of patients during the study period. Another limitation of the present study may be the fact that the number of analgesics taken by our patients could not be standardized. We think that this may have affected both the VAS values and certain sub-scales of the OHIP-14 questionnaire. In addition, even if the OHIP-14 scale was used to assess the patients' quality of life after the operation, non-comparison with the pre-

operative OHIP-14 scores can be considered another limitation of this study.

CONCLUSIONS

Within the limitations of the present study, it was observed that the application of LLLT on the palatal donor wound site following the FGG procedures may have positive effects on physical pain, psychological discomfort and physical disability with regard to the quality of life. It was also observed that PRF applications may have a favorable impact on the patient comfort with respect to the postoperative pain.

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None

CONFLICTS OF INTEREST

None

Serbest Dişeti Grefti Uygulanan Hastaların Ağız Sağlığı ile İlişkili Yaşam Kalitesinin Değerlendirilmesi

ÖZ

Amaç: *Ağız sağlığı ile ilişkili yaşam kalitesi bireyin, ağız sağlığının yaşam kalitesi ve genel sağlığını nasıl etkilediğini kişisel olarak algılamasıdır. Periodontal plastik cerrahi prosedürlerinin operasyon sonrası hastaların yaşam kalitesini negatif olarak etkilediği bildirilmiştir. Bu çalışmanın amacı, serbest dişeti grefti (SDG) uygulamasını takiben verici bölgenin iyileşmesi için uygulanan farklı tedavi prosedürlerinin yaşam kalitesi üzerine etkisini değerlendirmektir.* ***Gereç ve Yöntemler:*** *SDG operasyonu sonrası, 60 palatal donör bölge, her bir grupta 10 hasta olacak şekilde, randomize olarak altı gruba ayrılmıştır. Palatal yara bölgeleri trombositten zengin fibrin (TZF), essix plağı, ozon tedavisi, düşük-doz lazer tedavisi (DDLT) veya kolajen sünger materyali uygulamalarından biri ile tedavi edilmiştir. Kontrol grubuna herhangi bir tedavi uygulanmayarak sekonder iyileşmeye bırakılmıştır. Hastaların cerrahi işlem sonrası yaşam kalitesi Ağız Sağlığı Etki Profili-14 (OHIP-14) ölçeği ve postoperatif rahatsızlıklarına ilişkin parametreler ise Görsel Analog Skalası (VAS) ile değerlendirilmiştir.* ***Bulgular:*** *OHIP-14 ölçeğinin Türkçe versiyonuna (OHIP-14 TR) ilişkin sorularda, grup nitel değişkenleriyle soru 7 ve soru 10 nitel değişkenleri arasında istatistiksel olarak anlamlı ilişki bulunmuştur (p=0,002 ve p=0,015). Bu sorulara ait en düşük skorlar en çok DDLT grubunda verilmiştir. Toplam OHIP skoru (TOHIP) ve OHIP-14 anketinin 7 alt ölçeğine ait değerleri gruplar arasında istatistiksel açıdan herhangi bir fark göstermemiştir (p>0,05). VAS ölçeğine göre postoperatif ağrı düzeyleri değerlendirildiğinde, operasyon sonrası 5. günde TZF ile ozon grupları arasındaki fark istatistiksel olarak anlamlılık göstermiştir (p=0,011).* ***Sonuçlar:*** *SDG operasyonunu takiben verici yara bölgesine uygulanan DDLT yönteminin yaşam kalitesinde olumlu etkiler oluşturabileceği ve TZF uygulamasının operasyon sonrası hasta konforu açısından daha etkili olabileceği gözlenmiştir.* ***Anahtar Kelimeler:*** *Hemostatik yöntemler, lazer tedavisi, oral cerrahi işlemleri, yaşam kalitesi.*

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Original research

IS NOVAMIN TOOTHPASTE EFFECTIVE ON ENAMEL REMINERALIZATION? AN IN-VITRO STUDY

ABSTRACT

Objectives: New bio-active glass containing toothpaste (NovaMin) is one of the most effective cariostatic products when used as a daily application the aim of this in-vitro study is to evaluate the influence of NovaMin on enamel remineralization.

Materials and Methods: Twenty-eight sound human enamel samples were randomly divided into four groups (A-D) each having seven samples as follows: A (Novamin), B (1450 ppm NaF and Novamin), C (CPP-ACP), D (1450ppm NaF). After inducing caries-like lesions, each group was maintained daily for demineralization-remineralization cycle for seven days. During this cycle, samples were treated by the selected toothpaste for each group. Enamel mineral loss was assessed by surface microhardness. Surface enamel microhardness was determined on the enamel blocks. Non-parametric Kruskar-Wallis test compares the amount of surface microhardness recovery (SMHR%) across four different toothpastes.

Results: PLM data revealed a mineral precipitation band on the surface layer of all toothpastes; however, when compared to treated lesions, no statistically differences among the groups ($p>0.05$) were found.

Conclusions: NovaMin containing dentifrice has similar remineralization potential on carious-like lesions when compared to fluoride containing dentifrices.

Keywords: Toothpaste, tooth remineralization, tooth demineralization, in vitro techniques, tooth

*Zerrin Abbasoğlu[1]
Damla Akşit Bıçak[2]
Dilara Özenay Dergin[3]
Didem Kural[3]
İlknur Tanboğa[3]

ORCID IDs of the authors:
Z.A.0000-0002-0077-5581
D.A.B.0000-0002-0375-9026
D.Ö.D.0000-0003-3368-0463
D.K.0000-0002-6089-5569
İ.T.0000-0003-1383-5819

[1] Lecturer, Department of Pediatric Dentistry, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey
[1] Fellow, Division of Orthodontics, Faculty of Dentistry, University of Connecticut, Farmington, USA
[2] Lecturer, Department of Pediatric Dentistry, Faculty of Dentistry, Near East University, Nicosia, North Cyprus
[3] Department of Pediatric Dentistry, Faculty of Dentistry, Marmara University, Istanbul, Turkey

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***Corresponding Author**
Yeditepe Üniversitesi Dis Hekimliği Fakültesi Caddebostan Mahallesi Bağdat Cad. No:238, 34728 Goztepe / Kadıköy/Istanbul, Turkey
E-mail: zerrin.abbasoglu@gmail.com

INTRODUCTION

Preventive dentistry is one of the most preferred research subjects. In many of *in situ* and *in vivo* research projects in cariology, laboratory tests are used to examine dental caries, especially the impact of fluoride (F) on prevention of enamel-dentin demineralization and enhancement of remineralization.[1-4]

Demineralization is the first step in dental decay process, while remineralization controls and reverses the decay process. Demineralization occurs when the acidogenic bacteria reduce pH of the calculus. On the other hand, when Ca^{+2} and $PO4^{-3}$ ions in saliva increase the pH in calculus, remineralization process allows demineralized lesions to become remineralized. When demineralization is equal to or higher than remineralization, decay occurs.[5]

The buffer capacity of the saliva depends on the concentration levels of its Ca^{+2} and $PO4^{-3}$ ions. The amount of remineralization increases when the fluoride ions are in the saliva. Therefore, studies that deal with the prevention of caries and reversing the decay or the demineralization process are focused on the role of fluoride ions.

Some toothpastes include different formulas which are biocompatible with tooth structure chemically, and aim to decrease demineralization, prevent adhesion of bacteria on teeth, provide remineralization and prevent the sensitivity of dentin. According to most researchers, toothpastes that contain a similar dose of fluoride (500-1000 ppm) provide approximately the same effect on demineralization; however, fluoride concentrations of 500 ppm and under are accepted as minimum dose and have minimal effect on demineralization.[6,7]

The pH cycling model mimics mineral loss and remineralization procedures, needing smaller sample size and the response variables that can be employed in pH-cycling models are more sensitive than those available for use in the clinical situation.[8,9] In pH-cycling test, artificial enamel lesions are treated with oral hygiene products in demineralization and remineralization cycles to mimic oral pH-fluctuation patterns.[10,11]

Recently, bioactive glass materials have been introduced in many fields of dentistry. This material has numerous novel features the most important of which are its ability to act as a biomimetic mineralizer matching the body's own mineralizing traits while also affecting cell signals in a way that benefits the restoration of tissue structure and function.[12] Bioactive glass isconsidered to be a breakthrough in remineralization technology; it is a multicomponent inorganic compound made up of elements such as silicon, calcium, sodium and phosphorus.[13] The active ingredient is amorphous calcium sodium phosphosilicate. This compound in an aqueous environment release bioavailable calcium, sodium and phosphate ions contributing to the remineralization process.[14] However, the remineralization potential of bioactive glass has so far not been evaluated and compared with fluoride, CPP-ACP and bioactive glass with fluoride using an *in-vitro* pH cycling method. Artificial early caries like lesions of enamel show all the principal histological features of natural caries and are a useful analog for natural lesions when studying demineralization and remineralization of enamel *in-vitro*.[15] Hence the aim of this in-vitro study is to investigate the efficacy of bioactive glass containing toothpaste (Novamin) on remineralization of artificial incipient enamel lesion using pH cycling method.

MATERIALS AND METHODS

Enamel Block Preparation

A total of 28 human molar teeth were extracted due to periodontal problems. The soft-tissue debris on the teeth were cleaned and inspected for intact surfaces that are free from caries, hypoplasia, and white spot lesions.

35 enamel blocks (2x3mm) were formed from extracted human teeth using a diamond bur and kept in 2% formaldehyde solution at pH 7.0.[9] The specimens were embedded in the epoxy resin and the surface of the enamel blocks were grounded flat. Later the buccal surface of enamel blocks were polished using a 1.2 grit waterproof silicon carbide paper and water-cooled carborundum discs so that 50µm of the surface layer was removed and controlled with a digital

micrometer. The prepared samples were submitted to the microhardness test.

NovaMin- Toothpaste Evaluation

After treatment with different experimental dentifrices, enamel blocks were randomly selected into four groups of seven; in group A: teeth were treated with Dr. Collins Restore Toothpaste (NovaMin); in group B: teeth were treated with Sensodyne Repair And Protect Toothpaste (1450 ppm NaF and NovaMin); in group C: teeth were treated with Gc Toothmousee (CPP-ACP); for group D: teeth were treated with Sensodyne® Pronamel™ ® for Chidren (1450 ppm NaF). The ingredients of the experimental toothpastes are displayed in Table 1.

Table 1. Remineralizing agents used in the study

Materials	Ingredients*
Dr.Collins Restore Toothpaste (NovaMin)	Glycerin, Amorphous Silica, PEG 400, Sodium Lauryl Sulphate, Mint Flavor, Carbomer, Potassium Acesulfame, Titanium Dioxide, Novamin (Calcium Sodium Phosphosilicate)
Sensodyne Repair and Protect Toothpaste	Purified water, sorbitol, Liquid (non-crystallising), Silica, Dental type, Glycerol, Macrogols, Xanthan Gum, Titanium Dioxide (E171), Cocamidopropyl Betaine, Saccharin Sodium, Sodium Hydroxide, Titanium Dioxide, Flavour Blend 10926, Sodium Fluoride, Potassium Nitrate
GC Tooth Mousee	Pure water, CPP-ACP, D-sorbitol, CMC-Na, glycerol, propylene glycol, silicom dioxiode, titanium dioxide, xylitol, phosphoric acid, flavoring, zinc oxide, sodium saccharin, ethyl p-hydroxy benzoate, magnesium oxide, guar gum, propyl p-hydroxy benzoate, butyl p-hydroxy benzoate
Sensodyne Pronamel	Purified water, sorbitol, Liquid (non-crystallising), Silica, Dental type, Glycerol, Macrogols, Xanthan Gum, Titanium Dioxide (E171), Cocamidopropyl Betaine, Saccharin Sodium, Sodium Hydroxide, Mint Flavour 10926

*Informed by the manufacturers.

After inducing caries-like lesions, daily demineralization and remineralization cycles were applied for 7 days. After pH cycling, the surface was assessed, and the integrated loss of subsurface hardness calculated. Artificial caries-like lesions were formed on specimens of intact human enamel after demineralizing solution was applied for 32 hours.

Toothpaste Treatments and Remineralizing pH-Cycling Model

Samples were subjected to five pH cycles during 7 days at 37° C for each group.[16] During pH cycling blocks were put in a demineralization solution [Demineralization solution in 75 mmol/lt acetate buffer, pH 4.7; 2.2 ml/mm^2; 2.0 mmol/lt $Ca(NO_3)_2$. H_2O, 2.0 mmol/lt NaH_2PO_4. H_2O and 0.04 µg F/ml (NaF)] for 6 hours and in a remineralization solution [Remineralization solution, in 0.1 mol/lt cacodylate buffer, 7.0 1.1 ml/mm^2; 1.5 mmol/lt $Ca(NO_3)_2$. H_2O, 0.9 mmol/lt $NaH_2PO_4.H_2O$, 150 mmol/lt KCl and 0.05 µg F/ml NaF for 18 hours. The treatment included a bi-daily 1-minute soak in 2 ml/block of toothpaste/deionized water slurries (1:3 w/w) under agitation daily before the solution was changed from demineralization to remineralization or vice versa. Deionized water was applied before each step. Samples were kept in the remineralization solution for 2 days. This pH-Cycling model was developed by Vieira *et al.* [16]

Hardness Analysis

The hardness of the enamel surface was determined via the Surface Microhardness Analysis (SMH) before and after pH cycling with a Digital Micro-Vickers Hardness Tester (Wilson Wolpert; Europe BV, 401 MVD, Netherland). The Digital Micro-Vickers Hardness Tester was fitted with a Vickers diamond and 25 gram load was used to make indentations on the enamel surface. The loaded diamond was allowed to rest on the surface for 10 seconds.[17]

Three indentations spaced by 100 µm and in different parts of the enamel were taken at the baseline, and after the caries like lesion, after pH-cycling SMH was again determined and percentage of SMH recovery (%SMHR) was calculated (%SMHR=[(SMH3-SMH2) /(SMH1 - SMH2)]x100.[18] (SMH1: Baseline surface

microhardness, SMH2: After 32 hours demineralization application, SMH3: After pH-Cycling)

Statistical Analysis

Statistical analysis was performed using the SPSS 15.0 software for Windows (SPSS Inc., Chicago, IL, USA). Since the data do not follow a normal distribution, Kruskal-Wallis test was employed to compare parameters between groups. Also parameters within each group were compared by Wilcoxon sign test. In both tests, $p \leq 0.05$ was considered to be statistically significant.

RESULTS

The mean and SD values of enamel surface microhardness at baseline, after demineralization and after pH cycling with four different toothpastes were calculated.

In the groups the lowest value of the mean baseline surface microhardness was 5.28±0.63 and the highest was 28.35±10.77. Our results indicate that no statistically significant difference in mean microhardness levels existed across different toothpastes in either prior to or following demineralization ($p>0.05$). Similarly, no statistically significant difference was observed neither for mean microhardness levels after the application of toothpaste, or after remineralization ($p>0.05$).

For all four groups of toothpaste [i.e. Sensodyne Fluorine, Sensodyne repair, Toothmousse and Dr. Collins), the increase in microhardness from pre-demineralization levels to post-remineralization levels was statistically significant ($p<0.05$). The increase in microhardness from post-demineralization to post-toothpaste application levels was also statistically significant ($p<0.05$). Our results also suggest Novamin performs as well as other conventional toothpastes (Table 2).

Table 2. Assessment of microhardness according to types of toothpastes

	Sensodyne Fluor	**Sensodyne Repair**	**Toothmousse**	**Dr. Collins**	^{+}p
	Mean ± sd (Median)	**Mean ± sd (Median)**	**Mean ± sd (Median)**	**Mean ± sd (Median)**	
Pre Demineralization	6.70±3.30 (6.20)	8.35±3.50 (6.96)	6.62±1.63 (6.60)	7.22±1.82 (7.43)	***0.400***
Post Demineralization	5.91±1.09 (5.96)	5.50±1.30 (4.93)	5.55±1.09 (6.03)	5.28±0.63 (5.33)	***0.689***
Post Toothpaste Application	17.75±5.12 (19.63)	13.71±1.93 (13.23)	14.44±3.53 (14.90)	16.29±5.46 (17.73)	***0.381***
Post Remineralization	24.44±12.78 (22.26)	20.65±2.15 (19.83)	20.70±5.18 (21.40)	28.35±10.77 (22.73)	***0.497***
Post Remin – Pre Demin ^{++}p	***0.018****	***0.018****	***0.018****	***0.018****	
Post Toothpase – Post Demin. ^{++}p	***0.018****	***0.018****	***0.018****	***0.018****	

*$^{+}$ Kruskal Wallis Test $^{++}$ Wilcoxon sign test * $p<0.05$*

More specifically, the percentage increase of microhardness from pre-demineralization to post-remineralization phases do not statistically significantly vary across different types of toothpaste ($p<0.05$). Similarly, when we compare the percentage increases in levels of microhardness from pre-demineralization to post-remineralization across four types of toothpaste, we do not observe any statistically significant difference (Table 3).

Finally, no statistically significant difference exists among these four types of toothpaste when the percentage increases in microhardness levels are compared from post-demineralization to post-toothpaste stage ($p<0.05$) (Table 4).

Table 3. Percentage increase from Pre-demin to Post-remin

	Mean	p50	p25	p75	sd	*p*
Dr. Collins	325.76	263.93	133.68	467.31	215.95	
Sensodyne Fluor	303.22	304.73	121.45	362.50	207.77	
Sensodyne Repair	178.68	195.97	120.24	212.80	98.24	***0.495***
Toothmousse	226.18	236.48	112.55	350.00	104.43	
Total	258.46	221.04	127.56	347.96	167.74	

Kruskal Wallis Test (Post remin-Pre demin* 100/Pre-demin)

Table 4. Percentage increase from Pre-Demin to Post-Toothpaste (post toothpaste-pre demin)* 100/pre-demin)

	Mean	p50	p25	p75	sd	*p*
Dr. Collins	141.49	133.26	21.94	242.86	105.22	
Sensodyne Fluor	191.86	194.00	85.45	248.39	105.29	
Sensodyne Repair	80.37	68.97	45.83	109.90	52.89	***0.174***
Toothmousse	128.77	126.98	71.27	209.55	73.28	
Total	135.62	122.11	65.37	201.77	91.50	

Kruskal Wallis Test

DISCUSSION

Minimal invasive approaches that preserve healthy tooth structure have gained importance in dental practice in recent years.[19,20] Remineralization is the deposition of calcium, phosphate and other ions in the demineralized region.[21,22] Toothpastes containing new remineralization agents can be used due to their easy application, low cost and ability to prevent dental caries formation with their remineralizing properties.[19,20]

Fluoride has positive effects on dental caries, as well as toxic effects, which limit its use and its amount. It is widely accepted that fluoride is the most effective agent in protection against dental caries. However, there has been increasing debate over the use of fluoride in recent years. For this reason, studies towards different remineralization agents that are safer and as effective as fluoride have gained importance.[23] Therefore, we investigated the effectiveness of newly developed alternative remineralization agents, which is one of the most emphasized topics in today's preventive dentistry.

Novamin, also known as calcium sodium phosphosilicate, is a white, powdery, highly biocompatible compound that comes from the combination of body-produced minerals and bioactive glass.[24] Novamin reacts when it comes into contact with liquids, such as water, saliva, and releases calcium, sodium, phosphorus, and silica into the solution, resulting in hydroxycarbonate apatite crystals similar to the hydroxyapatite crystals that make up the mineral composition of enamel.[25] Bioactive glasses provide release of calcium and phosphate ions in the oral environment. Gjorgievska *et al.*[26] stated that toothpaste with bioactive glass gives successful results in hard tissue repair. Matsuyoshi *et al.*[27] found that toothpastes containing bioactive glass successful in terms of remineralization.

A number of studies, similar to ours, have focused on remineralization effect of Novamin. Palaniswamy *et al.*[28] 2016 compared the remineralization potential CPP-ACP (GC Tooth Mousse), Novamin and fluoride containing 'Sensodyne Repair and Protect' named toothpaste. The samples were tested for microhardness. Sensodyn Repair and Protect showed better results

initially, but eventually both had similar remineralizing potential as in the present study.[28] Also, Mony *et al.*[29] 2015 found that NovaMin was effective in improving the Ca/PO4 ratio and hardness in a demineralized enamel as fluoride. Similarly, we found that Novamin can be a new alternate material for remineralization of enamel.

In another in-vitro study, when they compared the remineralizing potential of four commercially available products namely SHY-NM (Novamin), GC Tooth Mousse Plus (CPP-ACP and 900 ppm fluoride), ReminPro (hydroxyapatite 1450 ppm fluoride and Xylitol) and Colgate strong teeth (1000 ppm fluorid) on demineralized human teeth, SHY-NM had the most remineralizing potential followed by ReminPro, GC Tooth Mousse Plus and fluoridated toothpaste.[30] Mettu *et al.*[31] reported that CPP-ACP increases enamel surface hardness. In a study, the CCP-ACP paste showed remineralization-inducing effect on artificially induced initial caries lesions. It was observed that this effect increased in direct proportion to the duration of application. Narayana *et al.*[32] 2014 found that Bioactive glass (SHY-NM) showed more remineralization potential than Fluoride tooth paste (Amflor), CPP-ACP (Tooth mousse), CPP-ACPF (Tooth mousse plus) using an in-vitro pH cycling method. In another contemporary study, the potential remineralization effect of topical NovaMin and Sodium Fluoride gel on caries like lesions in permanent teeth were compared. Specimens were then evaluated by a Surface Micro Hardness test. The researchers demonstrated that NovaMin dentifrice had a greater effect on remineralization of carious-like lesions when compared to that of fluoride containing dentifrice in permanent teeth.[33] However, Dr. Collins toothpaste (Novamin) showed similar remineralization potential to other dentrifices in our study. The differences on results between our study and other studies may be related to the ingredients of products or different amount of Novamin.

Furthermore, Mehta *et al.*[34], compared the remineralization potential of Novamin and CPP-ACP containing dentrifice. The baseline surface microhardness was measured using the vickers microhardness testing machine for all the specimens. Artificial enamel carious lesions were created by inserting the specimens in demineralizing solution and 10 days of pH cycling regimens was carried out. Although Novamin and CPP-ACP were found effective on remineralizing early enamel caries as in our study, the researchers demonstrated that novamin was more effectively remineralized the carious lesion when compared with CPP-ACP. Similarly, another study showed that Sensitive Pro-Relief and NovaMin® presented an advantage in enhancing remineralization and inhibiting demineralization for early enamel carious lesions in comparison with GC Tooth Mousse.[35] In our study both novamin and CPP-ACP containing dentrifices had similar effects in remineralization process *(*$p>0.05$).

Microhardness evaluations, either superficial or cross-sectional, imply quantitative measures that can evaluate minimum changes on mineral content and it is a widely used method and together with intra-oral models, has great importance in de- and re-mineralization experiments.[36,37] In this study, microhardness measurements after demineralization and after pH cycling are used to determine demineralization and remineralization changes on enamel surface. When the effects of toothpastes containing different remineralization agents on the surface microhardness were examined, it was observed that all agents used in this study had similar remineralization abilities. Our results indicated that no statistically significant difference in mean microhardness levels existed across different toothpastes in either prior to or following demineralization. Similarly, no statistically significant difference was observed either for mean microhardness levels after the application of toothpaste, or after remineralization. For all four groups of toothpaste (novamin contaning toothpaste, novamin and fluoride containing toothpaste, CPP-ACP containing paste and Fluoride-containing toothpaste) used in this study, the increase in microhardness from pre-demineralization levels to post-remineralization levels was statistically significant. The increase in microhardness from post-demineralization to post-

toothpaste application levels was also statistically significant. More specifically, the percentage increase of microhardness from pre-demineralization to post-remineralization phases did not statistically vary across different types of toothpaste. Similarly, when we compared the percentage increased in levels of microhardness from pre-demineralization to post-remineralization across four types of toothpaste, we didn't observe any statistically significant difference. Finally, no statistically significant difference was observed among these four types of toothpaste when the percentage increase in microhardness levels is compared from post-demineralization to post-toothpaste stage.

In all of the in vitro studies[28-35,38] described above in which human teeth were used; all researchers demonstrated Novamin as an effective remineralizing agent as in our study, but there were some differences found between the studies, such as novamin which was found more effective in some studies[34, 35] or less effective in other studies than dentrifices including fluoride and CPP-ACP. Some studies found no statistical differences between dentrifices in remineralizing potential as in our study.[28,29] The reason for these findings might be differences in pH-cycling regimens, microhardness evaluation methods, different ingredients of pastes, different mechanisms of remineralization processes of agents, differences in the forms and amounts of dentrifices used and differences in the tooth structures in these studies.

CONCLUSIONS

It was determined that all the remineralization materials applied to the initial enamel carious lesions prepared artificially on the enamel surface had statistically significant remineralization effect and these remineralization materials can be successfully used in cases of initial enamel caries.

Toothpastes used in this study were effective in maintaining remineralization after pH cycling but no difference was observed among the groups.

There was no significant difference among groups in surface microhardness value after pH cycling.

NovaMin dentifrice appears to have an effect on remineralization of carious-like lesions similar to that of fluoride and CPP-ACP containing dentifrices. Therefore novamin-containing products can be used as an alternative to fluoride and CPP-ACP.

More extensive scientific studies are needed to prevent the formation of dental caries or to develop effective agents in the initial stages of treatment. Our study may direct future researchers to conduct new studiesfor this purpose.

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None

CONFLICTS OF INTEREST

None

Novamin Diş Macunu, Mine Remineralizasyonu Üzerine Etkili Mi? Bir İn-Vitro Çalışma

ÖZ

Amaç: *Yeni biyo-aktif cam içerikli diş macunu (Novamin) günlük diş macunu olarak kullanıldığında etkili diş çürüğü oluşumunu azaltan ürünlerden birisidir. Bu in-vitro çalışmanın amacı, Novamin'in mine remineralizasyonu üzerindeki etkisinin değerlendirilmesidir.* ***Gereç ve Yöntemler:*** *28 sağlam insan diş minesi, rastgele A-D olarak adlandırılan 4 ayrı grubu içermektedir: A (Novamin), B (1450 ppm NaF and Novamin), C (CPP-ACP), D (1450ppm NaF). Örneklerde çürük benzeri oluşturduktan sonra her grupta günlük demineralizasyon ve remineralizasyon döngüsü 7 gün boyunca devam ettirilmiştir. Bu döngü esnasında her gruptaki örneklere seçilmiş değişik diş macunu uygulanmıştır. Diş minesinden mineral kaybı, örnek mine bloklarının yüzey mikrosertliği ile değerlendirilmiştir. Dört farklı macunun yüzey mikrosertlik geri kazanım (%YMGK) miktarinin karşılaştırılması parametrik olmayan Kruskar-Wallis ile yapılmıştır.* ***Bulgular:*** *PIM ile yapılan ölçüm verileri ile örneklerin diş minesi üzerinde bir mineral çöküntü tabakası görülmüş fakat minedeki remineralizasyon tabakası arasında bir fark*

görülmemiştir (p>0,05). Sonuçlar benzer kaynaklı ve konsantrasyonlu fluorid içeren diş macunlarının değişik derecede remineralizasyona neden olduğunu göstermiştir. ***Sonuçlar:*** *Novamin içerikli diş macunları, fluorid içerikli dişmacunları ile karşılaştırıldığında çürük benzeri lezyonlarda benzer remineralizasyon potansiyeline sahiptir.* ***Anahtar kelimeler:*** *Diş macunu, diş remineralizasyon, diş demineralizasyon, in vitro teknikler, diş.*

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Original research

EFFECTS OF SPEED SINTERING ON MULTILAYERED MONOLITHIC ZIRCONIA

ABSTRACT

Objectives: In dentistry, different products are being developed in order to shorten the chairside but the interactions between these materials needs further investigations. This study aims to investigate the two different short time sintering protocols on monolithic multilayered zirconia's surface roughness (SR), translucency parameter (TP), and contrast ratio (CR).

Materials and Methods: 20 monolithic multilayer zirconia specimens were prepared with the dimension 10x10x1 mm and divided into two sintering groups (speed sintering group 30 min at 1510 ^{0}C, high speed sintering group 10 min 1580 ^{0}C) and SEM analyzed was performed. Surface roughness tests were performed by using profilometer and optical measurements were performed by using spectrophotometer. The data was statistically analyzed by using Wilcoxen test at the 0.05 probability level.

Results: Surface roughness and contrast ratio among groups were not statistically different. In all parts of monolithic multilayered zirconia, the difference of TP between sintering groups were statistically significant ($p<.05$). No obvious grain size difference was detected according to the SEM images.

Conclusions: High speed sintering parameters has promising effects on monolithic multilayered zirconia with combined acceptable optical properties. Because of their different content, different layers show different reactions in terms of contrast ratio and translucency parameters and these changes should be taken into account in treatment planning.

Key words: Zirconia, sintering, contrast ratio, translucency

*Mehmet Emre Coskun[1]
Fatih Sarı[2]

ORCID IDs of the authors:
M.E.C.0000-0002-2430-5170
F.S.0000-0002-4818-8562

[1] Department of Prosthodontics, Faculty of Dentistry, Sivas Cumhuriyet University, Sivas, Turkey.
[2] Department of Prosthodontics, Faculty of Dentistry, Gaziantep University, Gaziantep, Turkey.

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***Corresponding Author**
Cumhuriyet University, Faculty of Dentistry, Department of Prosthodontics Sivas, Turkey.
Tel : +90 346 2191010-2758 **Fax:** +90 346 2191237 **E-mail:** dtcoskun@hotmail.com

INTRODUCTION

The approved high flexural strength, fracture toughness, corrosion resistance, biocompatibility, and the chemical stability increase the acceptance and the demand of the zirconia over metal-ceramic restorations in prosthetic dentistry.[1–4] Zirconia is widely used in most prosthetic rehabilitation scenario, the applications in prosthodontic scope are ranged from a single framework veneered with ceramic to the full arch monolithic restoration, from an implant body and the abutment to the screw retained implant supported full arch prosthesis. The most frequent problem of zirconia restorations is chipping, failure of the zirconia-ceramic bond strength[5], which was mentioned that the occurrence frequency is 13% after three years.[6] Recently, full anatomic monolithic zirconia restorations are introduced to overcome the chipping issue[7] with the advantages of the decreasing cost and production time, sufficient fracture toughness within the minimal invasive preparation depth[8–10] and ease of application.[11] However, such restorations are not satisfactory for the rehabilitation of the anterior region because of the opacity of the zirconia. The enhancement of the crystalline content to improve the mechanical properties, deteriorate the optical properties owing to the discrepancies of the refractive index of multiple crystalline structure of zirconia.[12]

Making tooth like zirconia restorations, the major concern to mimic the natural appearance is to replicate the color of tooth. Two different methods are performed for coloring zirconia. The first attitude in order to obtain different shades of color is immersing the zirconia into colorant rare earth element chloride solution. This method is easy to perform, time saving, and useful for the frameworks which are veneered with ceramics however, two failings, irregular color distribution and different color regions after grinding for the modification of substructure due to the amount of infiltration depth.[13] Furthermore, Tuncel *et al.*[14] mentioned that the colorant solution increase the contrast ratio. The latter attitude to produce the different color zirconia is adding the metal oxides into the zirconia structure in manufacturing stage which alters the microstructure. Adding metal oxides to obtain o homogenous color distribution, increases the translucency.[15] However, adding metal oxide is not the only determinant for the optical properties of the zirconia. Translucency, the amount of light passing through the material[16], depends on the sintering parameters and the additives into the zirconia powders before pressing.[17] Especially, surface roughness (SR), grain size, amount of crystallographic transformation (monolithic→tetragonal), density, pores within the structure are determined by sintering temperature and dwelling time.[18]

In sintering process, the pores between particles within the granular material decreased by atomic diffusion.[19] The Increasing temperature and dwelling time of sintering process made the grain size larger and forms the zirconia much translucent.[7] The common method of conventional sintering (CS) process is placing the samples into the furnace at room temperature and regulating the heat rate, holding temperature, holding time, and cooling rate according to the manufactures' instructions. However, only one sintering protocol is advised, but there are a lot of differences in terms of sintering protocols. For instance, unlike the routine process of CS, in the novel sintering protocol [high-speed sintering protocol (HS)] the samples are placed into the furnace which have already reached the sintering temperature (1580 ^{0}C) and hold only for 10 minutes. For this reason, searching the interaction between optical properties of zirconia and sintering parameters is of great importance.

Optical properties are also depends on the surface texture[20] which arranges the direction of light reflection; the rougher surface, the more scattered light reflection.[21] On the other hand, it is a complex issue and hard to clarify the relation between surface texture and light scattering.

Recently, multi-layer monolithic zirconia with the help of state of art furnace, along with a HSP, are more preferred over other prosthetic restorations in order to shorten the treatment time. However, there is no publication in the literature searching the effect of HSP on the optical properties of multi-layered monolithic zirconia. Until now, only the effect of HSP on flexural strength were investigated in literature and mentioned that the flexural strength was higher than CS.[22]

Therefore, this in vitro study aimed to investigate the effect of speed and high-speed sintering protocols on surface roughness and translucency at all layers of monolithic multi-layered zirconia. The tested hypotheses were that the decreased dwelling time with the increased temperature would (a) decrease on surface roughness and (b) improve optical properties, decrease the contrast ratio and increase the translucency parameter, at all layers of the multi-layered zirconia.

MATERIALS AND METHODS

Specimen preparation

CAD-CAM-milled, square shape (10 mm x 10 mm) 20 specimens of 1 mm thickness were prepared from pre-shaded (A light) multi-layered monolithic zirconia (ML, Katana, Noritake, Japan). Specimens were divided into two groups according to the sintering parameters (n:10).

The high-speed sintering protocol (HS): The specimens were placed in a heated furnace inFire HTC Speed (Sirona, Bensheim, Germany) at 1580 ^{0}C for 10 min and take out for bench cooling immediately. The total sintering protocol with dwelling time is 10 min.

The speed sintering protocol (SS): The specimens were placed into the furnice at room temperature and placed for 30 min at 1510 ^{0}C than cooled to 600 ^{0}C then bench cooling. All sintering protocols were performed in inFire HTC Speed (Sirona, Bensheim, Germany).

Surface roughness test

All specimens were cleaned ultrasonically with isopropanol for 5 min before surface roughness test. Tests were performed by using profilometer (Surftest SJ-301; Mitutoyo, Tokyo, Japan) with a travelling distance of 2 mm across the layers (enamel, transition, body) of the specimens. 6 measurements from each layer were used to determine the average Ra (μm) value.

Optical Properties

The specimens from all groups were optically analyzed by using spectrophotometer using D65 light (Easyshade advance; Vita Zahnfabrik, Badsackingen, Germany) according to the CIELab* scale for three times from each layer. Two different black (CIE L*= 1.1 a*=13.8 b*=52.2) and white (CIE L*= 17.6 a*= 2.0 b*= 6.6) backgrounds were used for measurements. Increase in value means increase in translucency. The formula used for the translucency parameter (TP) calculation:

$$TP = [(L_B - L_W)^2 + (a_B - a_W)^2 + (b_B - b_W)^2]^{1/2}$$

The contrast ratio (CR) measurements were performed using the formula:

Y_B/Y_W, where Y is: $[(L+16)/116]^3$ x 100

In all formulas the B represents the black background, while W represents white background.[23] According to the CR value calculations '0' represent translucent and '1' is opaque.

Statistical analysis

The numerical data was checked for normal distribution using Shapiro-Wilk test and analyzed using Wilcoxen test by SPSS 22.0 statistic (SPSS Inc, Chicago, USA) at a significant level of P<.05.

RESULTS

The mean values of optical measurements and SR were depicted in Table 1 and Figure 1.

Table 1. The mean values and standard deviations of surface roughness, contrast ratio and translucency parameter.

Groups	Enamel	Transition	Body
SR HS	0.64±0.13	0.61±0.07	0.55±0.09
SS	**0.61±0.1**	**0.55±0.15**	**0.57±0.11**
CR HS	0.82±0.01	0.80±0.02	0.82±0.03
SS	**0.83±0.02**	**0.83±0.02**	**0.81±0.02**
TP HS	9.59±0.67^b	9.7±1.05^e	9.89±1.11^g
SS	**3.09±0.11^b**	**3.1±0.17^e**	**3.14±0.18^g**

* Surface roughness (SR); contrast ratio (CR); translucency parameter (TP); high speed sintering (HS); speed sintering (SS). The values with same superscript means statistically significant difference (p<.05.)

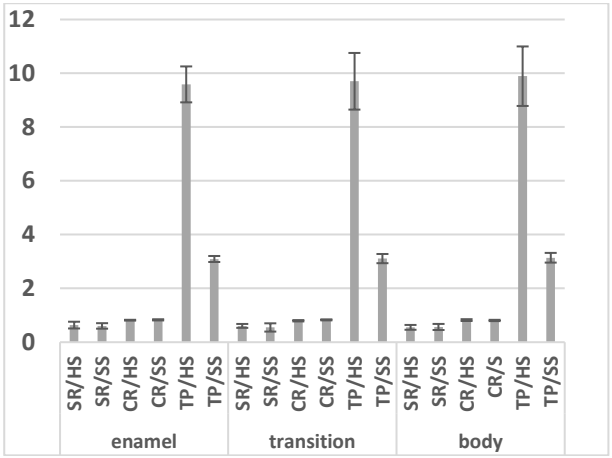

Figure 1. The mean values and standard deviations of obtained optical properties, and surface roughness. Translucency parameter (TP); contrast ratio (CR); surface roughness (SR); high speed (HS); super speed (SS).

As it was mentioned, SR didn't show significant difference at any layer between sintering groups. The mean CR showed no significant difference on any part of the zirconia in all sintering groups. The only significant difference was obtained on translucency, in all groups significant difference was detected between sintering groups and the mean TP values were always higher in HS groups and the difference showed an increase from enamel to body. Molecular diversity among layers was detected according to SEM images however, the difference between the grains was not clearly determined (Figure 2).

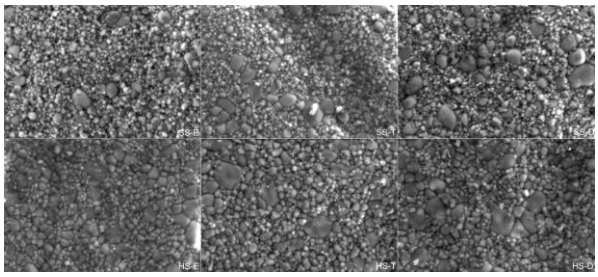

Figure 2. SEM images of the samples. Speed sintering enamel (SS-E), speed sintering transition (SS-T), speed sintering dentin (SS-D), high speed sintering enamel (HS-E), high speed sintering transition (HS-T), high speed sintering dentin (HS-D).

DISCUSSION

According to the results of the study which compare the surface textures and optical properties, decreased dwelling time with the increased temperature would not have a significant effect on SR and CR of the zirconia, however the TP values were improved, so the first hypothesis was rejected.

The first mentioned topic would be the effect of high speed sintering protocol on mechanical properties of zirconia, since the specimens were sintered at a pre-heated furnace. Internal stresses are expected to occur as the material is subjected to sudden heat changes and these stresses must deteriorate the mechanical properties of the material. However, Ersoy *et al.*[22] compared the flexural strength of different zirconia brands which were sintered at 1510^0 for 120 min, 1540^0 for 25 min, and 1580^0 for 10 min and mentioned that the highest flexural strength values for all brands were obtained at 1580^0 for 10 min groups. The optical improvement of anatomic monolithic zirconia sintered at high speed parameter was detected in this research and this is due to the fact that the last temperature applied in the sintering process was higher.

In the present study, the SR of the different sintered monolithic zirconia was evaluated. The obtained data showed that there was no significant difference between groups. Although, increasing the sintering temperature reduce the SR via decreasing the gaps between zirconia molecules, the results obtained in this study did not support this situation and it is thought to be due to the short duration of high temperature application.

In this research, a SEM evaluation was used to determine the grain size changes. However, due to the molecular diversities, precise indication of the effect of the two different sintering processes on grain size has become complicated and needs quantitative analyses. For this reason, the interpretation of grain size changes in zirconium after different sintering protocols is based on the value of translucency.

In literature, the relation between grain size and translucency of zirconia mentioned in many research and indicated that the translucency was increased parallel with the increasing grain size.[7,24] However, this optical improvement is not endless; the scattering effect of the zirconia increased when the grain size becomes equivalant to the wavelenght of the light (400-700 nm) and this make the material opaque.[25] Besides, it can not be obtained an expansion of grain size at this level by the sintering process that have been prefered in the literature or adviced by the manufactures. Despite the short dwelling time in the HS group, higher

molecular expansion is obtained due to the higher sintering temperature and as a result much translucent material is formed. This result emphesises that the sintering temperature is the major determinant for the grain size.

According to the results of recent study, monolithic zirconia became more translucent in HS group and the most translucent part was identified as the body part of the multi-layered zirconia which is darkest region to mimic the dentinal part of the tooth. Such a result may be attributed to the increment of the zirconia grain caused by the higher sintering temperature. While the higher TP may be a positive factor to meet aesthetic expectations, no matter which sintering parameter is preferred, there is no change in the CR of monolithic zirconia. For this reason, the prosthetic treatment on anterior region to fulfillment of the aesthetic expectation, must be considered carrefully.

The limitation of this study is the performing the tests on only one zirconia brand. The results may not be convenient for other commercial products with different grain sizes, different content, and different manufacturers. Furthermore, each manufacturer may recommend a different sintering parameter for its product.

CONCLUSIONS

According to the results of the study within the limitations, it can be summarized that:

Time-saving sintering process made the zirconia much translucent.

Although sintering process carried out in reverse, no adverse effect is caused on optical properties of zirconia.

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CONFLICTS OF INTEREST

The authors have no declared financial interests in any company manufacturing the types of products mentioned in this article.

Hızlı Sinterlemenin Çok-Katmanlı Monolitik Zirkonya Üzerine Etkisi

ÖZ

Amaç: *Diş hekimliğinde, koltukta geçirilen sürenin kısaltılması adına farklı ürünler geliştirilmektedir fakat bu ürünlerin birbiriyle olan etkileşimleri daha ileri araştırmalara ihtiyaç duymaktadır. Bu çalışma, monolitik çok-katmanlı zirkonyanın yüzey pürüzlülüğü (SR), translüsentlik parametresi (TP) ve kontrast oranı (CR) üzerine iki farklı kısa süreli sinterleme protokolünün etkilerini incelemeyi amaçlamaktadır.* ***Gereç ve Yöntemler:*** *20 adet 10x10x1 mm boyutlarında monolitik çok-katmanlı zirkonya örnekler hazırlanıp, iki farklı sinterleme grubuna ayrıldı (1510 0C' de 30 dk' lık hızlı sinterleme grubu, 1580 0C' de 10 dk' lık yüksek hızlı sinterleme grubu) ve SEM analizleri gerçekleştirildi. Profilometre yardımıyla yüzey pürüzlülük değerleri ölçülürken, spektrofotometre kullanılarak optik özellikleri tespit edildi. Elde edilen verilerin analizinde Wilcoxen testi kullanıldı ve anlamlılık düzeyi 0,05 olarak ayarlandı.* ***Bulgular:*** *Gruplar arasında yüzey pürüzlülük değerleri ve kontrast oranları bakımından istatistiksel olarak önemli bir farklılık tespit edilmedi. Sinterleme grupları arasında, monolitik çok-katmanlı zirkonya örneklerin bütün katmanlarının translusentlik değerleri arasındaki fark istatistiksel olarak önemli olarak tespit edildi (p<.05).* ***Sonuçlar:*** *Yüksek hızlı sinterleme parametreleri, monolitik çok-katmanlı zirkonya üzerinde kabul edilebilir optik özelliklerle birlikte umut verici etkilere sahiptir. Farklı içerikleri nedeniyle, farklı katmanların kontrast oranı ve translusentlik parametreleri farklı reaksiyonlar gösterebilmektedir ve bu farklılıklar tedavi planlamasında dikkate alınmalıdır.* ***Anahtar Kelimeler:*** *Zirkonya, sinterleme, kontrast oranı, translusensi.*

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Original research

CLINICAL AND RADIOLOGICAL EVALUATION OF ELONGATED STYLOID PROCESS IN PATIENTS WITH TEMPOROMANDIBULAR JOINT DISORDER

ABSTRACT

Objectives: Clinical findings of elongated styloid process (SP) can easily be confused with clinical symptoms associated with temporomandibular joint disorders (TMD). This study aims to investigate the presence of elongated SP in patients with TMD.

Materials and Methods: This retrospective study was performed on the digital panoramic radiographs of 300 patients between 14-68 years of age, where the study group consisted of 150 (300 SP) patients diagnosed with TMD and the control group consisted of 150 (300 SP) individuals without TMD. 224 of the patients were female and 76 were male. SP measurement was performed by a physician with radiography experience. The measurement values higher than 30 mm were accepted as elongated SP.

Results: There was a significant difference between the TMD group and the control group in terms of SP length ($p<0.05$). While 62% of the patients with TMD had elongated SP, this rate was 38% in the control group.

Conclusions: Elongated SP rate was higher in patients with TMD. Since TMD and Eagle syndrome have similar clinical findings, physicians should consider the differential diagnosis of patients with TMD compared to Eagle's syndrome.

Key words: Temporomandibular joint disorder, eagle syndrome, styloid process

Günay Yapıcı Yavuz[1]
*Aydın Keskinrüzgar[1]

ORCID IDs of the authors:
G.Y.Y.0000-0002-1093-6297
A.K.0000-0001-5735-6890

[1] Department of Oral and Maxillofacial Surgery Faculty of Dentistry, Adıyaman University, Adıyaman, Turkey

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***Corresponding Author**
Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Adıyaman University, 02000, Adiyaman, Turkey
Phone : +90 416 2251920 **E-mail :** akeskinruzgar@gmail.com

INTRODUCTION

The number of patients with temporomandibular joint disorder (TMD) and orofacial pain has been increasing. Approximately 40% to 75% of the population exhibit TMD symptoms.[1,2] TMD is a term used for diseases that affect a large area including the temporomandibular joint (TMJ) and the chewing muscles. In the preauricular region, symptoms such as pain on palpation, limited jaw movements, joint noises, persistent pain, headache, ear pain, tinnitus, and dizziness are observed accompanying TMD. These symptoms can sometimes be confused with the symptoms of other diseases in this region.[1,3,4]

Eagle syndrome is not widely known among dentists. The styloid process (SP) in the temporal bone is located near the TMJ on the inferior side of the skull. Styloid process is a 20-30 mm long cylindrical bone, which is located in the caudal-anterior and slightly medial direction, near important cervical veins and nerves. When the SP is longer than 30 mm, it is defined as an elongated SP.[4,5] Symptomatology, clinical and radiological diagnosis and treatment of elongated SP were first described by Eagle in 1937.[6] The SP is also known as styloid syndrome, stylohyoid syndrome, elongated styloid protrusion, and styloid protrusion neuralgia. Eagle syndrome is a term used for the symptomatic extension of the SP or the mineralization of the stylohyoid or stylomandibular ligament.[7,8] Elongated SP may be asymptomatic, however, when symptoms occur (Eagle syndrome), foreign body sensation in the throat, dysphagia, ear pain, headache, eye pain, pain in the TMJ area, and tooth pain may be present.[5,9,10] Many of these findings may also be associated with TMD. Some findings can be found in both TMD and Eagle syndrome.[9,10] In the diagnosis of elongated SP, pain occurring during palpation of the tonsillar fossa and SP felt by hand are used and this diagnosis can be supported by digital panoramic radiography and computed tomography.[11] The aim of this study was to determine the SP length from the digital panoramic images in TMD patients.

MATERIALS AND METHODS

This study was approved by the Adiyaman University Non-Interventional Clinical Research Ethics Committee (Protocol no: 2018 / 4-27). The study protocol consisted of two groups of patients who applied to Adiyaman University, Faculty of Dentistry, Oral and Maxillofacial Surgery Clinic; one group consisted of patients diagnosed with TMD (TMD group) while the other group included individuals who did not have any complaints in the TMJ region and the surrounding area (control group). For the diagnosis of TMD, RDC/TMD criteria (research diagnostic criteria for TMDs) were taken into account.[12] Also, pain and tenderness in the TMJ region and in the masticatory muscles lasting at least 3 months, a psychopathological disease and the absence of previous TMJ surgery were included in the selection criteria.[12] In this retrospective study, digital panoramic radiographs of 150 patients (300 SP) in the TMD group and 150 individuals (300 SP) in the control group were analyzed and SP was evaluated bilaterally. Clinical and radiological examinations were performed by an experienced oral surgeon. The radiograph results were randomly numbered by another investigator without separation into groups, ensuring the reliability of the study result. The digital panoramic radiographs that were utilized in this study were taken with a panoramic x-ray device (Planmeca, Promax, Helsinki, Finland) at the Faculty of Dentistry of Adiyaman University. The length of SP was measured by an experienced oral surgeon with the digital bar of Romexis 2.9.2 program which was used in the Faculty of Dentistry during radiographic evaluations. Digital measurement calibration was performed before each measurement. The length between SP endpoint and tympanic bone was measured to determine the SP length, as described by İlgüy *et al.*[13] A SP length of 20-30 mm was defined as normal length, whereas longer SP was called elongated SP (Figure 1).

Figure 1. Measurement of bilateral elongated styloid process.

Statistical Analysis

The data obtained in this study were analyzed with IBM SPSS Statistics Version 22 package program. When analyzing the variables with a normal distribution, Shapiro Wilks was used because of the number of units. When interpreting the results, 0.05 was used as the level of significance. In the case of $p<0.05$, the variables were assumed not to have a normal distribution, while for $p>0.05$ it was stated that the variables exhibit a normal distribution. When examining the differences between the groups, the Mann Whitney U Test was used because the variables did not have a normal distribution. The chi-square analysis was applied to examine the relationships between the groups of the nominal variables. When interpreting the results, 0.05 was used as the level of significance and it was stated that there was a significant relationship in the case of $p<0.05$ and no significant relationship in the case of $p>0.05$.

RESULTS

The study consisted of 150 patients with bilateral TMD (300 SP) and 150 control patients (300 SP). Of these patients, 224 were female and 76 were male, aged between 14-68 years. The TMD group consisted of 115 females and 35 males, and the mean age was 29.98 ± 11.8 years, while the control group consisted of 109 women and 41 men, with a mean age of 30 ± 7.8 years. There was no statistically significant difference in terms of gender between the groups ($p>0.05$). There was also no statistically significant difference with respect to age between the groups ($p>0.05$). Age and gender distributions between the groups were homogeneous (Table 1).

Table 1. Distribution of the sex and age between groups.

		Groups				
		TMD		Control		Chi Square Test p value
		n	%	n	%	
Sex	Female	115	76.7	109	72.7	0.426
	Male	35	23.3	41	27.3	

	Groups		
Age	TMD Mean±sd	Control Mean±sd	Mann Whitney U Test p value
	29.98±11.1	30±7.85	0.350

TMD: Temporomandibular Joint Disorders **Sd:** Standard deviation

There was a statistically significant difference in SP length between the groups ($p<0.05$). The mean length of SP in the TMD group was 32.65 ± 6.35 mm (Min: 17.6; Max: 62.5), while the mean SP was 29.36 ± 3.92 mm in the control group (Min: 20.4; Max: 41.4) (Table 2).

Table 2. Comparison of groups in terms of bilateral styloid process.

	n	Mean(mm)	Min	Max	sd	Mann Whitney U Testi p value
TMD	300	32.65	17.6	62.5	6.35	**0.000**
Control	300	29.36	20.4	41.4	3.92	

TMD: Temporomandibular Joint Disorders, **Sd:** Standard deviation.

In addition, 62% of patients with TMD had elongated SP and 38% had normal SP. In the control group, 63% of the patients had normal SP lengths and 27% of them had elongated SP (Table 3).

Table 3. Elongated styloid process rate in the TMD and control groups

Styloid process lengths	Bilateral TMD (n=300)	Bilateral Control (n=300)
>30 mm	186 (%62)	111 (%37)
<30 mm. 30mm	114 (%38)	189 (%63)

TMD: Temporomandibular Joint Disorders

DISCUSSION

Elongated SP is a common condition and its prevalence is between 1.4% and 83.6%.[14-16] According to the literature, most elongated SPs are not associated with any clinical symptoms. A low percentage of patients with orofacial and neck pain (approximately 5%) have been reported to have elongated SP.[17] The etiology of elongated SP is still unknown. It has been reported that there may be various reasons such as congenital elongation, stylohyoid ligament ossification and

osseous tissue growth on the stylohyoid ligament.[18] Eagle syndrome, which occurs when elongated SP is symptomatic, is difficult to diagnose because its symptoms resemble the symptoms of pathologies originating from the oral and maxillofacial region. It can be easily confused with a toothache and TMD, which may result in misdiagnosis and unnecessary procedures. Therefore, dentists should be aware of the differential diagnosis of these diseases.[19]

Both detailed patient anamnesis and radiological analysis should be done in elongated SP patients. Therefore, the radiological analysis is very important in these studies. Andrade *et al.* compared the results of digital lateral cephalometric radiography and digital panoramic radiography to determine the SP length and found that the results were close to each other which suggested the digital panoramic radiographs to be a reliable method in the measurement of SP length.[1] Similarly, digital panoramic radiography images were used for SP measurements in the present study.

There is no consensus regarding the relationship between SP length and gender; although some studies[20,21] report that SP length and gender are associated, others[4,7,10,13] report that there is no relationship between SP length and gender. In our study, there was no statistically significant association between the SP length and gender.

There is no consensus regarding the relationship between SP length and age. While several studies[20,21] have reported that there is a relationship between SP length and age, others[7,20-23] have reported that there is none. In our study, we found no statistically significant relationship between the SP length and age.

There are very few studies on the prevalence of elongated SP in patients with TMD. Zaki *et al.*[9] reported that 27% of the patients with TMD had elongated SP in a study on 100 patients. De Andrade *et al.*[1] investigated SP length and clinical symptoms in a study on 50 patients with TMD and found that 76% of patients had elongated SP. They reported that elongated SP prevalence was high in patients with TMD, but there was no correlation between symptoms such as a headache, orofacial pain, tinnitus and vertigo, and the SP length. Krohn *et al.*[4] found that the mean SP was 40.8 mm in patients with TMD and the prevalence of elongated SP was high. In contrast to these studies, Sancio-Golçalves *et al.*[10] reported that there was no statistically significant association between TMD and SP length.

In our study, the mean SP length was 32.65 mm and 29.36 mm in the TMD group and the control group, respectively. While 62% of the patients with TMD had elongated SP, 38% had normal SP. These data suggest that the prevalence of elongated SP is high in patients with TMD. The present study analyzed the highest number of SPs in the literature. In addition, this study is the first to examine the relationship between TMD and elongated SP in the Turkish population.

CONCLUSIONs

Based on the findings of our study, we conclude that:

- Panoramic radiographs are sufficient for determining SP length.

- The prevalence of elongated SP in patients with TMD is high. Dentists should examine patients presenting with TMD in clinically and radiologically more detail and should consider Eagle's syndrome for differential diagnosis in the presence of elongated SP.

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None

CONFLICTS OF INTEREST

None

Temporomandibular Eklem Düzensizliği Bulunan Hastalarda Styloid process Uzamasının Klinik ve Radyolojik Olarak Değerlendirilmesi

ÖZ

Amaç: *Uzamış styloid process klinik bulgular, TMD ile ilişkili klinik semptomlar ile kolaylıkla karışabilmektedir. Bu çalışma TMD bulunan hastalarda uzamış SP varlığının araştırılmasını amaçlamaktadır.* ***Gereç ve Yöntemler:*** *Bu çalışma, TMD tanısı konulan 150 (300 SP) hasta ve kontrol*

grubu olarak da 150 (300 SP) bireyin dijital panoramik radyografileri retrospektif olarak incelenmesi ile yapıldı. Hastaların 224'ü kadın ve 76'sı erkek olup, 14-68 yaş aralığındadır. SP ölçümü radyografi üzerinde tecrübeli bir hekim tarafından yapıldı. 30 mm'den yüksek olan ölçüm değeri uzamış SP olarak kabul edildi. ***Bulgular:*** *Gruplar karşılaştırıldığında, TMD bulunan grup ile kontrol grubu arasında SP uzunluğu bakımından anlamlı farklılık bulunmuştur (p<0,05). TMD bulunan hastaların %62 uzamış SP mevcut iken, kontrol grubunda bu oran %38'dir.* ***Sonuçlar:*** *TMD bulunan hastalarda uzamış SP oranı daha fazla görülmektedir. TMD ve Eagle sendromu benzer klinik bulgulara sahiptir. Bu nedenle, hekimler TMD bulunan hastaları muayene ederken Eagle sendromu bakımından da ayırıcı tanısını göz önünde bulundurmalılardır.* ***Anahtar Kelimeler:*** *Temporomandibular eklem hastalığı, eagle sendromu, styloid proçes.*

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Original research

COMPARISON OF CYCLIC FATIGUE RESISTANCE OF ONE CURVE, HYFLEX EDM, WAVEONE GOLD AND RECIPROC BLUE NICKEL-TITANIUM ROTARY FILES AT INTRA-CANAL TEMPERATURE

ABSTRACT

Objectives: To compare the cyclic fatigue resistances of One Curve (OC), Hyflex EDM (HEDM), WaveOne Gold (WOG), Reciproc Blue (RPC Blue), and nickel-titanium rotary files at intra-canal temperature (35°C).

Materials and Methods: Twenty OC (25/.06), 20 HEDM (25/.08), 20 WOG (25/.07) and 20 RPC Blue (25/.08) files were tested for cyclic fatigue at intra-canal temperature (35°C). All the instruments were rotated in artificial which were made of stainless steel with an 60° angle of curvature and a radii of curvatures of 5 mm until fracture occurred, and the time to fracture was recorded in seconds using a digital chronometer and the number of cycles to fracture (NCF) for each file was calculated. The Kruskal-Wallis test was performed to statistically analyze the data by using SPSS 21.0 software. The statistical significance level was set at $p<.05$.

Results: NCF values revealed that the HEDM had the highest cyclic fatigue resistance at intracanal temperature ($p<.05$) and followed by WOG, RPC Blue and OC. The lowest NCF values were determined in the OC group and statistically significant difference was observed between the OC group the other groups ($p<.05$). No statistically significant difference in the mean length of the fractured fragments in curvature was evident for the instruments ($p>.05$).

Conclusion: Within the limitations of the present *in-vitro* study, HEDM instrument resisted static cyclic fatigue significantly more than RPC Blue, WOG and OC instruments.

Keywords: Endodontics, root canal therapy

*Koray Yılmaz[1],
Taha Özyürek[2],
Gülşah Uslu[3]

ORCID IDs of the authors:
K.Y.0000-0001-6096-7385
T.Ö.0000-0003-3299-3361
G.U.0000-0003-3176-1251

[1] Department of Endodontics, Faculty of Dentistry, Hatay Mustafa Kemal University, Hatay, Turkey.
[2] Department of Endodontics, Faculty of Dentistry, Medeniyet University, İstanbul, Turkey.
[3] Department of Endodontics, Faculty of Dentistry, Çanakkale Onkekiz Mart University, Çanakkale, Turkey.

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***Corresponding Author**
Department of Endodontics, Faculty of Dentistry, Hatay Mustafa Kemal University, Hatay, Turkey
E-mail: koray1903@hotmail.com

INTRODUCTION

Nickel-titanium (NiTi) rotary files are the most popular files used in the preparation during the root canal treatment. Beside of advantages such as effective shaping capability, shortening the treatment duration, and helping in maintaining the original form of root canals, NiTi files may also cause negative outcomes such as postoperative pain, periapical pathologies, and failure of treatment in the long-term because of the unexpected instrument fractures during the use of file.[1]

The unexpected failure of NiTi files during the clinical use arises from two different reasons named cyclic or torsional fatigue.[2] Torsional fatigue failure occurs when the stress, which emerges when the tip of file is stuck at any point in the canal but the shaft keeps rotating, exceeds beyond the elasticity limits of the instrument.[3] In cyclic fatigue failure, however, the fracture occurs as a result of the accumulation of repetitive tensile and compaction stresses that the file is exposed to in curved canals. The cyclic fatigue was shown to be the main reason for instrument failures during the clinic use.[2] The kinematics, alloy, and metallurgical properties of instrument are accepted to be among the factors influencing the cyclic fatigue.[4,5]

In order to minimize the failure incidence of NiTi files during the clinical use, the manufacturers apply various heat treatments to the alloys, of which the instruments are made, and they aim to increase the cyclic fatigue resistance of instruments by changing the design properties.[6,7] One Curve (OC; Micro Mega, Besancon, France) and HyFlex EDM (HEDM; Coltene/Whaledent, Altstatten, Switzerland) are the single file systems working with continuous rotation movement and produced by using different heat treatment procedures. OC is a new-generation root canal file, which was recently introduced to the market by manufacturer and is produced with C-Wire heat treatment technology. The manufacturer declares that this technology offers 33% faster root canal preparation in comparison to the reciprocating single-file systems and thus the clinicians would have more time for irrigation. When compared to OneShape (OS; Micro Mega, Besancon, France), which is the previous-generation single file system of this manufacturer, the cyclic fatigue resistance was reported to be 2.4 times higher.

HEDM, however, works with continuous rotation movement and is made of controlled memory (CM) by using the electronic discharging machining (EDM) technology. This method is based on shaping the file by melting and vaporizing the material through the electrical discharges. EDM technology was reported to give the file a crater-like appearance and an increased resistance to cyclic fatigue.[8,9]

WaveOne Gold (WOG; Dentsply Sirona, Baillagues, Switzerland) and Reciproc Blue (RPC Blue; VDW, Munich, Germany) are the reciprocating single-file systems. WOG is manufactured using gold heat treatment. M-Wire technology is based on the heat treatment before production, whereas the gold heat treatment is performed by heating and then slowly cooling the file after production. The file has a parallelogram cross-section having 2 cutting edges.[10,11]

RPC Blue is manufactured by using a technology (blue heat-treated) altering the molecular structure of file during the production. It was reported that the cyclic fatigue resistance of file increased at the end of this procedure.[12] RPC Blue has an S-shaped cross section with two cutting edges and a noncutting tip.

In the comprehensive literature review made by the authors of present study, on study examining the cyclic fatigue resistance of OC file was found. For this reason, it is aimed in the present study to compare the cyclic fatigue resistances of single-file systems having different kinematics and heat treatment technologies, which were applied in production process, at the intra-canal temperature level. The null hypothesis of present study is that there would be no difference between the cyclic fatigue resistances of NiTi files tested in present study.

MATERIALS AND METHODS

20 pcs OC (25/.06), 20 pcs HEDM **(**25/.08), 20 pcs WOG (25/.07), and 20 pcs RPC Blue (25/.08) files were involved in the present study. Before

using in study, the files were examined by using a stereomicroscope (Olympus BX43; Olympus Co, Tokyo, Japan) in terms of the presence of any defect. Since no defect was found on the files, all of them were involved in the study.

Cyclic fatigue testing was performed in a stainless steel artificial canal manufactured by reproducing the instrument's size and taper. A simulated root canal with a 60° angle of curvature and 5-mm radius of curvature was constructed for both the instruments tested. The centre of the curvature was 5 mm from the tip of the instrument and the curved segment of the canal was approximately 5 mm in length.[13] Twenty files for each instrument type were operated in distilled water at 35°C[14] Evidence for reduced fatigue resistance of contemporary rotary instruments exposed to body temperaturusing a torque-controlled endodontic motor (VDW Gold; VDW Munich, Germany). The OC files were used at 450 rpm and 2.5 gcm^{-1} torque until fracture occurred. The RPC Blue files were used in the "Reciproc ALL" program until fracture occurred. The WOG files were used in the "WaveOne ALL" program until fracture occurred. The HEDM files were used at 500 rpm and 2.5 gcm^{-1} torque until fracture occurred. During experiment, the temperature was measured with an infrared thermometer (GM320, Benetech, CAN) and maintained constant (± 1°C).

The number of cycles to failure (NCF) for each file was calculated using the following formula: (NFC = revolutions per minute (rpm) × time to fracture (sec)/60). The fractured fragment length (FL) was determined by a digital micro caliper.

Statistical analysis

The data were first analyzed using the Shapiro-Wilk test to verify the assumption of normality. The Kruskal-Wallis test was performed for statistically analyze the data by using SPSS 21.0 (IBM-SPSS Inc, Chicago, IL) software. The statistical significance level was set at $p<.05$.

RESULTS

Mean NCF and FL values and standard deviations of the files are presented (Table 1).

Table 1. The Means and Standard Deviations of the Number of Cycles to Failure (NCF) and Fracture Length (FL) of Instruments in Distilled Water at 35° C.

Group	NCF		FL	
	Mean	Standard Deviation	Mean	Standard Deviation
WaveOne GOLD	1355.3 [a]	216.8	5.4	0.3
Reciproc Blue	1245.5 [a]	195.2	5.5	0.5
HyFlex EDM	1647.3 [b]	239.6	5.3	0.2
One Curve	864.2 [c]	129.6	5.7	0.8
p - value		< .05		> .05

* Different superscripts letter was statistically significant (p< .05).

NCF values revealed that the HEDM had the highest cyclic fatigue resistance at intracanal temperature (p=0.001) and followed by WOG, RPC Blue and OC. There were no significant differences between the WOG and RPC Blue (p>.05). The lowest NCF values were determined in the OC group and statistically significant difference was observed between the OC group the other groups (p=0.912).

The mean length of the fractured fragment was also recorded to evaluate the correct positioning of the tested instrument inside the canal curvature and whether similar stresses were being induced. No statistically significant difference in the mean length of the fractured fragments in curvature was evident for the instruments (p>.05).

DISCUSSION

The complication that is most frequently observed by the clinicians during the root canal treatments is the NiTi instrument failures.[15] The previous studies showed that the main reason for these instrument failures is the cyclic fatigue.[16,17] The reciprocal movement decreases the torsional stress, which the instruments are exposed to inside the root canal, and the consequent torsional fatigue[18], and it also positively contributes to the cyclic fatigue resistance of instruments.[19] The canal instruments, which generally work by reciprocating, are produced in single-file form, and they are recommended for using in 2 or 3 canals depending on the anatomic complexity of teeth, in which they are used. For this reason, the cyclic fatigue test is much more important to the

reciprocating files.[13] The manufacturer companies generally apply different heat treatments to the files in order to improve the cyclic fatigue resistance of files, and they aim to minimize the incidence of instrument failures. In the present study, it was aimed to compare the cyclic fatigue resistances of 4 current rotary single file systems named HEDM (CM-Wire), WOG (Gold-Wire), RPC Blue (Blue-Heat Treated), and OC (C-Wire) that are subject to different heat treatments and work with different kinematics.

The cyclic fatigue tests have not been exactly standardized yet and there is no test procedure, on which all the researchers could arrived at a consensus.[20] Plotino *et al.*[21] recommended the use of stainless steel canals, which are specific to the tested files (size and taper) in order for files to follow the same trajectory in the static cyclic test setups. For this reason, the stainless steel artificial canals, which were prepared specific to the sizes and tapers of files tested in the present study, were used.

In their study, de Hemptinne *et al.*[22] reported the intra-canal temperature to be 35ºC and it was reported in previous studies that the NiTi files might be affected from the intra-canal temperature. For this reason, the cyclic fatigue test of heat-treated NiTi canal files was performed at 35±1 °C in order to mimic the clinical conditions.

According to the results obtained in present study, the cyclic fatigue resistance of HEDM files was found to be statistically significantly higher than WOG, RPC Blue, and OC files ($p<.05$). For this reason, the null hypothesis of present study was rejected. Pedulla *et al.*[20] (2016) compared the cyclic fatigue resistances of HEDM, Reciproc (VDW), and WaveOne (Dentsply Sirona), and they reported the cyclic fatigue resistance of HEDM file to be higher. They asserted that this is because HEDM file is made of CM alloy by using EDM technology. Özyürek *et al.*[12] tested the cyclic fatigue resistance of HEDM, WOG, RPC Blue, and 2shape (TS; Micro-Mega, Besancon, France) files in the artificial canals having 45° and 90° slope, and they compared the time-to-fracture (TTF) values obtained in that study. The researchers reported that, when compared to the other files, RPC Blue had higher cyclic fatigue resistance in both of canals having different slope levels. Pedulla *et al.*[8] performed the cyclic fatigue tests at the room temperature, whereas the tests were conducted at the intra-canal temperature in the present study. Similarly, Özyürek *et al.*[12] compared the TTF values, whereas the NCF values were compared in the new study. The authors of present study assert that the results obtained here are different from the literature because of the differences between the methodologies.

According to the results of present study, no statistically significant difference was found between the cyclic fatigue values of RPC Blue and WOG files ($p>.05$). In a study on comparing the cyclic fatigue resistance of RPC Blue, RPC, and WOG files, RPC Blues showed better cyclic fatigue values than the others did.[3] According to the results obtained here, on the contrary with the results of other study, the difference between the cyclic fatigue resistances of RPC Blue and WOG files might be because of the tests performed at the room temperature and the cyclic fatigue resistance and the comparison between cyclic fatigue values by taking the TTF values into consideration.

Since OC file is a newly introduced file, there is no study in the literature, which can be used in directly comparing with the present results. The manufacturer alleges that OC file has 2.4 times higher cyclic fatigue resistance when compared to OneShape (OS; Micro Mega,) file. They assert that this is because of the C-Wire heat treatment used in the production, which is different from OS file[7]. Gündoğar & Özyürek[7] compared the cyclic fatigue resistances of OS, HEDM, RCP Blue, and WOG files. They reported that HEDM file has the maximum cyclic fatigue resistance, whereas the minimum value was observed in OS files. It is thought that, despite the heat treatment applied, the OC file showed lower cyclic fatigue resistance than RPC Blue and WOG because of the different kinematics of the files.

CONCLUSIONS

Within the limitations of the present *in-vitro* study, HEDM instrument resisted static cyclic

fatigue significantly more than RPC Blue, WOG and OC instruments. The novel NiTi rotary instrument OC showed significantly lowest cyclic fatigue resistance compared to the other systems.

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CONFLICTS OF INTEREST

None

İçi Sıcaklıkta Döngüsel Yorgunluğa Karşı Dirençlerinin Karşılaştırılması

ÖZ

Amaç: *One Curve (OC), Hyflex EDM (HEDM), WaveOne Gold (WOG) ve Reciproc Blue (RPC Blue) NiTi döner kanal aletlerinin kanal içi sıcaklıkta (35°) döngüsel yorgunluğa karşı gösterdikleri dirençlerin karşılaştırılmasıdır.* ***Gereç ve Yöntemler:*** *Yirmi OC (25/,06), 20 HEDM (25/,08), 20 WOG (25/,07) ve 20 RPC Blue (25/,08) kanal aleti kanal içi sıcaklıkta (35°) döngüsel yorgunluk direnci testine dahil edildi. Tüm kanal aletleri, 60° kurvatur açısı ve 5 mm kurvatur yarıçapına sahip paslanmaz çelik yapay kanallarda kırılıncaya kadar döndürüldü. Kırılıncaya kadar geçen süreler djital kronometre ile ölçülüp saniye cinsinden kaydedildi ve kırılıncaya kadarki tur sayıları (KKTS) hesaplandı. SPSS 21.0 yazılımında Kruskal-Wallis testi ile istatistiksel analiz yapıldı. İstatistiksel anlamlılık değeri p<,05 olarak tespit edildi.* ***Bulgular:*** *KKTS değerlerine bakıldığında HEDM kanal içi sıcaklığında en yüksek döngüsel yorgunluk direnci değerlerini göstermiştir (p<,05) ve onu sırasıyla WOG, RPC Blue ve OC takip etmektedir. Diğer gruplar ile karşılaştırıldığında istatistiksel olarak anlamlı derecede en düşük döngüsel yorgunluk direncini OC göstermiştir (p<,05). Aletlerin kırık uzunlukları açısından istatistiksel olarak aralarında anlamlı bir farklılık yoktur. (p>,05).* ***Sonuç:*** *Çalışmamızın limitasyonları dahilinde döngüsel yorgunluğa karşı en yüksek direnci RPC Blue, WOG ve OC' ile kıyaslandığında HEDM kanal eğesi göstermiştir.*

Anahtar Kelimeler: *Endodonti, kök kanal tedavisi.*

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Original research

EFFECTS OF DIFFERENT GLAZE TREATMENTS ON THE OPTICAL PROPERTIES AND ROUGHNESS OF LITHIUM DISILICATE CERAMICS

ABSTRACT

Objectives: To investigate effects of different glaze procedures on the colour, translucency, and roughness of lithium disilicate (LDS) ceramics after short-term ageing.

Materials and Methods: Eighteen LDS specimens (thickness: 0.6 mm) were divided into three groups (paste (EP), spray (ES), and powder–liquid glaze (EL)) based on the type of glaze treatment (n=6). After glaze firings, specimens were thermally aged (5000 cycles). Before and after thermocycling, the colour, translucency, and roughness values of the specimens were measured. Before and after thermocycling, the translucency and roughness data were analysed using a one-way analysis of variance (ANOVA) and compared using a Wilcoxon signed-rank test. Changes in colour, translucency, and roughness data were analysed using one-way ANOVA, and the correlations between them were analysed using Spearman's correlation analysis (p=.05).

Results: The EL group showed the highest and clinically unacceptable colour change value (p≤.005). Before and after ageing, the EL group exhibited higher translucency than the other groups (*p*<.001), and the EL and EP groups exhibited higher roughness values than the ES group (p≤.001). Wilcoxon signed-rank test results showed that although a significant difference between the initial and final translucency values was observed in the EL group (*p*=.028), no significant differences between the initial and final roughness values were observed in each group. Only in the EL group, a significant correlation was found between the colour and translucency change values (r=.943, p=.005).

Conclusions: After short-term ageing, based on the evaluation of the LDS ceramics' colour and translucency changes, ES and EP treatments are preferable for glazing. When dentists select a material (EP, EL, ES) for glazing LDS ceramics, they should consider the effects of this material on the optical properties and surface roughness of LDS ceramics.

Keywords: Lithia disilicatex, color, surface properties

*Gülce M. Subaşı[1],
Gülce Alp[2]

ORCID IDs of the authors:
G.M.S.0000-0002-2510-9745
G.A.0000-0003-1751-9207

[1] Department of Prosthetic Dentistry, Faculty of Dentistry, Kütahya Sağlık Bilimleri University, Kütahya, Turkey.
[2] Department of Prosthetic Dentistry, Faculty of Dentistry, İstanbul Okan University, İstanbul Turkey.

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***Corresponding Author**
Department of Prosthetic Dentistry, Faculty of Dentistry, Kütahya Sağlık Bilimleri University, Kütahya, Turkey.
Phone: +90 505 9399899 **Fax:** +90 274 2652261 **E-mail:** gulce2subasi@yahoo.co.uk

INTRODUCTION

In prosthetic dentistry, the advent of computer-aided design (CAD) and computer-aided manufacturing (CAM) has facilitated the design of frameworks, monolithic crowns, and fixed dental prostheses. CAD/CAM restorations exhibit acceptable shade, contour, and marginal adaptation compared with conventionally fabricated restorations.[1,2]

Achieving a natural tooth-like restoration is important for a successful treatment.[3] To attain optimum aesthetic results, the optical properties of the restoration must match those of natural teeth.[4] For this purpose, in recent years, numerous CAD/CAM-machinable ceramic materials have been developed. The choice of ceramic materials is based on their mechanical and optical properties.[3] Glass ceramics are often used in chairside CAD/CAM dental treatments.[5] Among glass ceramics, the lithium disilicate (LDS) glass ceramic (IPS e.max CAD) has better optical and mechanical properties than conventional dental ceramics. This ceramic can be used for three-unit fixed dental prostheses up to the first premolar and for single-unit crowns, inlays, and onlays.[6] In recent years, because of the various translucency levels and shades exhibited by LDS ceramics, they have been widely used for monolithic ceramic restorations.[3,6,7]

The translucency of a dental ceramic is a primary factor influencing the overall aesthetics.[8,9] Colour stability throughout the functional lifetime of a restoration is as crucial as mechanical properties of the material. A change in colour over time may limit the longevity and quality of a restoration.[10] Extrinsic factors, such as the type of solution, exposure time[11], firing time[12], glaze used[13], surface texture[14], surface treatment[15], and colour combination among the substrate/ ceramic/cement[16], and intrinsic factors, such as material composition[11,15] and crystal particle size[17], are important factors influencing the colour stainability of ceramic restorations.

Ceramic restorations must have smooth surfaces to yield patient comfort, attain aesthetics and to perform excellent biological and mechanical properties. A coarse surface may ease staining, enhance plaque accumulation, cause abrasion and wear of antagonistic teeth, and ultimately affect the fracture strength of the ceramic.[18] Therefore, glazing of restorations is mandatory before cementing them.[19,20]

Various parameters affecting LDS ceramics have been investigated[20–27], including the effects of roughness[20,26] and thickness on their translucency.[21–23] Yuan *et al*.[27] evaluated the effects of brushing and thermocycling on colour stability and roughness of glazed CAD/CAM ceramic restorations (LDS and zirconia). Other studies evaluated the effects of thermocycling and thickness either on the colour stability[25] or on both the colour stability and translucency of LDS ceramics.[24]

According to the instructions given by the manufacturer of the materials used, three methods for glazing monolithic LDS restorations have been recommended: paste, spray, and powder–liquid glaze. Although the manufacturer recommends each of the three glazing methods, studies on the effects of these procedures on optical properties and roughness of LDS ceramics are lacking. The aim of this study was to assess effects of different glazing procedures on the colour, translucency, and roughness of LDS restorations after short-term ageing.

The following are the research hypotheses:

1. The type of surface glazing treatment does not affect the colour change data.

2. Before and after ageing, the type of glazing treatment does not affect the translucency data.

3. Before and after ageing, the type of glazing treatment does not affect the roughness data.

MATERIALS AND METHODS

Table 1 lists the materials used in this research. Eighteen LDS specimens (12.4 mm×14.5 mm× 0.6 mm) (IPS e.max CAD, Ivoclar Vivadent AG, Schaan, Liechtenstein) (A3/HT) were sectioned using a low-speed sectioning device (Secotom 10, Struers A/S, Ballerup, Denmark) under water cooling. The specimens were ultrasonically cleaned (Sultan 600 ProSonic 600-MTH, Mexico) for 10 min and air-dried before taking the

roughness and colour measurements. They were then divided into three groups based on the glazing procedure (n=6): paste, spray, and powder–liquid glaze. All of the glazing applications and firing procedures were performed by the same operator.

Table 1. Materials used in this research.

Material	Code	Manufacturer	Lot No
IPS e.max CAD	LDS	Ivoclar Vivadent AG	V12245
IPS e.max CAD Crystall./Glaze Paste	EP	Ivoclar Vivadent AG	T38546
IPS e.max CAD Crystall./Glaze Spray	ES	Ivoclar Vivadent AG	W16246
IPS e.max Ceram Glaze Powder	EL	Ivoclar Vivadent AG	U54478
IPS e.max Ceram Glaze Liquid			U53409

I. Paste group (EP):

In this group, a paste (IPS e.max CAD Crystall/Glaze Paste, Ivoclar Vivadent AG, Schaan, Liechtenstein) was applied on specimens using a brush. Crystallisation and glaze firings were then simultaneously performed (Table 2).

Table 2. Firing parameters for crystallisation/glaze HT with paste or spray or for only crystallisation.

ST (°C)	CT (min)	HR t_1 (°C)	FT T_1 (°C)	HT H_1 (min)	HR t_2 (°C)	FT T_2 (°C)	HT H_2 (min)	V_1 (°C) $1_1/1_2$	V_2 (°C) $2_1/2_2$	LTC (°C)	CR (°C)
403	6	90	820	0:10	30	840	7	550/820	820/840	700	0

ST: Stand-by temperature; CT: Closing time; HR: Heating Rate; FT: Firing Temperature; HT: Holding Time; V: Vacuum; LTC: Long-term cooling; CR: Cooling rate.

II. Spray group (ES):

In this group, a spray (IPS e.max CAD Crystall/Glaze Spray, Ivoclar Vivadent AG, Schaan, Liechtenstein) was well shaken approximately 20 s before application. The spray can was held in an upright position, and the spray was applied on the specimen surface from a distance of 10 mm. The crystallisation and glaze firings were performed simultaneously (Table 2).

III. Powder–liquid glaze group (EL):

In this group, the crystallisation firing (Table 2) was performed before glaze firing. Thereafter, powder and liquid glazes (IPS e.max Ceram Glaze Powder and Liquid, Ivoclar Vivadent AG, Schaan, Liechtenstein) were mixed homogenously in a plate and applied on the crystallised specimen surface using a brush. Finally, the glaze firing (Table 3) was conducted.

Table 3. Firing parameters for glaze firing.

ST (°C)	CT (min)	HR (°C)	FT (°C)	HT (min)	V_1 (°C)	V_2 (°C)
403	6	60	770	1–2	450	769

ST: Stand-by temperature; CT: Closing time; HR: Heating Rate; FT: Firing Temperature; HT: Holding Time; V_1: Vacuum 1; V_2: Vacuum 2.

In all the groups, the firings were performed in a furnace (Programat P300, Ivoclar Vivadent AG, Schaan, Liechtenstein) according to the instructions provided by the manufacturer. After glaze firing, the specimens were aged in a thermal cycling machine (Thermocycler THE 1100, SD Mechatronik, Westerham, Germany) (5000 cycles, 5–55 °C, dwell time: 30 s, transfer time: 10 s).

Colour Measurement

The colour value of each specimen was measured using a chromometer (Minolta CR-321, Konica Minolta, Tokyo, Japan) both before and after thermocycling against a white backing. The *L*, *a*, and *b* values, representing the lightness, red–green axis, and yellow–blue axis, respectively, were recorded. The CIELab (Commission

Internationale de l'Eclairage) colour differences (ΔE) of each specimen were calculated using the CIELab formula.[28]

$$\Delta E = [(L_t - L_i)^2 + (a_t - a_i)^2 + (b_t - b_i)^2]^{1/2}$$

where the subscripts t and i denote the final and initial values, respectively.

Translucency Measurement

For the translucency measurements, the colour value of each specimen was measured on black and white backings both before and after thermocycling.

The translucency parameter (TP) was calculated for each specimen both before and after thermocycling using the following equation:[29,30]

$$TP = [(L_b - L_w)^2 + (a_b - a_w)^2 + (b_b - b_w)^2]$$

where the subscripts b and w denote the colour coordinates against black and white backings, respectively.

Roughness

The roughness values of specimens were measured using a profilometer (Perthometer M2, Mahr, Göttingen, Germany) (tracing length: 5.5 mm, cut-off length: 0.8 mm, and stylus speed: 1 mm/s). Three measurements were performed at the centre of each specimen, and the average of the measurements (Ra in μm) was considered for further analysis.

Statistical Analysis

The translucency and roughness data both before and after thermocycling were analysed using the one-way analysis of variance (ANOVA) and so were the colour, translucency, and roughness change data. For each group, the translucency and roughness data before and after thermocycling were compared using the Wilcoxon signed-rank test results. The correlations between the changes in the colour and translucency, colour and roughness, and translucency and roughness values were analysed using the Spearman's correlation analysis (p=.05).

RESULTS

Tables 4–6 list the statistical results of this study. The colour change data revealed that after thermocycling, the colour change values in the EL group were higher than those in the ES and EP groups (p≤ .005) (Table 4).

Table 4. Colour change values (ΔE) of different treatment groups.

	Mean	SD	p (one-way ANOVA)
EL	4.60[b]	2.72	
ES	0.72[a]	0.33	.001
EP	1.10[a]	0.53	

* SD: Standard deviation.
** Divergent superscript letters in the same column show significant differences (p<.05).

Both before and after thermocycling, the translucency values in the EL group were higher than those in the ES and EP groups (p<.001). The Wilcoxon signed-rank test results showed a significant difference between initial and final translucency values (p=.028) in EL group. The translucency change in EL group was significantly different from those in the other groups (p≤ .007) (Table 5).

Table 5. Translucency values of different treatment groups.

	Translucency initial	Translucency final	p (Wilcoxon signed-rank test)	Translucency change (final–initial)
	Mean+SD	Mean+SD		Mean+SD
EL	48.15+0.68^{b1}	43.40+2.34^{b2}	.028	−4.75+2.72^{a}
ES	14.60+1.14^{a1}	13.66+0.69^{a1}	.075	−0.93+1.15^{b}
EP	14.56+0.70^{a1}	14.78+1.20^{a1}	.600	0.21+1.22^{b}
p (one-way ANOVA)	<.001	<.001		.001

* SD: Standard deviation.
** Divergent superscript letters in the same column and divergent superscript numbers in the same row show significant differences (p<.05).

Before and after thermocycling, the roughness values in the EL and EP groups were higher than that in the ES group (p≤.001). The Wilcoxon signed-rank test results showed no significant differences between initial and final roughness values in each group. The one-way ANOVA test results showed no significant differences in the roughness change (final–initial) values in the different groups (Table 6).

Table 6. Roughness values (Ra in micrometers) in different treatment groups.

	Initial roughness Mean+SD	Final roughness Mean+SD	P (Wilcoxon signed-rank test)	Roughness change (final-initial) Mean+SD
EL	0.65+0.11^{b1}	0.70+0.14^{b1}	.345	0.05+0.13^{a}
ES	0.29+0.16^{a1}	0.27+0.09^{a1}	.528	−0.02+0.09^{a}
EP	0.67+0.10^{b1}	0.71+0.11^{b1}	.398	0.03+0.08^{a}
P (one-way ANOVA)	<.001	<.001		.635

* SD: Standard deviation.
**Divergent superscript letters in the same column and divergent superscript numbers in the same row show significant differences (p<.05).

The Spearman's correlation analysis revealed that except for the EL group, the other groups did not exhibit any significant correlation between the changes in the colour and translucency, colour and roughness, and translucency and roughness values. In EL group, a significant correlation was found between the colour and translucency change data (r = −.943 and p=.005).

DISCUSSION

The first null hypothesis, the type of surface glazing treatment does not affect the colour change data, was rejected (p=.001). This is because the colour change in the EL group was higher than those in the other groups (p≤.005). Except for the EL group, the colour change values in the other groups are clinically acceptable (ΔE < 3.7).

The second null hypothesis, before and after ageing, the type of glazing treatment does not affect the translucency data (p<.001), was rejected. This is because, both before and after ageing, the translucency value in EL group was higher than those in other groups (p<.001)

The third null hypothesis, before and after ageing, the type of glazing treatment does not affect the roughness data, was rejected (p<.001). This is because, before and after ageing, the roughness values in the EL and EP groups were higher than that in the ES group (p≤ .001).

In a previous study[27], the effects of brushing and thermocycling on colour stability and surface roughness of glazed LDS restorations were evaluated, and restorations were glazed using IPS e.max CAD Crystall/Glaze Paste. No correlation was found between colour change and surface roughness data. The colour change values of the LDS restorations were below the clinically perceptible threshold (ΔE=2.6). Similarly, in our study, the EP group showed clinically acceptable colour change values after ageing, and no correlation was found between the roughness and colour change data.

Vichi *et al.*[26] assessed the efficacy of finishing/polishing systems on the roughness and gloss of IPS e.max CAD treated using a glaze paste

and a spray. They found that the glaze paste was more effective in reducing the roughness of the LDS restorations than the spray treatment. In our study, the roughness value in the ES group was lower than that in the EP group. Although the same material (paste and spray) was used in both studies, the difference may lie in the two-step firing approach employed by Vichi *et al*.[26] We performed the crystallisation and glaze firings simultaneously for both glaze and paste treatments.

Subaşı *et al*.[24] compared the effects of material and thickness on the colour stability and relative translucency parameters (RTP) of monolithic ceramics (lithium disilicate ceramic (LDS), zirconia reinforced lithium silicate ceramic (ZLS), and pre-shaded monolithic zirconia) subjected to coffee thermocycling (5000 cycles). They used a two-step firing approach and IPS e.max ceram for glazing the LDS ceramics. Staining in coffee did not affect the translucency of LDS ceramics. The colour change in LDS ceramics was similar with respect to the different thicknesses, and the changes were perceptible. However, in our study, the EL group showed clinically unacceptable colour change after thermocycling, which significantly decreased the translucency value in the EL group. The difference between the two results could be due to the use of different devices for colour measurement, different material thickness, and different formulae for colour change measurement.

In this study, the EL group showed the highest colour change and translucency values. The higher translucency could be due to the two-step firing procedure, and the higher colour change after thermal cycling could be due to the roughness of the material.

Previous studies[19,20] reported that glaze treatment is preferred to surface polishing for LDS restorations. Based on these studies,[26,27] the effects of different glazing treatments on the optical properties and roughness of an LDS material were investigated in this study. The thickness of the LDS material (0.6 mm) was kept constant when comparing the effects of different glazing treatments on its colour, translucency, and roughness values. Three different types of glazing procedure were investigated because these treatments were suggested from the manufacturer for glazing monolithic LDS restorations. The colour, translucency, and roughness parameters were evaluated, because all of these parameters are important in maintaining long-term aesthetics and the mechanical properties of the restoration.[10,18]

Previous studies[31-33] on the colour of dental ceramics reported that colour change values below 3.7 are clinically acceptable. Therefore, the same limit was considered in this study.

The thermocycling process in oral cavity can affect the longevity of restorations. Using thermocycling parameters that can mimic oral environment in an in vitro condition could inspect the behaviour of restorations in a clinical setting.[34] Therefore, in this study, 5000 cycles were used for ageing the specimens; this corresponds to an ageing duration of six months.[35]

One of the limitations of this study was that the ageing was conducted for a short duration (5000 cycles). Moreover, the thickness of the LDS material was kept constant.

In the future, the effects of different thicknesses and glazing procedures (paste, spray, and powder–liquid glaze) on the roughness, optical and mechanical properties of LDS materials can be evaluated after long-term ageing. In addition, the topography of LDS materials treated with different glazing procedures can be investigated using scanning electron microscopy and atomic force microscopy.

CONCLUSIONS

At the end of short-term ageing, although the type of surface treatment affected the colour and translucency values of the LDS restorations ($p=.001$), it did not affect the surface roughness change (after–before) values.

The ES and EP groups showed clinically acceptable colour change values ($\Delta E<3.7$), whereas the colour change values in the EL group were clinically unacceptable ($\Delta E\geq3.7$).

The ES and EP processes should be preferred for the glaze treatment of LDS specimens when

their colour and translucency change values are evaluated simultaneously.

When dentists select a material for glazing monolithic LDS specimens, they should consider the effects of this material on optical properties and surface roughness of the LDS specimens.

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CONFLICTS OF INTEREST

None.

Farklı Glaze İşlemlerinin Lityum Disilikat Seramiklerin Optik Özellik ve Pürüzlülük Üzerindeki Etkileri

ÖZ

Amaç: *Farklı glaze işlemlerinin lityum disilikat seramiklerin (LDS) renk, translüsensi ve pürüzlülük üzerindeki etkisinin kısa dönem yaşlandırma sonunda incelenmesidir.* ***Gereç ve Yöntemler:*** *On sekiz LDS örnek (kalınlık: 0,6 mm) yapılan glaze işlemine göre üç gruba (pasta (EP), sprey (ES), toz-likit glaze (EL)) ayrıldı (n=6). Glaze fırınlamaları sonrası tüm örnekler termal olarak yaşlandırıldı (5000 devir). Yaşlandırma öncesi ve sonrası örneklerin renk, translüsensi ve pürüzlülük değerleri ölçüldü. Yaşlandırma öncesi ve sonrası translüsensi ve pürüzlülük verileri tek yönlü varyans analizi (ANOVA) ile analiz edildi ve Wilcoxon işaretli sıralar testi ile karşılaştırıldı. Renk, translüsensi ve pürüzlülük değişim verileri tek yönlü ANOVA ile analiz edildi ve aralarındaki kolerasyonlar Spearman kolerasyon analizi ile analiz edildi (p=,05).* ***Bulgular:*** *EL grubu en yüksek ve klinik olarak kabul edilemez renk değişim değeri göstermiştir (p≤,005). Yaşlandırma öncesi ve sonrası, EL grubu diğer gruplardan daha yüksek translüsensi değeri göstermiştir (p<,001) ve EL ve EP grupları, ES grubundan daha yüksek pürüzlülük değerleri göstermiştir (p≤,001). Wilcoxon işaretli sıralar test sonuçları göstermiştir ki, EL grubunun başlangıç ve sonuç translüsensi değerleri arasında anlamlı fark (p=,028) gözlenir iken, her bir grubun başlangıç ve sonuç pürüzlülük değerleri arasında anlamlı bir farklılık bulunamamıştır. Sadece EL grubunda renk ve translüsensi değişim değerleri arasında anlamlı bir kolerasyon bulunmuştur (r=0,943, p=,005).* ***Sonuçlar:*** *Kısa dönem yaşlandırma sonrasında, LDS seramiğin renk ve translüsensi değişimleri değerlendirildiğinde, ES ve EP işlemleri glaze için tercih edilebilir. Diş hekimleri LDS seramiklerin glaze işlemi için materyal (EP, EL, ES) seçeceklerinde, bu materyalin LDS seramiklerin optik özellik ve yüzey pürüzlülüğü üzerindeki etkisini göz önünde bulundurmalıdırlar.* ***Anahtar Kelimeler:*** *Lityum disilikat, renk, yüzey özellikleri.*

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Original research

THE EFFECTS OF DIFFERENT BASE MATERIALS ON THE STRESS DISTRIBUTION OF THE ENDODONTICALLY TREATED TEETH: 3D FEA

ABSTRACT

Objectives: This study evaluated stress distrubitions formed by oblique forces in dental hard tissues, base materials and restorations of endodontically treated permanent mandibular first molars that were restored with different base materials and direct composite restorations by using 3D-FEA method.

Materials and Methods: For two different restorative approaches; an MO cavity design and a MOD cavity design was created. Then root canal obturation was modeled. Composite resin (CR), conventional glass ionomer cement (GIC), fiber reinforced composite resin (FRC), resin modified glass ionomer cement (RMGIC), flowable composite (FC), and bulk-fill composite resin (BF) were used as base materials. Von Mises, compressive and tensile stresses in enamel, dentin, base materials and final restoration were analyzed using finite element stress analysis method.

Results: Regarding the resulting stresses, CR caused highest stresses and RMGIC caused lowest stresses in enamel, base material, and final restoration. RMGIC caused highest stresses and CR caused lowest stresses in dentin. It was noted that MOD cavity design caused more stress than MO cavity design for all analyzed materials.

Conclusions: Materials with elastic moduli similar to dentin; FRC and GIC, may be better choice to avoid high stresses within the tooth and restoration.

Keywords: Composite resins, glass ionomer cements, finite element analysis.

*Derya M Halaçoglu[1],
Kıvanç Yamanel[2]

ORCID IDs of the authors:
D.M.H.0000-0003-2569-6887
K.Y.0000-0003-4237-1232

[1] Department of Restorative Dentistry, Faculty of Dentistry, Yeditepe University, İstanbul, Turkey
[2] Department of Restorative Dentistry, Faculty of Dentistry, Başkent University, Ankara, Turkey

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***Corresponding Author**

Yeditepe University, Faculty of Dentistry, Department of Restorative Dentistry, Göztepe Mah. Bagdat Cad. No:238 Kadıköy/İstanbul
Phone: +90 533 6260689 **Fax:** +90 216 3636211 **E-mail:** merve.halacoglu@yeditepe.edu.tr

INTRODUCTION

Following endodontic treatment, teeth should be protected against chewing forces because they become prone to fracture.[1,2] Many restorative materials and techniques are available for the reconstruction of the endodontically treated teeth. It should be noted that the restoration must protect the tooth against the chewing forces by distributing the stress throughout the supporting tissues. To withstand masticatory forces in the oral cavity, the elastic modulus of the restorative material is an important factor and its role in the longevity of the final restoration is crucial. The elastic modulus of the restorative material should be close to the tooth structure.

Some investigators have showed that oblique forces created much more intense stress than vertical forces during mastication.[3,4] The restoration must minimize the loss of dental hard tissue and restorative material used by distributing the stress produced by oblique forces.[2] Restorative materials and changes in tooth structure are some of the factors that increases risk of failure.[1,5]

3D finite element analysis (3D FEA) has been widely used by many researchers to evaluate the effects of restorative materials on stress distribution.[6–8] It is also an effective way to evaluate the biomechanical characteristics of dental restorative materials, and the results of the analysis shows clinical significance.[8–10]

In the dental literature, too many studies have been done to evaluate the effects of base materials on stress distribution using 3D FEA, but the information about fiber reinforced composites as base materials is too limited. Therefore, the aim this study was to evaluate the stress distributions formed by oblique forces in dental hard tissues after restoration of endodontically treated teeth with different base materials including fiber reinforced composites with 3D FEA.

MATERIALS AND METHODS

A 3-dimensional (3D) main model was designed to represent an endodontically treated mandibular first molar tooth. The geometry used for the tooth model was previously described by Wheeler Atlas of Anatomy.[11] A simplified 0,25-mm-width periodontal ligament (PDL), 0,25-mm-width lamina dura and cortical shell were developed. The simulated PDL and alveolar bone structure were added to the main model. The remaining bone was modeled as trabecular bone (Figure 1a).

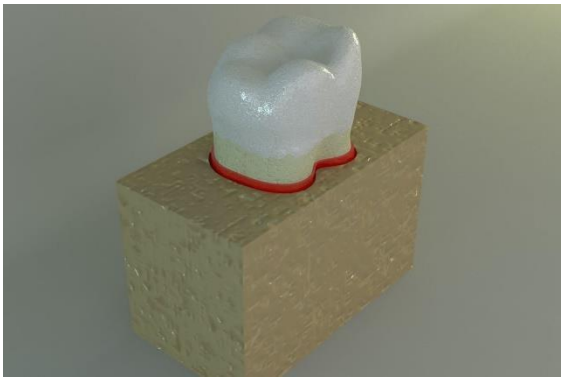

Figure 1a. Designed model; tooth structure, periodontal ligament and alveolar bone.

Two different submodels were designed to evaluate the effects of cavity preparation on the stress distribution: a mesio-occlusal (MO) cavity design and a mesio-ocluso-distal (MOD) cavity design (Figure 1b,c).

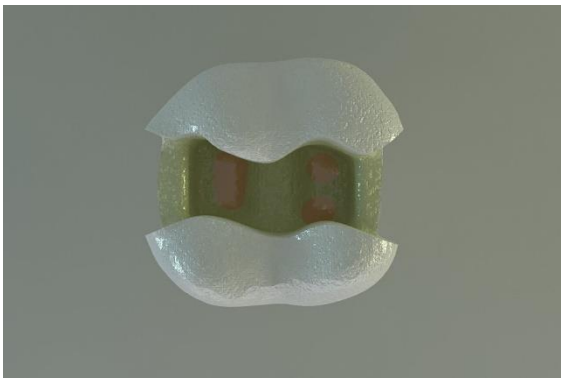

Figure 1b. Designed model; MOD cavity design.

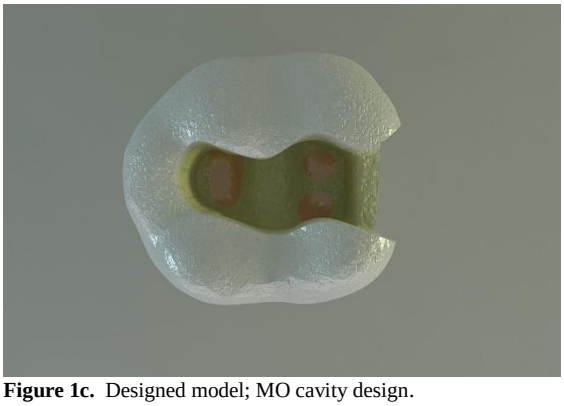

Figure 1c. Designed model; MO cavity design.

Cavity preparations were created by deleting the overlapping tooth and restoration volume. MO and MOD cavity designs were created with 8-mm cavity depth, 3-mm isthmus width, and 2-mm gingival wall width. Twelve different models

were investigated to evaluate six different type of base material. 2 of these models were directly restored with composite resin (CR). For the other models, base materials were designed as conventional glass ionomer cement (GIC), fiber reinforced resin composite (FRC), flowable resin composite (FC), resin modified glass ionomer cement (RMGIC), and bulk-fill resin composite (BF). All the restorations were finished with the use of one type of composite resin. The elastic moduli and Poisson's ratios of restorative materials, enamel, dentin, trabecular and cortical bone, and gutta percha were introduced, also the brands of materials designed in this study are listed in Table 1.

Table 1. Properties of materials and dental tissues

	Brand Name	Manufacturer	Elastic Modulus (GPa)	Poisson's Ratio(v)
FRC[12)]	EverX Posterior	GC, Tokyo, Japan	12.3[a]	0.31[a]
BF[13)]	SDR	Dentsply, Konstanz, Germany	4.7	0.4
GIC[14)]	Fuji IX	GC, Tokyo, Japan	12.6	0.3
RMGIC[7)]	Vitrebond	3M ESPE, St Paul, MN, USA	3.7	0.36
FC[15)]	Tetric Flow	Ivoclar Vivadent, Schaan, Liechtenstein	5.3	0.28
CR[16)]	Grandio	Voco, Cuxhaven, Germany	20.4	0.33
Gutha Percha[17)]			0.14	0.45
Cortical Bone[17)]			13.7	0.3
Spongious Bone[17)]			1.37	0.3
Dentine[17)]			20	0.31
Enamel[17)]			46.8	0.3

[a] Data provided by the manufacturer (GC, Tokyo, Japan)

Rhinoceros 4.0 software was used to obtain tooth models and these models meshed for analysis in Algor Fempro software (ALGOR, INC. 150 Beta Drive Pittsburgh, PA, USA) in STL format. As a result of meshing, models composed of 10-node point (brick-type) units were created. Regarding the bounds of the program, excessive number of units for all dimensions of the tooth models were selected to obtain most realistic results. A MO cavity designed model with 51950 nodes and 274431 elements, and MOD cavity designed model with 60889 nodes and 296933 elements were used. All components were assumed to be in contact with one another for identification of surface relationships among the model's parts and analysis of the mathematical models. Zero motion and rotation were identified at six degrees of freedom from the side and upper surfaces of dental tissues.

An oblique loading of 240N with 45° was applied to central fossa, distal marginal ridge, mesiobuccal cusp tip, and distobuccal cusp tip (60N for each point) (Figure 2).[18]

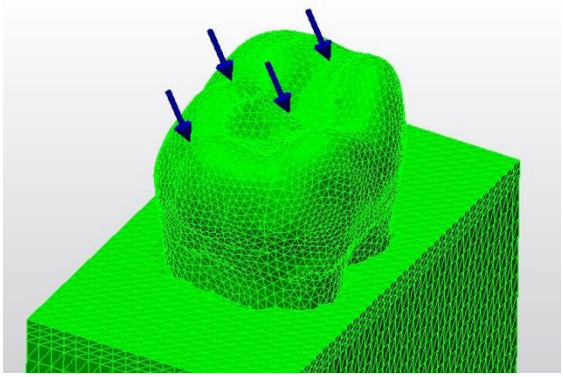

Figure 2. Applied forces.

For each twelve models, 3-D finite element analysis was used to evaluate von Mises stress, maximum principle stress (tensile) and minimum principle stress (compressive) on the restorative materials, base materials, enamel and dentin. Besides of that, different points were selected on dentin and base materials to compare stresses occurred with different base materials and cavity designs. Three of this selected points were located on the gingival walls of MOD and MO cavity designs (Figure 3a,b) and two of them were located on the upper and lower surfaces of the base materials (Figure 3c,d).

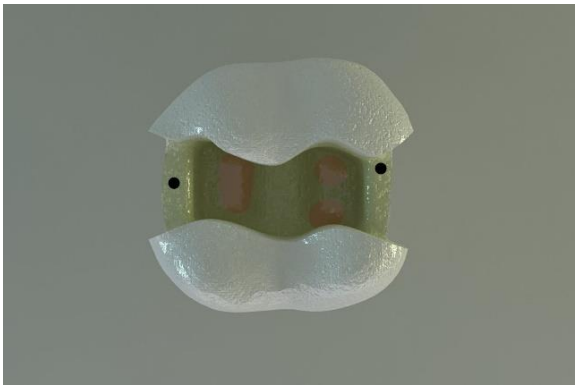

Figure 3a. Selected points for von Mises, compressive and tensile stress analyzes; dentine of MOD cavity design.

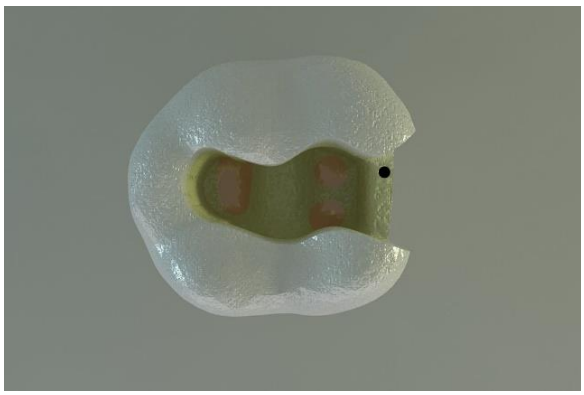

Figure 3b. Selected points for von Mises, compressive and tensile stress analyzes; dentine of MO cavity design.

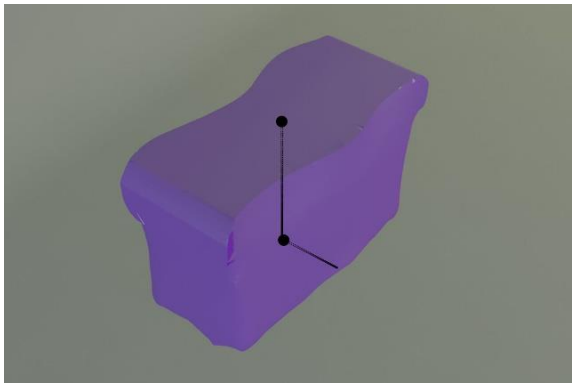

Figure 3c. Selected points for von Mises, compressive and tensile stress analyzes; base material of MOD cavity design.

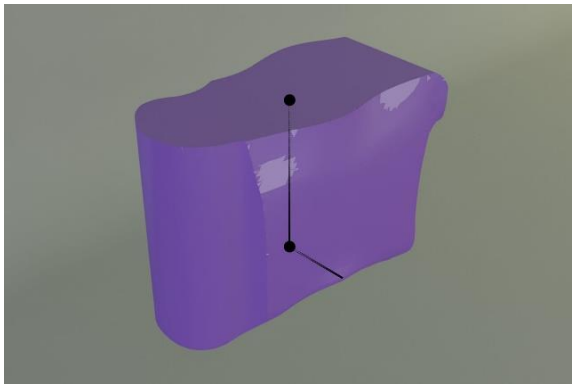

Figure 3d. Selected points for von Mises, compressive and tensile stress analyzes, base material of MO cavity design.

RESULTS

Stress Analysis in Enamel

Von Mises stress distributions occurred in enamel after oblique force application found to be very similar for both cavity types, the high stress areas were concentrated on the lingual cervical area and distobuccal cusp tip (Figure 4a-d).

Regarding the stresses occurred in final restoration material, stress distributions were found to be similar for both cavity design, and high stress areas were concentrated in lingual area of the final restoration and differences were observed in neighboring gingival wall areas. Stress distributions on this area showed higher values in CR models, and lower values obtained in RMGIC models (Figure 5a-d).

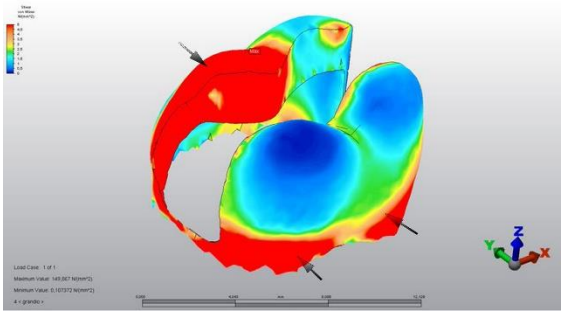

Figure 4a. Highest and lowest von Mises stresses in enamel for MOD-CR design.

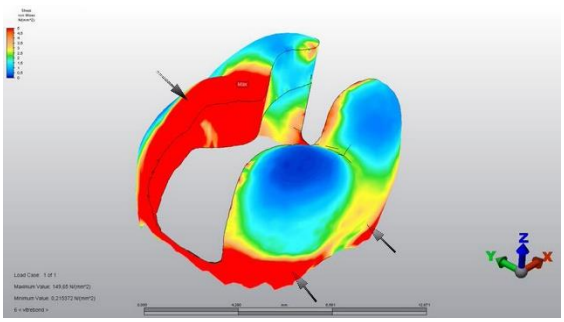

Figure 4b. Highest and lowest von Mises stresses in enamel for MOD-RMGIC design.

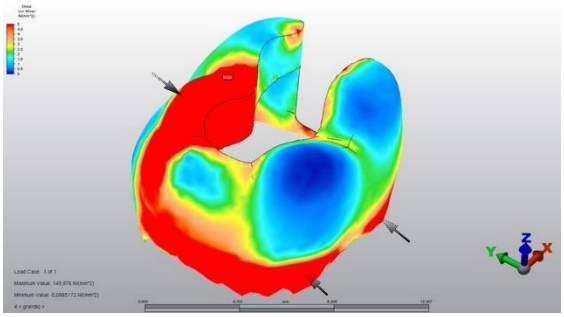

Figure 4c. Highest and lowest von Mises stresses in enamel for MO-CR design.

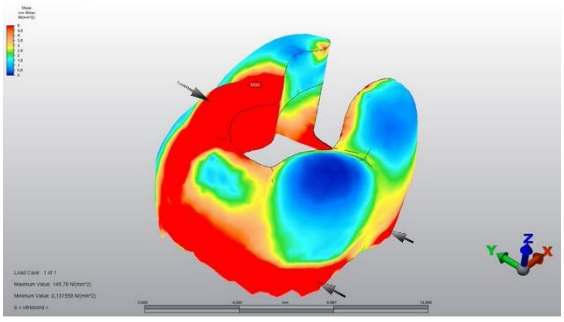

Figure 4d. Highest and lowest von Mises stresses in enamel for MO-RMGIC design.

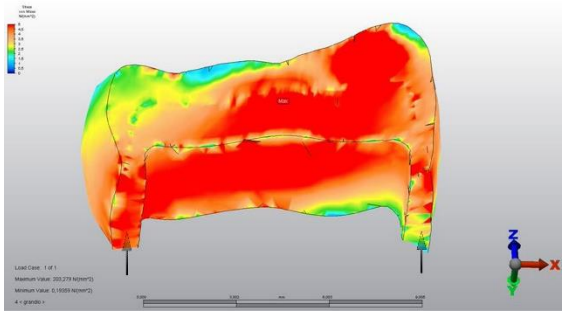

Figure 5a. Highest and lowest von Mises stresses in final restoration for MOD-CR design.

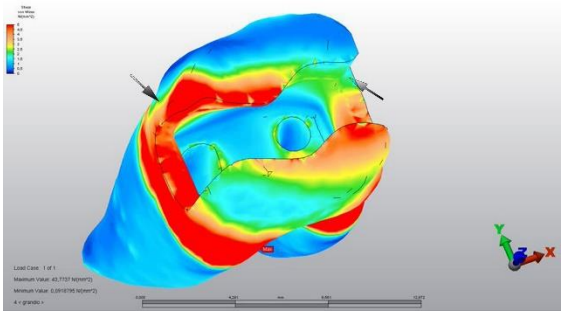

Figure 6a. Highest and lowest von Mises stresses in dentin for MOD-CR design.

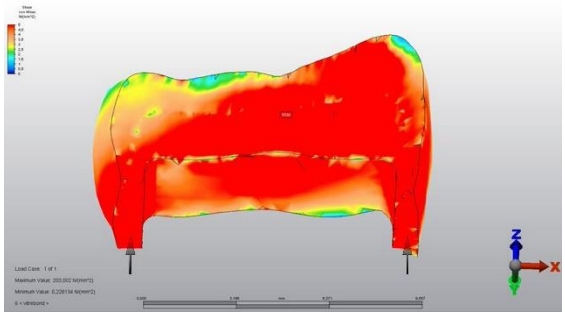

Figure 5b. Highest and lowest von Mises stresses in final restoration for MOD-RMGIC design.

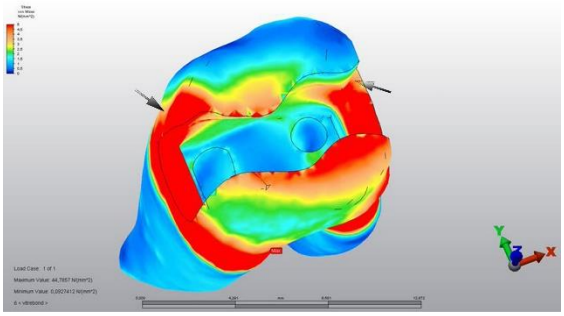

Figure 6b. Highest and lowest von Mises stresses in dentin for MOD-RMGIC design.

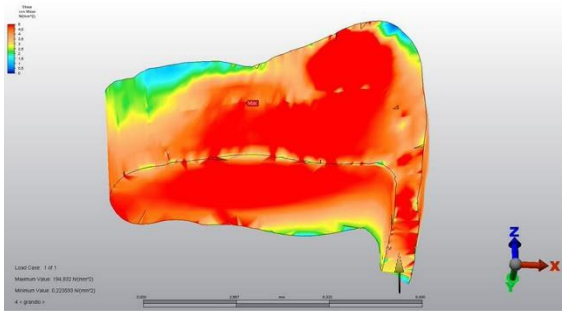

Figure 5c. Highest and lowest von Mises stresses in final restoration for MO-CR design.

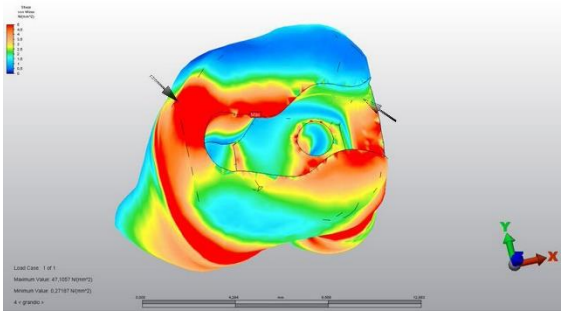

Figure 6c. Highest and lowest von Mises stresses in dentin for MO-CR design.

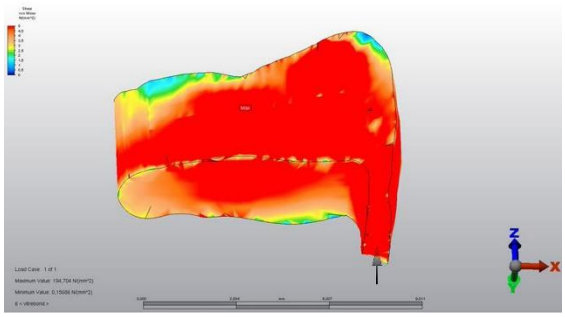

Figure 5d. Highest and lowest von Mises stresses in final restoration for MO-RMGIC design.

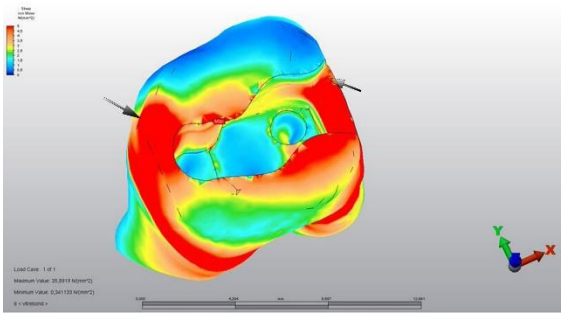

Figure 6d. Highest and lowest von Mises stresses in dentin for MO-RMGIC design.

When von Mises stress distributions were evaluated according to the type of base material, differences were observed in dentine for both cavity designs (Figure 6a-d).

The highest von Mises stress values were observed in CR models and the lowest von Mises stress values were found in RMGIC models. Regarding selected points on dentine, the highest von Mises and compressive stress values were observed in RMGIC models and the lowest values observed in CR models (Table 2).

Table 2. von Mises, compressive and tensile stress values (MPa) on the selected points of MOD and MO cavity design.

	von Mises			Compressive			Tensile		
	MO - MGW	MOD-MGW	MOD-DGW	MO - MGW	MOD-MGW	MOD-DGW	MO - MGW	MOD-MGW	MOD-DGW
CR	3.0080	2.2781	5.1823	-2.2533	-1.8834	-4.5647	1.1258	0.6164	1.2141
GIC	3.6348	2.7731	6.0319	-2.7528	-2.2897	-5.2836	1.3210	0.7551	1.4403
FRC	3.6763	2.8054	6.0824	-2.7696	-2.3011	-5.3026	1.3555	0.7890	1.4870
FC	4.8608	3.7857	7.6924	-3.7044	-3.0851	-6.6316	1.7405	1.1034	1.9673
BF	5.1372	4.0519	7.9453	-3.6659	-3.0439	-6.5076	2.1558	1.5521	2.4893
RMGIC	5.4156	4.2892	8.3824	-3.9880	-3.3304	-6.9982	2.1224	1.4976	2.4518

(MO -MGW: MO cavity mesial gingival wall, MOD-MGW: MOD cavity mesial gingival wall, MOD-DGW: MOD cavity distal gingival wall)

The highest tensile stress values were obtained in BF models and the lowest stress values were obtained in CR models (Table 2). When cavity designs were compared, the highest stress values observed in distal gingival wall of MOD cavity design and the lowest stress values observed in mesial gingival wall of the MOD cavity design.

When stress distributions in base materials were evaluated, it is noted that high stress areas were concentrated on the occluso-lingual side of the base materials for all material types and cavity designs (Figure 7a-d).

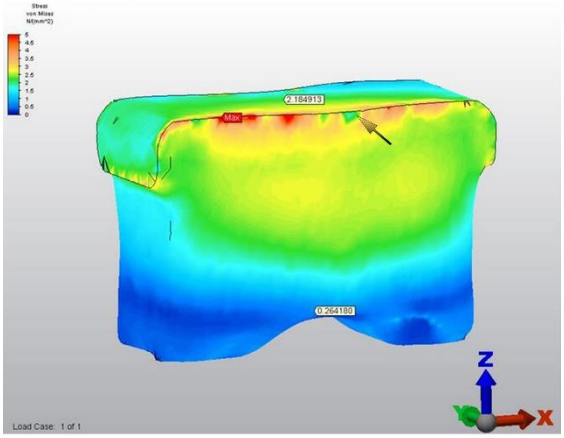

Figure 7b. Highest and lowest von Mises stresses in base material for MOD-RMGIC design.

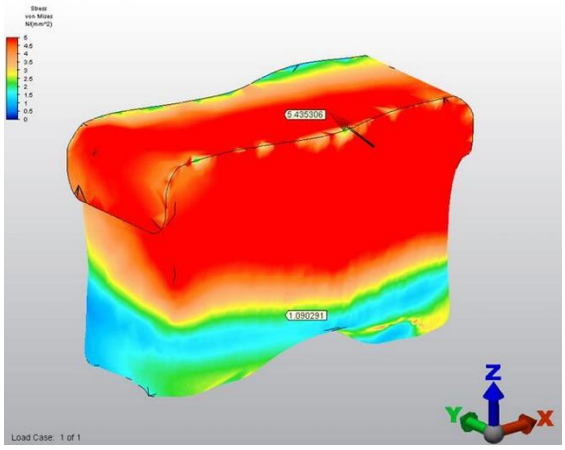

Figure 7a. Highest and lowest von Mises stresses in base material for MOD-CR design.

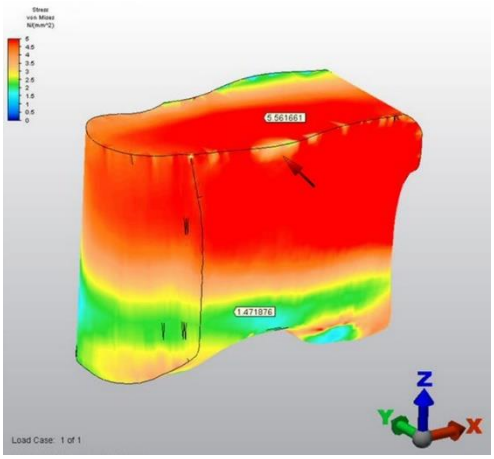

Figure 7c. Highest and lowest von Mises stresses in base material for MO-CR design.

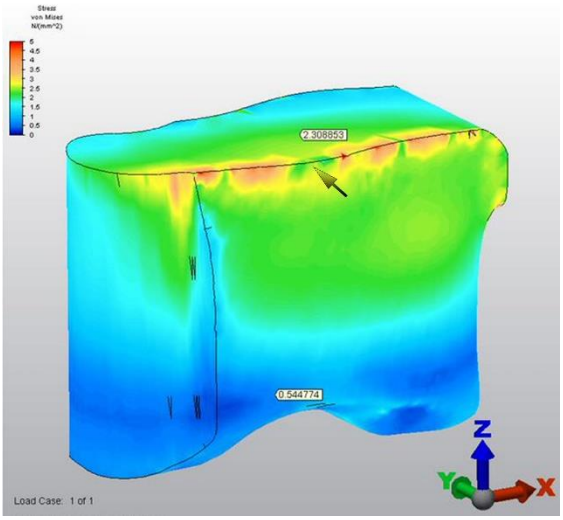

Figure 7d. Highest and lowest von Mises stresses in base material for MO-RMGIC design

Stress distribution differences were observed for both cavity designs regarding base material type. The highest von Mises stress values were observed in CR models and the lowest values were observed in RMGIC models for both cavity type. When selected points on base materials were evaluated, differences were observed regarding the base material type and cavity design. The highest von Mises, compressive, and tensile stress values were obtained in CR models and the lowest von Mises and compressive stress values were obtained on RMGIC models for both cavity type. However, in MOD cavity lower surface the lowest compressive stress value was obtained in FC model (Table 3).

Table 3. von Mises, compressive and tensile stress values (MPa) on the selected points of base materials.

	von Mises				Compressive				Tensile			
	MOD-US	MOD-LS	MO-US	MO -LS	MOD-US	MOD-LS	MO -US	MO -LS	MOD-US	MOD-LS	MO -US	MO -LS
CR	5.4353	1.0902	5.5616	1.4718	-5.0346	-0.9184	-5.0332	-1.7750	0.9073	0.3385	0.9972	-0.1484
GIC	4.6744	0.7036	4.6747	1.1239	-4.4008	-0.8962	-4.3239	-1.6004	0.7013	-0.0950	0.7402	-0.3631
FRC	4.6070	0.6932	4.6025	1.1031	-4.3799	-0.9049	-4.2992	-1.6081	0.6528	-0.1152	0.6905	-0.3923
FC	3.1817	0.3529	3.0568	0.7387	-3.0365	-0.6370	-2.8737	-1.1670	0.4400	-0.8510	0.4456	-0.3831
BF	2.4651	0.3151	2.6056	0.5792	-2.6654	-0.8866	-2.9459	-1.3992	0.0773	-0.5234	-0.0843	-0.7684
RMGIC	2.1849	0.2641	2.3088	0.5447	-2.2272	-0.7041	-2.4445	-1.1277	0.1968	-0.4043	0.0825	-0.5497

(MOD-US: MOD cavity upper surface, MOD-LS: MOD cavity lower surface, MO-US: MO cavity upper surface, MO-LS: MO cavity lower surface)

On the upper surface of the base materials, the lowest tensile stress values were observed in the BF models and on the MOD and MO cavities' lower surfaces of the base materials, the lowest values were observed in the FC and BF models, respectively (Table 3).

DISCUSSION

A number of studies have been conducted that investigated the effects of cavity design and restorative material on stress distribution in tooth structures and restorative materials.[3,8,16] The results obtained from these studies are confusing and contradicting. To clarify this issue, a 3D FEA of stresses associated with the MO and MOD cavity designs and different base materials in endodontically treated molars was performed in this study.

During mastication, teeth are subjected to forces that vary magnitudes and directions. Because of stresses and strains occurred on the teeth and restorative materials caused by these chewing forces, the fracture resistance of teeth and restoration structures decrease.[19] Intraoral loads vary between the range from 10N-431N.[18] In addition to this, a number of studies showed that oblique loads create more stress than vertical loads.[2,20,21] In the current study, an oblique loading of 240N was applied to the central fossa, distal marginal ridge, mesiobuccal cusp tip, and distobuccal cusp tip to mimic the forces applied to the mandibular first molar during the closing phase of mastication.[18]

Apart from chewing forces, the cavity design and the restorative procedure has been described to affect stress and strain produced in restored teeth. A lot of studies have been analyzed the biophysical stress and strain in restored teeth and they have shown that restorative procedures can make tooth more vulnerable to fracture and teeth should be strengthened by choosing the appropriate restorative material.[22–24]

According to the 3D FEA results performed in the current study, the von Mises stress areas were concentrated on the points that oblique forces were

applied. Regarding the stress occurred on enamel, high stress areas were concentrated on distobuccal cusp, and cervical area, which was the neighboring area to the cortical bone for both cavity type (Figure 4). It was thought that similar stress distributions on enamel were occurred because of the same final restorative material (resin composite) used for all models. Since the elastic modulus of base materials were different, stress distribution differences were observed in the area between mesiolingual and distolingual cusps. It was observed that when the elastic modulus of the base material reduced, the stress occurred in that area increased.

Regarding the von Mises stresses that occurred in the final restorative material, high stress areas were concentrated on the lower surface and neighboring area to the gingival walls of the restoration (Figure 5). As the elastic modulus of base materials reduced, the high stress areas occurred on the neighboring area to the gingival wall increased. If high stress areas become more concentrated, cracks and fractures could be seen on the gingival wall of the cavity and restoration. As a result of this situation microleakage and secondary carries, and eventually failure of the restoration might occur.

Recently a few studies suggested that restorative materials with low elastic modulus could be used as stress barrier on gingival wall of the cavity. According to the results of current study, as the elastic modulus of base materials reduced, high stresses on the neighboring area to the gingival wall became more concentrated. In these high stress areas, restorative materials with low elastic modulus would be vulnerable to deformation and then this would result with the failure of the restoration. Further investigations are needed to evaluate stress distributions on the neighboring area to the gingival walls of restorations.

Regarding the stresses that occurred in dentin, the highest von Mises, compressive and tensile stress values were obtained in RMGIC, BF, and FC models. The lowest stress values were obtained in CR models. It might be the reason of this result depended on the elastic modulus of base materials. The elastic modulus of RMGIC, BF and FC were lower than other base materials, and CR had the highest elastic modulus.

When differences in cavity type was considered, high stress areas found to be concentrated on gingival walls of both cavities. Because of that, compressive and tensile stress values obtained from the selected points on gingival walls and the effect of base materials on the stress distribution was evaluated according to these selected points. Considering selected points on dentine in MOD cavity design (distal gingival wall, mesial gingival wall), the highest von Mises, compressive and tensile stress values observed on distal gingival walls of the cavity. The chewing force applied on distal marginal ridge might be the reason of this situation. Regarding the base material type, the highest stress values observed in RMGIC, BF and FC models. Stresses occurred in gingival walls considered to be important regarding longevity of the final restoration because the cracks and fractures occurred in this area may lead to microleakage and secondary caries. Some investigators have reported that cracks, fractures and microleakage occurred in class II cavities appeared to be major clinical problem.[25–29]

When selected points on MO and MOD cavity designs were compared, it is observed that the von Mises and compressive stresses were higher in MOD cavity design and the tensile stresses were similar for both cavity design. After endodontic treatment, it is noted that the amount of stress that occurred in endodontically treated teeth might increase and the fracture resistance tend to decrease because of dental hard tissue loss.[6] Eraslan *et al*.[17] compared different cavity designs to compare stress distributions occurred on dental hard tissues and reported that lowest stress values observed in teeth with less hard tissue loss and these results are compatible with the current study.

After oblique forces that applied to the models with MOD and MO cavity designs, it is observed that high stress areas were concentrated on the upper surface of base materials (Figure 7). For this reason, two different points -upper and lower surfaces of base material- were selected to evaluate stress distributions on base materials.

These selected points were determined so that they centered on the upper and lower surfaces of the base materials. Regarding stresses occurred on these points, the highest von Mises and compressive stress values were observed in CR models and the lowest values observed in RMGIC models. CR had the highest elastic modulus among all tested materials hence it absorbed the stresses and didn't transmit to the dental hard tissues, vice versa for RMGIC. The stress values that occurred on the lower surface of the base materials were lower than that occurred on the upper surface. The values that occurred on the lower surface were similar regarding the type of base material because the stresses might not be transmitted to the lower surface of base materials.

When tensile stress values were evaluated for both cavity designs, the highest values were obtained in CR models and the lowest values were obtained in BF models on the upper surface of the base materials. Although BF material doesn't have the lowest elastic modulus among all materials, it has the highest Poisson's Ratio and this might be reason of the difference in stress distributions.

Among the materials tested in the current study, FRC is a new material which have developed more recently and there are not so many studies available in the literature that evaluated the stresses occurred in teeth restored with FRC. The elastic modulus and poisson ratio of FRC obtained from the manufacturer and the material was presumed to be isotropic. Regarding the results of the study, FRC and GIC might be best choices to restore endodontically treated teeth because their elastic modulus is similar to elastic modulus of dentin. Also, FRC reduces high stress values and prevents the crack formation on composite/ adhesive resin interface because this material contains fiber particles.[29] Additionally, the fluor releasing mechanism of GIC might be beneficial because of anticariogenic effect.

CONCLUSIONS

Within the limitations of the current study, it might be concluded as;

- Regarding the effect of base material, materials with elastic moduli similar to dentin; FRC and GIC, may be better choice to avoid high stresses within the tooth and restoration.
- Regarding the effect of cavity design, MO cavity design caused low stress values on tooth structures than MOD cavity.

ACKNOWLEDGEMENTS

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CONFLICTS OF INTEREST

None

Farklı Kaide Materyallerinin Kanal Tedavili Dişlerdeki Stres Dağılımı Üzerine Etkileri: 3B SEA

ÖZ

Amaç: *Bu çalışmada diş sert dokularında, kaide materyalinde ve restorasyonda oblik kuvvetlerin oluşturduğu stres dağılımları, farklı kaide materyalleri ve direkt kompozit restorasyonla restore edilen endodontik tedavili daimî mandibular ilk molar dişlerde 3B-SEA metodu ile değerlendirildi.* ***Gereç ve Yöntemler:*** *İki farklı restoratif yaklaşım için; MO kavite tasarımı ve MOD kavite tasarımı oluşturuldu. Sonra kök kanal tedavisi modellenmiştir. Kompozit rezin (CR), geleneksel cam iyonomer siman (GIC), fiberle güçlendirilmiş kompozit rezin (FRC), rezin modifiye cam iyonomer siman (RMGIC), akışkan kompozit (FC) ve Bulk-Fill kompozit rezin (BF) kaide olarak kullanılmıştır. Von Mises, basınç ve çekme stresleri; mine, dentin, kaide materyalleri ve nihai restorasyonda sonlu elemanlar stres analizi yöntemi kullanılarak analiz edildi.* ***Bulgular:*** *Ortaya çıkan stresler ile ilgili olarak; mine, kaide materyali ve nihai restorasyonda CR en yüksek streslere ve RMGIC en düşük streslere neden olmuştur. Dentinde, RMGIC en yüksek strese ve CR en düşük strese neden oldu. MOD kavite tasarımının, analiz edilen tüm materyaller için MO kavite tasarımından daha fazla strese neden olduğu not edildi.* ***Sonuçlar:*** *Dentine yakın elastik modülüsü olan materyaller; FRCR ve GIC, diş ve restorasyonda yüksek streslerden kaçınmak için daha iyi bir seçenek olabilir.* ***Anahtar Kelimeler:*** *Kompozit rezin, cam iyonomer simanlar, fiberle güçlendirilmiş kompozit, sonlu eleman analizi.*

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Original research

INTRAOPERATIVE PAIN DURING GLIDE PATH CREATION WITH THE USE OF A ROTARY OR RECIPROCATING SYSTEM

ABSTRACT

Objectives: The objective of this study was to compare the intraoperative pain levels of patients caused from using different glide path systems in creating the glide path before the root canal shaping the teeth with asymptomatic irreversible pulpitis.

Materials and Methods: The study included 88 patient with asymptomatic irreversible pulpitis in mandibular molar tooth. The teeth were randomly assigned to four groups according to use of glide path files: R-pilot (RP), WaveOne Gold Glider (WOG G), One G (OG), Proglider (PG). In all the groups, the patients were asked to specify the pain level by using Visual Analogue Scale (VAS). Kruskall-Wallis and Mann-Whitney U was used to determine significant differences at $p< 0.05$.

Results: In the present study, it was determined that the lowest intraoperative pain level was observed in PG, followed by OG, RP, and WOG G. Statistically significant differences were observed between PG and RP and between PG and WOG G groups ($p<.05$).

Conclusion: All of the file systems used in creating the glide path in root canal treatment caused intraoperative pain. The minimum intraoperative pain was found with PG glide path file, whereas RP and WOG G caused higher level of intraoperative pain.

Keywords: Endodontics, pain, root canal treatment

*Pelin Tüfenkçi[1],
Mehmet Adıguzel[1],
Koray Yılmaz[1]

ORCID IDs of the authors:
P.T.0000-0001-9881-5395
M.A.0000-0002-9363-6264
K.Y.0000-0001-6096-7385

[1]Department of Endodontics, Faculty of Dentistry, Hatay Mustafa Kemal University Hatay, Turkey

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***Corresponding Author**
Mustafa Kemal University, Faculty of Dentistry, Department of Endodontics, Hatay, Turkey,
Phone: +90 326 245 60 60 **Fax:** +90 326 245 50 60 **E-mail:** pelintufenkci@gmail.com

INTRODUCTION

Root canal treatment is one of the most frequently performed procedures in dentistry, and it is also the most fearful operation for the patients.[1,2] For this reason, the management of intraoperative or postoperative pain is very important for both clinicians and patients.[2] The factors affecting the pain during or after the endodontic treatment are the local anesthetics, premedication, irrigation solutions and systems, root canal preparation techniques, and designs of canal instruments that were used.[3]

There are many studies carried out on measuring the patients' pain level after the use of various preparation methods and different file systems in root canal treatment.[4] In general, the studies in literature focus on the post-op subjects, and there are few studies carried out on measuring the intraoperative pain level. It was reported that the demographical factors, anatomical differences between teeth, preparation method, and file systems operating based on different kinematics might affect the level of pain during the root canal treatment.[5, 6]

The advancements in metallurgy in recent years enabled many new file systems working on different kinematics, besides the innovative designs. Despite the technological advancements, all of the preparation methods and file systems, which have been used to date, have been reported to cause dentine extrusion at various levels.[7] In previous studies[8,9], the nickel-titanium (NiTi) single file systems, which operate with rotational movement and reciprocal movement, used in root canal preparation were reported to cause lower amount of debris extrusion during the preparation when compared to the preparation made by using manual files.

The term glide path, which is defined as the space from the root canal to the apex, is very important for safely shape the root canals.[10] Creating the glide path is very useful in preventing the complications, which might be seen during the preparation, such as stepped structure, apical transportation, and instrument fracture.[11] In creating the glide path, it was recommended to use the stainless steel K-type files or rotary nickel-titanium (NiTi) instruments.[4,8,11,12] When compared to the stainless steel manual instruments, the NiTi rotary instruments were reported to offer better protection of canal morphology and to offer a better path for file systems to be used.[13]

In recent years, many single-file glide path systems such as One-G (OG, Micro-Mega, Besançon, France), ProGlider (PG, Dentsply Maillefer), R-pilot (RP, VDW, Munich, Germany), and WaveOne Gold Glider (WOG G, Dentsply Maillefer) were introduced to the market. PG is made of M-Wire alloy developed by using special thermal methods. PG has 0.16 mm of tip diameter, taper varying between 2% and 8% through the shaft, and four cutting edges with square cross-section. OG has 0.14 mm of tip diameter and 3% taper that is constant throughout the shaft. The file has three cutting edges with asymmetric cross-section.[10,14] RP is a glide path file made of M-wire alloy and working with reciprocal movement. RP has single size (with tip diameter of 12.5), constant 4% taper and an S-shaped cross-section.[12] WOG G has 0.17 mm of tip diameter, taper varying between 2% and 6% through the shaft and a parallelogram shaped cross-section. [12]

Although the intraoperative pain does not affect the success of treatment, it is a very important factor for clinicians and patients. In the comprehensive literature review made here, no study on the effect of different glide path file systems on intraoperative pain could be found. For this reason, it was aimed in the present study to compare the intraoperative pain levels of patients caused from using different glide path systems in creating the glide path before the root canal shaping the teeth with asymptomatic irreversible pulpitis. The null hypothesis of present study is that there would be no statistically significant difference between the compared groups.

MATERIALS AND METHODS

This randomly controlled and single-blind clinical study was approved by the Clinical Studies

Registration Center of Mustafa Kemal University (2018/182). The present study was carried out on the patients, who applied to the Department of Endodontics, Faculty of Dentistry, in Mustafa Kemal University between January 2018 and March 2018. A power calculation was conducted using G*Power 3.1 software (Heinrich Heine University, Dusseldorf, Germany). For analysis with α=0.05 and 80% power, the sample size was calculated to be minimum 22 patients in order to determine the difference level between the groups accurately.

Patient Selection

88 patients (50 female and 38 male patients) aged between 18 and 69 years and diagnosed for asymptomatic irreversible pulpitis in 1st or 2nd mandibular molar tooth were involved in the present study (Table 1).

Table 1. Demographic and clinical characteristics of patients

Gender	**Female**	50
	Male	38
Age		40±13
Lower First Molar		47
Lower Second Molar		41
Total		88

The diagnosis of asymptomatic irreversible pulpitis is made based on increased response to cold test performed using Green Endo-ice (1.1,1.2-tetrafluoroetan, Hygenic Corp, Acron, OH, USA) and the presence of deep caries reaching at the pulp determined in radiographic imaging. The patients found to have fistula or abscess in the mouth and to have lesion determined in periapical radiography were excluded from the study. The patients were required to have not taken any analgesic or non-steroidal anti-inflammatory medication, which can alter their pain perception, in last 12 days. Those having history of analgesic or anti-inflammatory medication, maternity, systemic disease, allergy to any medication, calcified canal in relevant tooth, internal or external resorption, and teeth with unclosed apex were excluded from the study. The patients meeting the criteria were informed about the study, and the informed consent forms were obtained from them. The study flow diagram is shown in Fig 1.

Randomization

The names of glide path systems were written on the papers, the papers were folded, and these papers were placed into a dark box, which cannot be seen from the outside. Before each treatment, the clinical assistant chose a paper randomly from the dark box and the glide path system written in that paper was applied to the patient.

Treatment Protocol

A single operator performed all of the treatment procedures. For the purpose of anesthesia, the inferior alveolar nerve blockage was achieved using 1.8% Articaine with 1:100,000 epinephrine (Ultracaine D-S Forte; Aventis, Istanbul, Turkey), and then rubber-dam was placed on the tooth.

Before opening the entrance cavity, using cold or vitality test checked the effectiveness of anesthesia and, when necessary, the intraligamentary support anesthesia was applied. By observing the blood coming from pulp when the entrance cavity was opened, the vitality of tooth was confirmed. The working length was measurement using Root ZX II apex finder (J Morita Corp, Kyoto, Japan) by entering the mesiobuccal and mesiolingual canals with #10 K-type file. The measurement result was confirmed by using periapical radiography, and the working length was set to be 0.5mm shorter than the radiographic apex. Since reaching at the apical is more difficult when compared to distal canal, the mesiobuccal and mesiolingual canals were preferred in the present study.

RP group: R-pilot file (12.5, .04) was operated at the predetermined working length together with the instructions of manufacturer in 'Reciproc All' settings of the endodontic motor (Silver Reciproc; VDW, Munich, Germany).

WOG G group: WaveOne Gold Glider (17, variable taper) file was operated at the predetermined working length in "WaveOne All" setting of the endodontic motor.

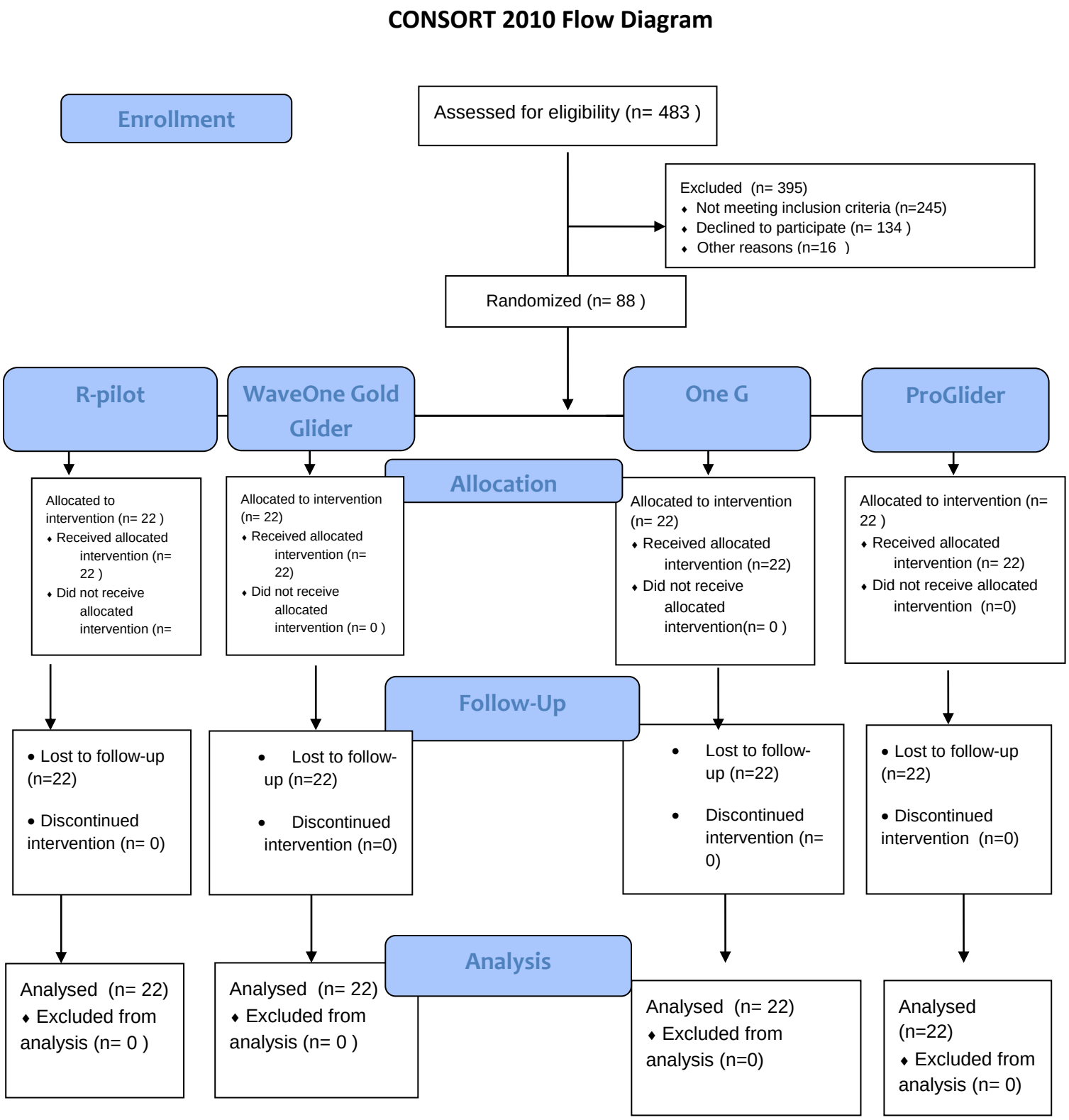

Figure 1. A flow diagram of the study design according to the CONSORT statement

OG group: OG (14, .03) instruments were operated according to the manufacturer's instructions. The OG instrument was used with same motor in continues rotation at 300 rpm, 1.2 N cm torque.

PG group: ProGlider (16, variable taper) file was operated together with the same device with OG group at 300 rpm and 5 Ncm in continuous rotational movement.

In all the groups, the patients were asked to specify the pain level by using Visual Analogue Scale (VAS). In this scale, the level of pain is specified by using numbers between 0 and 10; no pain (0), mild pain (1-3), moderate pain (4-6) and severe pain (7-10). In each file group, the patients were asked to specify the level of pain for the mesiobuccal and mesiolingual canals separately. The average of two values reported by the patient was taken and then accepted as VAS value.

Statistical Analysis

The data, which were collected, were analyzed using SPSS 20.0 version (SPSS Inc., Chicago, IL). The normality of variables' distribution was tested using Shapiro-Wilk test, and it was determined that the distribution of data was not normal. In order to compare the pain between the groups, non-parametrical Kruskall-Wallis and Mann-Whitney U analysis tests were utilized ($p< 0.05$).

RESULTS

88 of 110 patients meeting the inclusion criteria of the present study were involved. All the data were collected from the patients in written and signed for right after the treatment, and the statistical analysis was performed. No data loss occurred during collecting the data from patients. Given the demographical data of patients, no statistically significant difference was observed ($p>.05$).

In the present study, in which the effect of different glide path files on the intraoperative pain, it was determined that the lowest intraoperative pain level was observed in PG (Table 2).

Table 2. Median and standard deviations of groups. Different supperscipt letter in the same column indicate statistically significant difference ($p<0.05$)

Glide Path Files	n	Median	Minimum	Maximum	Standart Deviation
Grup RP	22	2.0000[a]	1.00	5.00	.95346
Grup WG	22	3.0000[a]	.00	4.00	1.01183
Grup OG	22	2.0000[ab]	1.00	3.00	.63960
Grup PG	22	1.5000[b]	.00	3.00	.80178

Statistically significant differences were observed between PG and RP, and between PG and WOG G groups ($p<0.05$). There were no statistically significant differences between RP and WOG G groups, and between OG-PG groups ($p<0.05$).

DISCUSSION

The main objective of root canal preparation is to protect the original canal configuration, to remove the debris in the root canal, and to shape the canal. Preparation of the glide path, which is the first step of root canal preparation, allows for an understanding the original canal anatomy, renders the canal patent to receive rotary files, and enables a more effective and safer action during root canal shaping.[15]

It is known that preparing the glide path increases the efficiency of files to be used in preparation and decreases the occurrence of transportation and ledge formation, frequency of strip perforation, incidence of the fractured NiTi instrument.[16] Moreover, when compared to the manual files, the NiTi glide path files were reported to decrease the preparation duration and better protect the root canal anatomy.[17]

It was reported that different file systems used in preparation caused the extrusion of infected debris form apex this might cause acute inflammatory response.[18] The selection of file systems (type, number, and working principle of files) is an important factor since the transportation of debris from debris to periapical tissues might cause postoperative pain.[19,20]

One of the fundamental concerns in studies carried out on pain is the subjective nature of this

evaluation. Every individual has his/her own pain threshold that is different from that of others. In evaluating the postoperative and intraoperative pain, it is important for the questions to be completely understood by the patients and easily interpreted by the researchers.[21] For this reason, the intraoperative pain level was determined by VAS method, which is a reliable and valid method used widely in endodontic literature.[6] In order to standardize the measurement values to be obtained, the mesial canals of mandibular molar teeth, which have morphologically similar root canals, were preferred.[21]

RP, WOG G, OG, and PG are the single-file systems working with endodontic motor by using different kinematics. When compared to manual files, these systems were developed in order to simplify and accelerate the procedures of preparing the glide path.[3] Many studies[8,11,22] in the literature of endodontics examine the postoperative pain feeling of patients. Besides that, it is known that the patients, who will receive endodontic treatment, will relate the feel the fear of pain not to the period after the treatment but the pain, which they will feel during the root canal treatment.[4]

According to the present study carried out on assessing the effects of different glide path files on intraoperative pain, it was observed that all of the glide path files caused intraoperative pain. For this reason, the null hypothesis of present study was rejected. In the comprehensive literature review, it was determined that, after shaping the root canals by using the different file systems, the rotational movement caused more postoperative pain shaping when compared to the reciprocal movement, and that this pain is related to the apical extrusion.[19,23, 24] Since there is no similar study in the literature, which was carried out on the effect of using glide path on intraoperative pain, the results of present study cannot be compared to the results of other studies.

In their study on evaluating the demographical characteristics of patients on intraoperative pain, Kayaoğlu *et al.*[5] reported that the demographical factors and the presence of preoperative pain are the determinant factors in intraoperative pain. Given the results of patients' demographical characteristics in the present study, no significant difference was observed between the groups.

During the reciprocal movement, the tip of file passes through the dentine by cutting it with its rotation in counterclockwise direction, and then it runs in clockwise direction in order to set the instrument free.[7] The rotary instruments operate based on the asymmetrical rotary movement. The center of asymmetrical rotary instruments is positioned off-center relative to the instrument's central axis of rotation. During the rotational movement, the mechanical movement wave runs through the length of working part of instrument, and the objective here is to minimize the contact between file and dentin. Thus, when compared to the reciprocal systems, the rotary systems have the advantage of the decrease in postoperative complications by enabling the removal of lower amount of debris from the apical.[25] In previous studies[18,26] reported that the ProGlider had the least extrusion of debris among the other rotary NiTi instrument groups. They analysed the geometric differences resulted in the difference of debris extrusion. In the present study, it was determined that RP and WOG G glide path files used with reciprocal movement caused more intraoperative pain, and that the minimum intraoperative pain was found with PG files. This could be explained by geometric differences of glide path instrument and kinematics.

In the literature, Gomes *et al.*[21] carried out a study on analyzing the effects of files on intraoperative discomfort. In their study, in which they compared the effects of multi-file rotary system (Mtwo) and single-file reciprocal (Reciproc) system on the intraoperative discomfort, Gomes *et al.*[21] found no statistically significant difference between the file systems. As the reason of this, the authors emphasized that the disadvantage of multi-file system was the length of preparation duration and the disadvantage of reciprocal movement was the dependence of file system on the movement kinematics. In the present study, the effects of different glide path

files consisting of single file and working on rotational and reciprocal movement on the intraoperative pain were examined. In a different study, the effects of root canal shaping methods on the intraoperative pain were compared, and it was reported that step-back method was applied with stainless-steel manual files, whereas crown-down method was implemented in shaping the root canals by using NiTi rotary files. According to the results of present study, the intraoperative pain level of patients, who were undergone root canal shaping by using rotary instruments, were higher than the other group.[6]

All glide path files used in the present study were observed to cause intraoperative pain at various levels. Since there is no study, with which the results of present study can be compared, it is though that the reason for difference between the groups in present study might be the cross-section, design, taper, and operation kinematics of the files used here.

CONCLUSIONS

Within the limitation of present study, it was observed that all of the file systems used in creating the glide path in root canal treatment caused intraoperative pain. The minimum intraoperative pain was found with PG glide path file, whereas RP and WOG G caused higher level of intraoperative pain.

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

CONFLICTS OF INTEREST

None

Kök Kanal Şekillendirilmesi Sırasında Kullanılan Farklı Glide Path Eğelerinin İşlem Sırasındaki Ağrı Üzerine Etkisinin Değerlendirilmesi: Bir Randomize Klinik Çalışma

ÖZ

Amaç: *Bu çalışmanın amacı, asemptomatik irreversible pulpitisli mandibular molar dişlerde kök kanal şekillendirilmesi öncesinde farklı glide path eğeleri ile oluşturulan kayma yolunun hastalarda oluşturduğu işlem sırasındaki ağrı düzeylerini karşılaştırmaktır.* ***Gereç ve Yöntemler:*** *Çalışmaya asemptomatik irriversible pulpitis teşhisi koyulmuş mandibular molar dişe sahip 88 hasta (50 kadın, 38 erkek) dahil edilmiştir. Dişler kullanılacak glide path eğesine göre; R-pilot (RP), WaveOne Gold Glider (WOG G), One G (OG), Proglider (PG) olmak üzere rastgele 4 gruba ayrılmıştır. Tüm gruplarda hastaların işlem sırasında hissettiği ağrı seviyelerini sormak amacıyla Görsel Analog Skala (VAS) kullanılmıştır. Gruplar arasında tedavi sırasında hissedilen ağrıyı karşılaştırmak için non-parametrik Mann-Whitney U ve Kruskall-Wallis analizi testleri p<0,05 anlamlılık düzeyinde kullanılmıştır.* ***Bulgular:*** *Yapılan değerlendirmeler sonucunda en düşük işlem sırasındaki ağrı seviyesi PG grubunda ölçülürken, onu sırasıyla OG, RP, WOG G takip etmektedir. PG-RP ile PG-WOG G grupları arasında istatistiksel olarak anlamlı farklılık gözlenmiştir (p<0,05).* ***Sonuçlar:*** *Kök kanal tedavisinde glide path oluşturulması sırasında çalışmamızda kullandığımız eğe sistemlerinin tümünün işlem sırasında ağrıya neden olduğu gözlenmiştir. İşlem sırasında oluşan ağrı en az ProGlider glide path eğesinde gözlenirken, resiprokal hareket ile çalışan RP ve WG glide path eğelerinin daha fazla işlem sırasında ağrı gösterdiği belirlenmiştir.* ***Anahtar Kelimeler:*** *Ağrı, endodonti, kök kanal tedavisi.*

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Original research

THE IMPACT OF DENTAL TREATMENTS ON BLOOD PRESSURE VARIATIONS

ABSTRACT

Objectives: The aim was to determine whether there are alterations in the fluctuations of systolic and diastolic blood pressure or the heart rate of normotensive versus hypertensive participants undergoing antihypertensive treatment during surgical and non-surgical dental treatments, regarding whether or not anaesthetics were used with a vasoconstrictor.

Materials and methods: A prospective, observational, epidemiological study was conducted in a sample of 200 participants older than 65 years (100 normotensive and 100 hypertensive participants on antihypertensive treatment). Five periods for evaluation were established. Demographic information was obtained regarding whether or not anaesthetics were used (with or without a vasoconstrictor) and whether or not the participants underwent surgical treatment. The statistical analysis consisted of a doubly multivariate analysis of repeated measures for multiple dependent variables.

Results: Significant differences were observed in the evolution of systolic blood pressure, with an initial increase in participants undergoing surgical treatment and those without a vasoconstrictor. On the other hand, systolic blood pressure decreased with non-surgical treatments, but it remained stable with the use of a vasoconstrictor. Diastolic blood pressure showed no interaction effect in participants undergoing surgical or non-surgical treatments; with the use of a vasoconstrictor, it initially decreased, while in the absence of a vasoconstrictor, it increased. Heart rate initially decreased in participants undergoing surgical and non-surgical treatments and was analogous whether or not a vasoconstrictor was used.

Conclusions: During blood pressure monitoring, blood pressure variations occur, but there is no clinical repercussion in participants because once the treatment is completed, the initial values are recovered.

Arterial hypertension is a pathology of high prevalence that tends to increase with age. The blood pressure response to surgical and non-surgical dental treatments and the effect of local anaesthetics is important because follow-up and blood pressure control in older patient cohorts can improve dental and clinical management.

Keywords: Blood pressure, hypertension, diastolic pressure, systolic pressure

*Belisa Olmo-González[1],
Miguel Ángel González-Martín[2],
José Manuel Olmo-Villaseca[3],
Anna Mañes-Medina[1],
Manuel Ribera-Uribe[1]

ORCID IDs of the authors:
B.O.G.0000-0002-3074-7987
M.A.G.M.0000-0001-5256-878X
J.M.O.V.0000-0003-3460-9036
A.M.M.0000-0002-8970-077X
M.R.U.0000-0002-9919-3281

[1] Department of Special Patients and Gerodontology, Faculty of Dentistry, International University of Catalonia, Barcelona, Spain
[2] Medical Department Amgen Laboratories, Barcelona, Spain.
[3] Medical Specialist in Family and Community Medicine, Sabadell, Spain.

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***Corresponding Author**
International University of Catalunya, Josep Trueta s/n, 08195 Sant Cugat del Vallès, Barcelona.
Phone: +34 935 042 000 **E-mail:** b.olmo@uic.es

INTRODUCTION

Arterial hypertension (AH) is a pathology of high prevalence that tends to increase with age.[1,2] It is a global health problem, and according to the World Health Organization (WHO), AH is one of the main risk factors for cardiovascular disease.

A dentist can provide a valuable public health service by regularly checking the blood pressure (BP) of their patients. However, a dentist cannot diagnose AH based on momentary actions, but must inform the patient when the values are suggestive of hypertension, suggest lifestyle behaviours and refer the patient to a specialist for further testing[1, 3-5] to obtain a correct diagnosis.

The response of BP to dental treatment is conditioned by factors that the dentist should try to reduce, such as physical and psychological stress, environment, humoral factors, central stimuli and neural reflexes.[6-8] Another determining factor is the possibility of finding patients with white coat hypertension (WCH) in the dental clinic. Although WCH is observed with a higher frequency in patients who experience a greater increase in BP under psychological stress,[9] most patients exhibit a higher BP in the office than outside.[10] The objective of the present study was to evaluate the impact of surgical and non-surgical dental treatments, with or without the use of anaesthetics with a vasoconstrictor, on BP variations in a sample of two adult populations of normotensive participants and hypertensive participants undergoing antihypertensive treatment > 65 years of age.

MATERIALS AND METHODS

Study design

This was a prospective, observational study, approved by the Ethics Committee of the International University of Catalonia *(Universitat Internacional de Catalunya)*, Barcelona, Spain (A-09JCT09). The experimental protocol was carried out according to the principles stated in the Declaration of Helsinki. The study was carried out with the collaboration of the Area of Special Patients and Gerodontology of the Faculty of Dentistry of the International University of Catalonia *(Universitat Internacional de Catalunya)*.

The notifying document was delivered to the participants, and informed consent was obtained from all the participants.

Study population

The sample consisted of participants over 65 years of age who attended the University Dental Clinic *(Clínica Universitaria Odontológica- CUO)* of the International University of Catalonia (Universitat Internacional de Catalunya). The inclusion criteria were (i) participants over 65 years of age, (ii) not classified as American Society of Anaesthesiologists (ASA) group IV or V, and (iii) without pheochromocytoma, hyperthyroidism, uncontrolled asthma, uncontrolled diabetes and/or allergy to sulfites.

The sample consisted of 200 participants (100 normotensive and 100 hypertensive participants treated with antihypertensive drugs). Each sample group consisted of the same number of participants (n = 50) with surgical treatment versus non-surgical treatment. In the surgical group, 25 participants had anaesthetics with a vasoconstrictor and 25 had anaesthetics without a vasoconstrictor. The non-surgical group consisted of 25 participants without an anaesthetic versus 25 participants under anaesthesia (20 with a vasoconstrictor and five without). The participants were classified as normotensive or hypertensive with antihypertensive treatment based on the medical history provided by the participant.

Study variables

The demographic data of age and gender were obtained, in order to verify the homogeneity of the study populations in relation to these variables. The dependent variables were systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR). The independent variables were the time in which the BP was measured during a dental visit (before, during or after the dental treatment was completed), whether or not dental anaesthesia was used with/without a vasoconstrictor and surgical or non-surgical treatment.

Statistical analysis

A doubly multivariate analysis of repeated measures was applied for multiple dependent variables. The SBP, DBP and HR of the subjects were measured, grouped by normotensive or hypertensive participants with antihypertensive treatment, at different times throughout the dental intervention. The multivariate approach was considered in relation to the time variable to avoid the sphericity assumption, and several dependent variables were included to apply a doubly multivariate design. For each effect, a test was obtained on an optimally weighted combination of the three dependent variables. When the test of the doubly multivariate analysis was significant, post-hoc tests of said effect were performed on each dependent variable, providing some protection against inflation of the α with multiple dependent variables.

Technique and data collection instruments

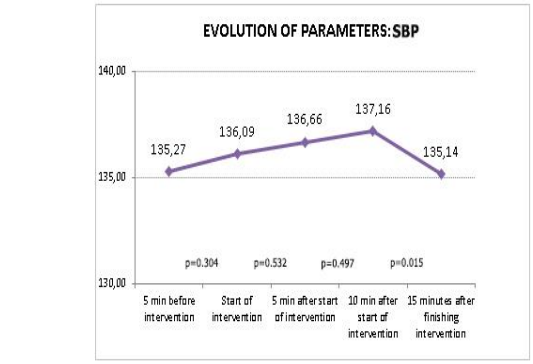
The clinical history form of the International University of Catalonia (Universitat Internacional de Catalunya- CUO) was included with the study registration form collecting sociodemographic data (age, sex). The type of dental treatment was specified, differentiating surgical and non-surgical treatments, whether or not dental anaesthetics were used with a vasoconstrictor (articaine with adrenaline 1/100,000) or without a vasoconstrictor (with mepivacaine), the anaesthetic technique and the number of carpules used. Five timepoints were established to measure BP fluctuations: level 1, at 5 minutes before the intervention; level 2, 1st measurement at the beginning of the intervention; level 3, 2nd measurement at 5 minutes after the intervention; level 4, 3rd measurement at 10 minutes after the intervention; and level 5, at 15 minutes after the intervention. The participant's BP was recorded using a digital sphygmomanometer (OMROM M6 digital sphygmomanometer model (HEM-7001-I), OMRON HEALTHCARE Co., Ltd, Kyoto, Japan), which is validated for use in elderly patients[11], and a Holter (BP PM50 NIBP/SPO2-Holter model, Contec Medical Systems Co.,Ltd, US), which is an appropriate method for elderly patients.[12] The participants were instructed to avoid exercising, ingesting caffeine or smoking for 30 minutes prior to the BP measurement and to rest for 5 minutes in a sitting or lying position before proceeding with the BP measurement. Normally, the BP was similar in both arms, but if the difference was equal to or greater than 10 mm Hg, the measurement was carried out in the arm that produced the highest values.

RESULTS

The homogeneity of the sociodemographic profile of the different groups of participants was analysed. Both p-values of Pearson's Chi^2 test for the comparison of proportions were 0.473, which indicates that there were no significant differences between gender according to BP levels or the type of treatment, surgical or non-surgical. The Mann-Whitney distribution comparison test indicated that there were no significant differences in the age of the participants according to BP level or treatment (p=0.165 and p=0.935, respectively).

Evaluation of the effect of time, group and treatment

In the two study populations, whether or not subjected to surgical treatment, the time factor implied a similar evolution of the study variables without distinguishing between groups of normotensive versus hypertensive participants with antihypertensive treatment. Therefore, a progressive increase in SBP was seen among the different measurement timepoints up to level 4 of the intervention period (p=NS between each of the intervals), followed by a significant fall (p=0.015), until the recovery of the initial levels in the last measurement. From the initial determination until the beginning of the intervention (timepoints 1 and 2) there was a significant decrease in DBP (p=0.001) and HR (p=0.0001), producing a significant rise in DBP (p=0.019) and HR (p=0.0001), until the recovery of the initial levels in the last measurement. (Figure 1).



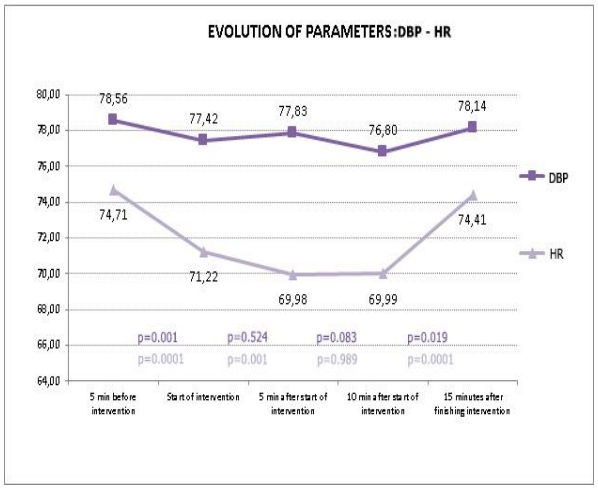


Figure 1. Evolution of SBP, DBP and HR. Evolution over time through five timepoints.

The evolution of some of the study variables was not the same in the participants undergoing surgical versus non-surgical treatments, without distinguishing between groups of normotensive versus hypertensive participants with antihypertensive treatment. Therefore, from the initial determination to the start of the intervention (timepoints 1 and 2 of measurement), there was an increase in SBP with surgical treatments, while there was a decrease with non-surgical treatments; the difference was significant (p = 0.002). In the surgical group, SBP remained stable until it decreased at the end of the surgical process (last measurement moment), while in the non-surgical group, a progressive increase occurred, with a significant difference between the two interventions after 15 minutes of the intervention (p = 0.001) (Figure 2).

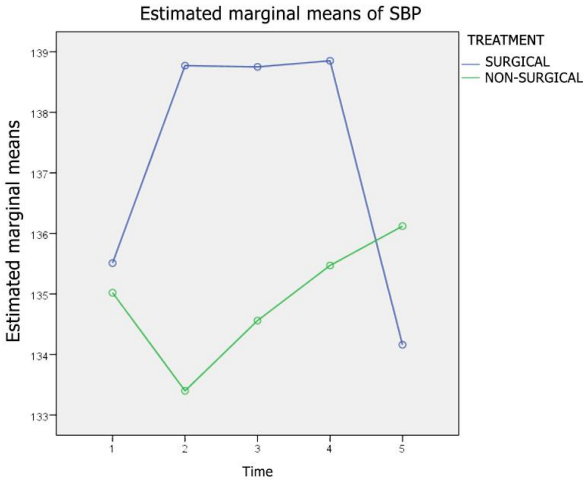


Figure 2. Estimated marginal means of the SBP (interaction effect between time and treatment). Evolution over time through five timepoints of measurement.

Regarding the effect of surgical versus non-surgical treatments, no significant differences were observed in DBP, but they were observed in relation to HR, resulting in a decrease in the two treatment groups to similar levels. This decrease in HR was more marked and significant in the surgical treatment group (p = 0.003), from the initial determination until the beginning of the intervention (timepoints 1 and 2), and more progressive in the non-surgical treatment group. Once the surgical or non-surgical treatment was finished (timepoint 4), there was an increase in HR to baseline levels, being more accentuated and significant in the surgical treatment group after 15 minutes of the intervention (p = 0.032) (Figure 3).

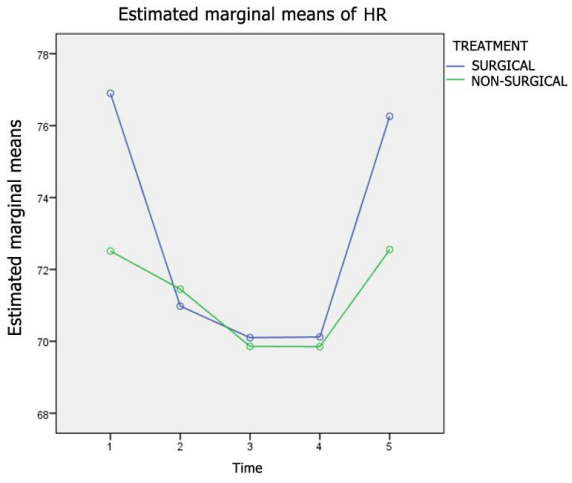


Figure 3. Estimated marginal means of HR (interaction effect between time and treatment). Evolution over time through five timepoints.

In the two study populations, the type of dental treatment, surgical or non-surgical, implied significant differences in the evolution of the

study variables**.** In hypertensive participants, a decrease in HR in the two treatment groups was observed, to similar levels, from the initial determination to the start of the intervention (timepoints 1 and 2). In normotensive participants, there was a decrease in HR with surgical treatments and an increase with non-surgical treatments, and there was a significant difference between the two groups depending on the type of treatment (p = 0.005). Between 5 and 10 minutes of the intervention (timepoints 3 and 4), in hypertensive participants, there was a decrease in HR with surgical treatments and an increase with non-surgical treatments; while in normotensive participants, there was an increase with surgical treatments and a decrease with non-surgical treatments, producing a significant difference between them (p= 0.003) (Figure 4).

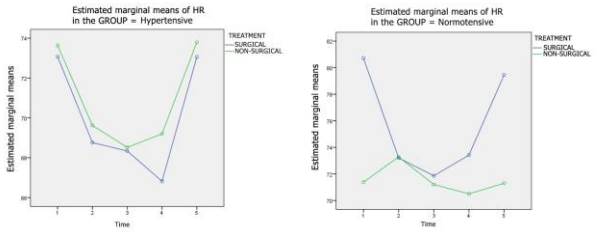


Figure 4. Estimated marginal means of the HR in the hypertensive and normotensive groups (interaction effect between time, group and treatment). Evolution over time through five timepoints.

Evaluation of the effect of time, group and use of vasoconstrictor

In the two study populations, whether or not they were exposed to the use of a vasoconstrictor, the time factor involved a similar evolution of the study variables, without distinguishing between groups of normotensive versus hypertensive participants with antihypertensive treatment. There was a significant progressive increase in SBP when anaesthesia was used, with or without a vasoconstrictor, between the different measurement timepoints up to level 4 of the intervention period (p = 0.017), producing a significant decrease (p = 0.001), until the recovery of the initial levels in the last measurement. From the initial determination until the beginning of the intervention (timepoints 1 and 2), there was a significant decrease in HR (p = 0.0001), producing a significant increase (p = 0.0001), until the recovery of the initial levels in the last measurement (Figure 5). No significant differences were observed regarding the DBP variations.

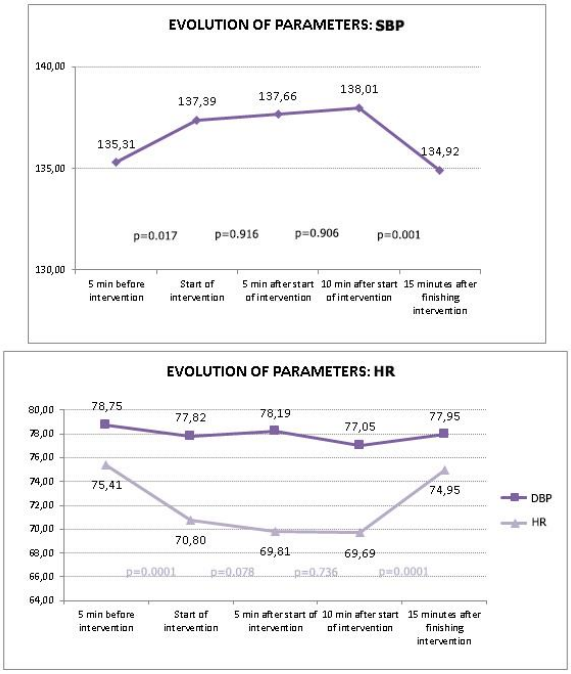


Figure 5. Evolution of SBP and HR. Evolution over time through five timepoints with the use of a vasoconstrictor.

The evolution of some of the study variables was different with the use of anaesthesia with or without a vasoconstrictor, without distinguishing between groups of normotensive versus hypertensive participants with antihypertensive treatment. From 5 minutes before the intervention until the beginning of the dental treatment (timepoints 1 and 2 of measurement), SBP increased sharply in participants without a vasoconstrictor, while in participants exposed to a vasoconstrictor, SBP remained stable; the difference was significant (p = 0.038). Initially, DBP decreased significantly when a vasoconstrictor was used (p = 0.001), thus ending with a significant increase (p = 0.018), while the use of anaesthesia without a vasoconstrictor produced an evolution of the DBP opposite to the previous evolution (Figure 6). Regarding HR, whether or not a vasoconstrictor was used did not produce significant differences in its evolution.

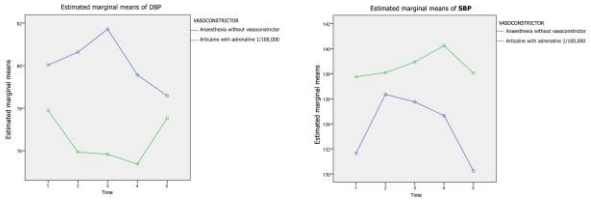


Figure 6. Estimated marginal means of SBP and DBP (interaction effect between time and the use of a vasoconstrictor). Evolution over time through five timepoints.

DISCUSSION

Preoperative measurements of BP reduce possible complications that may occur throughout the daily routine of dental practice.[5] In previous studies[1,7,13-25], as in the present study, BP values have been recorded during dental treatment. The fact that the BP monitoring is for a limited period of time determines that only punctual information of said values will be obtained. Therefore, to conclusively determine the presence of WCH, ambulatory BP monitoring should be carried out for 24 hours to exclude WCH and attain a reliable diagnosis.[26] In our study, the classification of participants according to whether they were normotensive or hypertensive with antihypertensive treatment was based on the medical history provided by the participant; therefore, a possible non-compliance bias cannot be excluded regarding the taking of treatments by a portion of the study population. Five measurement timepoints were established, similar to the more exhaustive studies[7, 13, 17, 20, 23] but unlike other studies that used fewer BP records for monitoring.[1, 14-16, 18, 19, 21, 22, 24] HR monitoring was determined using a digital sphygmomanometer and Holter monitor, as recommended by some authors in the case of high-risk patients with advanced age[12], achieving continuous monitoring and avoiding the loss of BP values.

Regarding the administration of local anaesthesia, negative aspiration was verified because there may be important variations in the haemodynamic changes if a solution of local anaesthetic is accidentally injected into a blood vessel.[21,22] Local anaesthesia was placed at the time corresponding to the start of the intervention (1st measurement) to determine BP fluctuations. A maximum of three carpules were administered in the group of normotensive participants, according to authors such as Santos *et al.*[27] who determined that small amounts of epinephrine appear to show relatively transient cardiovascular effects in healthy subjects. In the group of hypertensive participants with antihypertensive treatment, a maximum of two carpules was established because authors such as Holm *et al.* and Aubertin *et al.*[28,29] established that in patients with cardiovascular disease or uncontrolled hypertension, the maximum number of carpules that can be administered with an epinephrine concentration of 1:100,000 is a total of two to four carpules. Patients with hypertension are considered a high-risk group when they are administered local anaesthesia with a vasoconstrictor because epinephrine shows a high potential to increase BP levels and thus leads to the possibility of suffering a cardiovascular event.[30,31] However, international guidelines determine that it is safe to use local anaesthetics containing epinephrine in stage 1 hypertensive patients.[29] In 1964, the American Dental Association (ADA) and American Heart Association (AHA) established that local anaesthetic solutions containing normal concentrations of a vasoconstrictor were not contraindicated in cardiovascular patients, although they were patients for whom adequate monitoring and aspiration should be performed.

During BP monitoring in normotensive or hypertensive geriatric participants with antihypertensive treatment, the study variables varied in different ways throughout the interventions, to end up recovering after 15 minutes of concluding the intervention. Thus, at the beginning, the SBP increased progressively and then decreased between the two final measurement timepoints to thus return to the initial values. The DBP decreased between the first and the second periods of evaluation and then increased between the fourth and fifth timepoints. The HR decreased until the third timepoint, where it remained and then recovered at the end. These results are in agreement with the majority of previous studies.[7, 13, 20, 23] However, these results differ from a study by Gortzak *et al.*[14] probably because they stated that none of the participants were too anxious because they knew that they would only undergo a routine dental check-up; therefore, any fear of treatment involving anaesthesia or invasive treatment could be ruled out. These variations in the increase in the initial measurements could be related to a situation of stress and anxiety.[6,18,19,32] Surgical treatments may cause higher levels of stress and anxiety in some participants, which may

relate to increased BP.[33] Stress generated by pain, anxiety or distress may cause variations in BP and HR.[34-37]

The use of epinephrine in local anaesthesia increases the depth and duration of the anaesthetic and reduces bleeding and the absorption of the local anaesthetic in the operative field.[38,39] The use of a vasoconstrictor in the local anaesthetic will allow better pain control than anaesthetics without a vasoconstrictor, avoiding an exaggerated stress response as a result.[40] In our study, whether or not participants were subjected to surgical treatment, as well as the use of anaesthesia with or without a vasoconstrictor, implied variations in the study variables. The SBP increased between the first and the second timepoints in participants undergoing surgical treatments and with anaesthesia without a vasoconstrictor and decreased between the fourth and fifth timepoints. In participants undergoing non-surgical treatments, the opposite effect occurred: SBP decreased between the first and the second timepoints and then increased between the fourth and fifth timepoints. With the use of a vasoconstrictor, SBP remained stable. The DBP showed no interaction effect in relation to surgical or non-surgical treatments. Only at the beginning did DBP show higher values for the participants with surgical treatments; with the use of a vasoconstrictor, DBP showed an initial decrease, while without a vasoconstrictor, it showed an initial increase. HR was analogous whether or not a vasoconstrictor was used; between the first and the second timepoints, it decreased with surgical and non-surgical treatments and then increased between the fourth and fifth timepoints. BP variations according to the type of treatment and use of anaesthesia with a vasoconstrictor are in agreement with most previous studies[18,21,24,41], differing only from a study by Abu-Mostafa *et al.*[22] These differences could be attributed to the different amounts of local anaesthetics used. In our study, a maximum of three carpules were used, corresponding to 5.4 ml of local anaesthetic containing 0.054 mg of epinephrine, while in their study, they used 3.6 ml of local anaesthetic containing 0.036 mg of epinephrine. The present results could help explain the discrepancies cited above, agreeing with authors such as Knoll-Kohler *et al.*[42,43] who established that pain control was lower in participants who received a local anaesthetic without a vasoconstrictor, compared with participants who were exposed to a local anaesthetic with a vasoconstrictor.

Significant differences were observed in the evolution of SBP, with an initial increase in participants undergoing surgical treatments and without the use of a vasoconstrictor and a decrease with non-surgical treatments; but with the use of a vasoconstrictor, SBP remained stable. The DBP had no interaction effect in surgical or non-surgical treatments; it initially decreased with the use of a vasoconstrictor, while without a vasoconstrictor, it was the opposite. The HR initially decreased in participants undergoing surgical and non-surgical treatments and was analogous whether or not a vasoconstrictor was used.

We propose to carry out studies that differentiate additional population groups, such as an undiagnosed hypertensive population and a diagnosed hypertensive population, treated but not controlled.

CONCLUSIONS

During blood pressure monitoring, blood pressure variations occur, but there was no clinical repercussion in the participants because once the treatment concluded, a return to the initial values was observed.

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CONFLICTS OF INTEREST

None

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Original research

IMPROVEMENT OF ORAL HEALTH STATUS IN A GROUP OF STUDENTS WITH VISUAL IMPAIRMENT IN ISTANBUL

*Kübra Tonguç Altın[1],
Fatoş Alp[2],
Serpil Nazlı Aydın[2],
Şule Kavaloğlu Çıldır[2],
Nuket Sandallı[3]

ORCID IDs of the authors:
K.T.A.0000-0002-8509-6173
F.A.0000-0001-8637-8263
S.N.A.0000-0002-2514-2481
Ş.K.Ç.0000-0002-6967-7226
N.S. 0000-0002-0381-8583

[1] Department of Pediatric Dentistry, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey.
[2] Department of Pediatric Dentistry, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey and Pediatric Dentist, Dentarya Dental Clinic, Nicosia, Cyprus.
[3] Department of Pediatric Dentistry, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey. and Retired Now.

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ABSTRACT

Objectives: The purpose of this study was to determine the oral health status of a group of students with vision impairment and to compare the changes of oral hygiene after oral health education.

Materials and Methods: Dental examination of 6-19-year-old of 136 students with vision impairment in a Primary School for Individuals with Vision Impairment in Istanbul was performed. The students were divided into 6-9-year-age group (Group I) and 10-19-year-age group (Group II) and in the first visit, they were examined and their findings were recorded according to DMFT (Decayed, Missing, and Filled Teeth), DMFS (Decayed, Missing, and Filled Surfaces) indices of permanent teeth, dft and dfs indices of primary teeth and in the first visit and 3rd follow up period, their Dental Plaque (PI), Calculus (CI) and Oral Hygiene (OHI) Indexes were recorded. They received one-to-one oral health education (OHE). Statistical evaluation was carried out with Wilcoxon and Mann-Whitney U tests and $p<0.05$ was found as statistically significant.

Results: Regarding the pre and post OHE results of periodontal indexes, PI and OHI scores statistically significantly increased after OHE in Group I ($p<0.05$). On the other hand, CI results significantly decreased after OHE in Group II ($p=0.042$). Comparing post OHE results of PI and OHI, Group I showed statistically significantly higher scores than Group II ($p<0.05$). Comparing the difference values of PI and OHI between pre and post OHE, Group I showed statistically significantly lower scores than Group II ($p<0.05$).

Conclusions: Students with vision impairment have a high prevalence of dental caries and poor oral hygiene. We emphasise the importance of providing proper dental education and regular dental visits to them.

Key Words: Oral hygine education, vision impairment, students, dental plaque index

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***Corresponding Author**
Yeditepe University, Faculty of Dentistry, Department of Pediatric Dentistry, Bagdat Cad. No: 238, 34728, Goztepe, Istanbul, Turkey
Phone: +90 532 4073782 **Fax:** +90 216 3636211 **E-mail:** kubra.tonguc@yeditepe.edu.tr

INTRODUCTION

Oral health has significant biological, psychological, and social consequences due to its effects on aesthetics and communication; furthermore, quality of life is influenced by oral health status.[1] Good oral health is important for proper mastication, digestion, appearance, speech, and health.[2] The oral cavity serves an important role in the satisfaction achieved from daily life through functions such as mastication, aesthetics, phonetics, communication, and expression. Oral cavity is an integral part of the body, and dental treatment can affect and be affected by a patient's general physical and mental status.[3] Oral health is an important aspect of overall health in children and is particularly important for children with special health needs. The oral health of children with visual impairment tends to be compromised as they are at a disadvantage and are often unable to adequately apply plaque control techniques.[4]

Visual impairment is the most frequently occurring disability, followed by speech, hearing, movement, and mental disabilities.[5] The World Health Organization has estimated the number of individuals with visual impairment (presenting vision) to be 285 million (with 65% of them being aged>50 years). Of them, 246 million have low vision (63% aged>50 years) and 39 million are estimated to be blind (82% aged>50 years).[6] In Turkey, reportedly, almost 130,000 individuals are totally visually impaired; however, individuals afflicted with partial loss of vision increase the number of those suffering from a visual handicap to>750,000. In Turkey,>20,000 children are growing up with a visual impairment, and almost 8800 children reach school age every year.[7]

Children with visual impairment face challenges in learning everyday skills, with maintenance of proper oral hygiene being one of them. These children have been found to have a poorer oral hygiene than their sighted peers.[8] Chang and Shih[9] have reported that children with visual disabilities have higher levels of oral diseases. Priority is given to teaching these children how to manage their disabilities; consequently, oral hygiene is neglected.

Oral hygiene maintenance is important for preventing periodontal disease and dental caries development. Poor oral hygiene, gingivitis, and periodontal diseases have been reported among the children with visual impairment in studies from India, Iran, and Turkey.[4,7,10,11] Mann *et al.*[12] have suggested that this is attributable to their inability to visualize plaque on tooth surface, resulting in inadequate plaque removal and subsequent progression of dental caries and inflammatory diseases of the periodontium. Few studies have examined the health information needs of individuals with visual impairment and even fewer have investigated the dental health needs of this group.[13] Despite the prevalence of visual impairment in Turkey being 0.2%[14], little information is available regarding the dental health status and needs of individuals with visual impairment. Some studies have suggested that oral health is compromised in individuals with visual impairment, and these individuals tend to exhibit a higher incidence of dental caries and gingival disease.[15-17] To determine the comparative oral health care needs of individuals with visual impairment as well as those of sighted people, the oral health status and experiences of such groups with respect to dentistry need to be established.[18]

The aim of current study was to determine the oral health status of a group of students with visual impairment and to compare the changes of oral hygiene after OHE.

MATERIALS AND METHODS

The present study was registered with the Yeditepe University, Faculty of Dentistry, Institutional Review Board Committee, with the number 266. Signed informed consent forms were obtained from the parents of children, and the study was conducted according to the Helsinki Declaration.

Participants

A total of 136 students (age range, 6–19 years) with visual impairment with no systemic diseases were examined at the Türkan Sabancı Primary School for Children with Vision Impairment connected to the National Education Ministry in

Istanbul, Turkey. The students were divided into two groups according to their age: a 6–9-year age group (group I) and a 10–19-year age group (group II). The students with visual impairment received one-to-one OHE and motivation with the assistance of dental models and toothbrushes. All students had the ability to brush their teeth by themselves. They were educated by touching and holding toothbrushes with two pediatric dentists. Each of them were taught for twenty minutes. Apart from the tooth brushing education of the students, instructions regarding maintenance of good oral hygiene and horizontal scrub technique of tooth brushing were explained to all their parents.

Inclusion criteria of the study participants:

1. 100% bilateral visual impairment (as verified through school medical records)
2. Patient acceptance/cooperation for oral examination
3. Parental compliance

Exclusion criteria of the study participants:

1. Partial visual impairment/unilateral blindness
2. Concomitant medical conditions
3. Patient cooperation not attained
4. Parental consent not obtained
5. Those without the ability to brush their teeth or whose parents did not participate in the oral hygiene education sessions

Methods

Intraoral examinations of all students were performed in their schools under artificial illumination of headlamp using a mouth mirror and probe by two calibrated pediatric dentists. Interexaminer reliability was assessed using correlation coefficient (Table 1).

The students were examined on the first visit and then at the 3rd month following it, and pre- and post-OHE findings were recorded. Professional plaque control was not performed for these students in the school conditions. Therefore, following the Mann–Whitney-U tests were used to analyze the results. $p<0.05$ was considered as significant.

first clinical examination, complete plaque removal was performed using toothbrushes by the pediatric dentists

Table 1. Inter-examiner reliability

Index	Intraclass correlation coefficient	95% confidence interval
DMFT	0.841	(0.798-0.923)
DMFS	0.829	(0.833-0.943)
dft	0.913	(0.897-0.970)
dfs	0.867	(0.822-0.934)
PI	0.906	(0.853-0.951)
CI	0.897	(0.829-0.919)
OHI	0.914	(0.865-0.953)

DMFT (Decayed, Missing, and Filled permanent Teeth), DMFS (Decayed, Missing, and Filled permanent teeth Surface), dft (decayed, filled primary teeth), and dfs (decayed, filled primary teeth surface), Plaque Index (PI), Calculus Index (CI) and Oral Hygiene Index (OHI).

Dental caries were diagnosed and recorded according to the criteria of the Decayed, Missing, and Filled (DMF) index. During the intraoral examination, the scores for Decayed, Missing, and Filled permanent Teeth (DMFT); Decayed, Missing, and Filled permanent teeth Surface (DMFS); decayed, filled primary teeth (dft); and decayed, filled primary teeth surface (dfs) were recorded in the first visit. Radiographs were not used for caries detection.

The periodontal health of students was evaluated using the Plaque Index (PI), Calculus Index (CI), and Oral Hygiene Index (OHI) and was recorded at the first visit and at the 3rd month for all students. Oral hygiene was evaluated using the Simplified Oral Hygiene Index and its components, the Plaque Index (PI-S) and the Calculus Index (CI-S). [19]

Statistical analysis

All the data were analyzed using Number Cruncher Statistical System (NCSS) 2007 Statistical Software (Utah, USA). Wilcoxon and

RESULTS

Group I comprised 21 (51.22%) males and 20 (48.78%) females; Group II comprised 56 (58.95%) males and 39 (41.05%) females. At the

first dental examination, the mean values of DMFT, DMFS, dft, and dfs were 2.93±1.79, 3.37 ±2.93, 5.22±3.5, and 11.46±11.47, respectively, in Group I and 3.64±3.02, 4.41±4.37, 0.88±1.58, and 2.02±3.92, respectively, in Group II.

Regarding the pre- and post-OHE periodontal indices, the mean PI scores increased from 0.73 ± 0.54 to 0.91±0.53 and the mean OHI scores increased from 0.75±0.58 to 0.91±0.53 following OHE in Group I; these increases were significant ($p<0.01$). Conversely, in Group II, the mean CI scores were significantly decreased from 0.02 ± 0.1 to 0 ± 0.03 following OHE ($p=0.042$). When the mean PI scores post OHE were compared between the groups, the scores in Group I were found to be significantly higher than those in Group II ($p=0.004$). Similarly, regarding the mean OHI scores post OHE, the scores in Group I were significantly higher than those in Group II ($p=0.004$) (Table 2).

Table 2. Scores of periodontal indices for the two study groups pre and post OHE

Index	Group		Pre OHE	Post OHE	P-value*
PI	Group I	Mean±SD	0.73±0.54	0.91±0.53	**0.025***
		Median (IQR)	0.75 (0.28-1.04)	0.6 (0.2-1.16)	
	Group II	Mean±SD	0.71±0.62	0.63±0.57	0.259
		Median (IQR)	1 (0.54-1.16)	0.6 (0-1)	
	P-value		0.773	**0.004***	
CI	Group I	Mean±SD	0.02±0.12	0±0	0.317
		Median (IQR)	0 (0-0)	0 (0-0)	
	Group II	Mean±SD	0.02±0.1	0±0.03	**0.042***
		Median (IQR)	0 (0-0)	0 (0-0)	
	P-value		0.484	0.511	
OHI	Group I	Mean±SD	0.75±0.58	0.91±0.53	**0.047***
		Median (IQR)	0.75 (0.28-1.04)	0.6 (0.2-1.2)	
	Group II	Mean±SD	0.74±0.64	0.63±0.58	0.134
		Median (IQR)	1 (0.54-1.16)	0.6 (0-1)	
	P-value		0.920	**0.004***	

Standart Deviation (SD), Oral Health Education (OHE), Plaque Index (PI), Calculus Index (CI) and Oral Hygiene Index (OHI)
*Statistically significant at $p<0.05$.

Table 3 shows a comparison of the differences in the periodontal indices pre and post OHE between the two study groups. Regarding the differences in the PI and OHI scores pre and post OHE between the groups, Group I exhibited significantly lower scores than Group II ($p=0.01$ and $p=0.008$, respectively). A higher significant decrease in the PI and OHI scores was observed in Group II than in Group I post OHE (Table 3).

Table 3. Between-group differences in the pre- and post-OHE periodontal indices

Index		Difference between pre OHE and post OHE		P-value*
		Group I (n:41)	Group II (n:95)	
PI	Mean±SD	-0.18±0.49	0.08±0.76	**0.01***
	Median (IQR)	-0.25 (-0.49-0)	0 (-0.3-0.45)	
CI	Mean±SD	0.02±0.12	0.02±0.08	0.484
	Median (IQR)	0 (0-0)	0 (0-0)	
OHI	Mean±SD	-0.16±0.52	0.11±0.79	**0.008***
	Median (IQR)	-0.25 (-0.49-0)	0 (-0.3-0.45)	

Standart Deviation (SD), Oral Health Education (OHE), Plaque Index (PI), Calculus Index (CI) and Oral Hygiene Index (OHI)
*Statistically significant at $p<0.05$.

DISCUSSION

Oral diseases represent a major health problem

among individuals with disabilities.[20-22] Furthermore, the prevalence and severity of oral diseases among this group are higher than those in the healthy population.[23] Poor periodontal health and oral hygiene have been observed in children with disabilities.[24-26] These findings may be associated with the low physical abilities of these individuals and consequent difficulties in tooth brushing. Oral health may be affected by the following: limited understanding of the importance of oral health management, difficulties in communicating oral health needs, anticonvulsant medications that affect gum health, and a fear of oral health procedures.[21,27-29]

On comparison of the pre-OHE caries indices between the groups, significantly higher dft and dfs scores were observed in Group I than in Group II; furthermore, the PI and OHI scores increased post OHE in group I, whereas the CI scores decreased post OHE in Group II. The results indicated that the caries scores were higher in Group I than in Group II. This suggests that students in Group I did not perform tooth brushing properly and that their tooth brushing performance may have been influenced.

On comparing the pre- and post-OHI PI and OHI scores between the groups, group I was found to exhibit significantly lower values than group II. A higher significant decrease in the PI and OHI scores was observed in Group II than in Group I post OHE. Tooth brushing effectiveness is related to psychomotor skills and hand function ability.[30] A study has reported that chronological age is a reasonable predictor of tooth brushing ability and that the tooth brushing skills of children approach those of adults by the age of 10 years.[31] The results of the present study suggest that 10–19-year-old students with visual impairment possess the physical ability required for tooth brushing. This is contrary to the findings of Powell[32] who reported that the oral hygiene level improved with IQ and was not related to chronological age.

In the present study, students with visual impairment were examined on the first visit and then at the 3rd month. The visits had originally been planned in the 1st and 3rd month after the first examination. However, 1 month after the first examination, the students were on a semester break; therefore, the second visit had to be performed in the 3rd month following the first examination. A school-based intervention in children with visual impairment has shown an improvement in oral hygiene shortly following the end of intervention; this study by Costa[33]demonstrated that the oral health condition 3 months following the end of intervention was poorer than the condition immediately following the end of intervention.

According to Price *et al.*[34], when teachers and institutional attendants are included to assist in intervention, a better result can be expected. In the present study, the students with visual impairment received one-to-one OHE and motivation. Their teachers did not attend the education sessions. In future investigations, the involvement of teachers in education and motivation sessions should be planned. According to the literature on preventive OHE, targeting caregivers to establish dental home care could be a successful strategy to improve the oral health of children with special health care needs.[35] Therefore, we adopted this strategy by including an additional OHE session with parents to improve the oral hygiene of the visually impaired students.

In a previous study in which oral health intervention was performed with students with Down's syndrome, it was reported that a majority of the children were able to perform tooth brushing by themselves. If disabled individuals are motivated and encouraged for self-care, they can manage their own oral hygiene.[36] Therefore, the students in the present study, comprising children and adolescents, can become capable of managing their own hygiene.

The common methods of tooth brushing in children are the horizontal scrub and modified Bass methods. The horizontal stroke is the most commonly used brushing stroke in children.[37,38] The advantages of the horizontal scrub method are that it is easy to learn and practice for effective plaque removal.[39-41] It is important that brushing techniques for patients with disabilities who have fine and gross motor deficiencies are effective and

simple. Horizontal scrub method is often recommended for such individuals because it is easy and can yield good results.[42] A study of dental health status in Greek children and teenagers with cerebral palsy, mental retardation, and visual disorders reported that children with vision problems had better oral hygiene than those with other disabilities because the former are able to better comprehend the oral hygiene instructions and possess superior kinetic skills.[43] The horizontal scrub technique was explained to the students and their parents in the present study.

The present study was performed at a public school. Similarly, Bekiroglu *et al.*[10] conducted their study at a public school (Türkan Sabancı Primary School for Children with Vision Impairment); in their study, it was found that only 26.40% of the children were caries-free. In contrast, examinations by Oredugba and Akindayomi[44] and Desai *et al.*[45] were performed in private schools; in their studies, 66.7% and 53% of the subjects were found to be caries-free. The educational level and socioeconomic status of students' parents are higher in most private schools than in public schools. Therefore, children in private schools tend to be more aware of oral health care than those in public schools. Looking at these studies, the present study may be extended by including the examination of individuals with visual impairment in private schools.

Visual impairment affects the oral health through physical, social, or informational barriers associated with impairment, attendant medical condition (and associated medical disorders), and a lack of customized information.[46] The provision of good oral instructions and tactile devices to improve the tooth brushing skills of children with visual impairment is considered the most important aspect of oral hygiene education.[47,48] Children with visual impairment depend more on sound, speech, and touch to orient themselves to a particular situation.[49] Therefore, modification of OHE is required when teaching these groups of children. Shetty and Hegde[50] have evaluated the Gingival Index (GI) and PI scores of children with visual impairment at the beginning of their study and following OHE. They imparted OHE with the assistance of specially designed models, and tooth brushing was taught with specially formulated music-aided instructions in a song format. They found a significant drop in PI and GI scores from the pre- to post-OHE levels.

Education and motivation of the parents of children with visual impairment is vital toward improving and maintaining oral health and the overall general health of these children.[51] Bhandary and Shetty[8] have assessed the basic information on the oral health care knowledge of parents/care providers of children with visual impairment through a simple pre-structured questionnaire and have reported that there is a general lack of awareness among the care providers of these children regarding dental diseases and their prevention; furthermore, they have found the importance of oral hygiene among these care providers to be low. In a future investigation, we plan to obtain information on oral health care from parents of children with visual impairment through a questionnaire and plan to provide an OHE conference to parents, teachers, and care providers regarding oral hygiene, tooth brushing, and dietary guidance for children with visual impairment to enhance their health care.

CONCLUSIONS

A high caries prevalence demonstrates extensive unmet needs for dental treatment in students with visual impairment. It is an alarming situation that suggests the requirement of immediate dental treatment prior to a prevention-based intervention program for this group of children. The dental treatment costs were met by the Institution of Social Security. Therefore, dentists play a key role in not only diagnosing the oral health conditions of these children but also treating them and maintaining their oral health to contribute to their general well-being.

In the present study, the periodontal health of the students with visual impairment improved at the 3rd month follow-up. These results suggest that providing OHE interventions that include supervised tooth brushing during the school

classes can be a valuable approach for improving oral hygiene status. Further studies are necessary to assess the long-term sustainability of such educational interventions.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

İstanbul İlindeki Bir Grup Görme Engelli Öğrencinin Ağız Diş Sağlığındaki Değişiklikler

ÖZ

Amaç: *Bu çalışmanın amacı, bir grup görme engelli öğrencinin ağız ve diş sağlığı durumlarının belirlenmesi ve ağız-diş sağlığı eğitimlerinden sonra ağız hijyenindeki değişikliklerin değerlendirilmesidir.* ***Gereç ve Yöntemler:*** *Yaşları 6-19 arasında olan, T.C. MEB Türkan Sabancı Görme Engelliler İlköğretim Okulu'nda okuyan 136 görme engelli öğrencinin ağız-diş muayeneleri yapıldı. Öğrenciler yaşlarına göre 6-9 yaş grubu (Group I) ve 10-19 yaş grubu (Group II) şeklinde ikiye ayrıldı. Muayene çıplak gözle ve ayna-sond yardımı ile gün ışığında gerçekleştirildi. Muayene sırasında DMFT, DMFS, dft, dfs, plak (PI), diştaşı (DI) ve oral hijyen indeksleri (OHI) kaydedilen tüm öğrencilere, birebir diş fırçalama eğitimi verildi (OHE). 3 ay sonra aynı çocukların ağız-diş sağlığı gelişimlerinin izlenebilmesi amacı ile ikinci kez muayeneleri yapıldı. İstatistiksel değerlendirmede Wilcoxon ve Mann Whitney U testleri kullanıldı ve sonuçlar p<0,05 anlamlı kabul edildi.* ***Bulgular:*** *OHE'den sonra Group I'in PI ve OHI değerlerinde artış olduğu görüldü (p<0,05). Diğer bir taraftan, OHE'den sonra Group II'nin DI değerlerinde azalma gözlemlendi (p=0,042). OHE sonrası PI ve OHI skorları karşılaştırıldığında, Group I'deki değerlerin Group II'den istatistiksel olarak anlamlı derecede yüksek bulundu (p<0,05). Group I'in eğitim öncesi-sonrası, PI ve OHI değerleri arasındaki farkın, Group II'deki değerler arasındaki farktan istatistiksel olarak anlamlı derecede düşük bulundu (p<0,05).* ***Sonuçlar:*** *Görme engelli öğrencilerin diş çürüğü sıklığının fazla olduğu ve ağız hijyeninin zayıf olduğu görüldü. Bu bireylerin düzenli aralıklarla ağız-diş sağlığı kontrollerinin yapılmasının ve uygun eğitimlerin verilmesinin çok önemli olduğunu düşünmekteyiz.*

Anahtar Kelimeler: *Ağız hijyeni eğitimi, görme engelli, öğrenciler, dental plak indeksi*.

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Original research

EVALUATION OF EFFECTS OF PERIODONTAL DISEASES ON SOCIAL ANXIETY LEVEL

ABSTRACT

Objectives: The aim of this study was to determine the level of social anxiety in patients with periodontal disease, and to examine its relationship with the clinical characteristics of periodontal disease.

Materials and Methods: This study investigated 200 patients in a cross-sectional design. Sociodemographic data, clinical periodontal parameters and patient complaints were recorded. Patients were divided into four groups according to their clinical periodontal index values: chronic periodontitis (CP), aggressive periodontitis (AP), gingivitis (G), and periodontally healthy (PH). Social anxiety levels of the patients were assessed based on the Liebowitz Social Anxiety Scale (LSAS).

Results: A negative relationship was observed between LSAS scores and age, a positive relationship was observed with education level ($p<0.05$). The Liebowitz total score and total anxiety, socially related anxiety and total avoidance levels of patients with halitosis complaints were found significantly higher ($p<0.05$). LSAS scores for patients with complaints of aesthetics and mobility were significantly higher for all seven sub-items ($p<0.05$). Total avoidance and performance avoidance values were significantly higher in patients with complaints of gingival bleeding ($p<0.05$). All of the LSAS scores were higher in the AP and CP groups compared to the PH group and higher in the AP group than in the CP and G groups ($p<0.05$). In the G group, the performance-related avoidance level was significantly higher than in the PH group ($p<0.05$).

Conclusions: Periodontal diseases may negatively affect the psychological and emotional states of dental patients.

Key Words: Anxiety, periodontal diseases, social phobia

*Ayşegül Sarı[1],
Süleyman Ziya Şenyurt[2],
Kemal Üstün[3],
Seval Kul[4],
Kamile Erciyas[2]

ORCID IDs of the authors:
A.S.0000-0001-6180-9776
S.Z.Ş.0000-0001-5536-9110
K.Ü.0000-0001-9696-2041
Ş.K.0000-0002-4716-9554
K.E.0000-0001-9940-0423

[1] Department of Periodontology, Faculty of Dentistry, Mustafa Kemal University, Hatay, Turkey.
[2] Department of Periodontology, Faculty of Dentistry, Gaziantep University, Gaziatep, Turkey.
[3] Department of Periodontology, Faculty of Dentistry, Akdeniz University, Antalya, Turkey.
[4] Department of Biostatistic, Faculty of Medicine, Gaziantep University, Gaziatep, Turkey.

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***Corresponding Author**
Mustafa Kemal University, Faculty of Dentistry, Department of Periodontology 31040 Hatay/Turkey
Phone: +90 5071110868 **Fax:** +90 326 2455060 **E-mail:** aysegulsari@edu.tr

INTRODUCTION

Periodontal diseases, some of the most common multifactorial diseases in society, are chronic infectious diseases characterized by inflammation and destruction of the supporting tissues of the tooth that may result in tooth loss.[1] Although the most prevalent periodontal disease is gingivitis, past or active periodontitis has been reported in 80-90% of the adult population and severe periodontitis in 7-15%.[2,3]

Oral health affects facial aesthetics and physical functions such as eating, drinking and speaking in social environments.[4] Periodontal diseases that negatively affect oral health, have many pathological symptom, such as gingival bleeding, periodontal tissue loss, periodontal pocket formation, mobility and displacement of tooth, tooth loss, and oral malodor (halitosis).[5,6] While these symptoms affect the quality of life of the individual, they may also have negative effects on that person's psychiatric condition.[4, 7]

Social anxiety is a psychiatric disorder characterized by fear of humiliation in the social environment that prevents individuals from expressing themselves among strangers and causes them to avoid specific actions such as speaking, eating, and observing in public.[8, 9] Social anxiety negatively affects people's professional roles and daily activities and decreases the quality of life.[10, 11] Excessive stress in individuals with this psychiatric disorder is manifested externally through an essential tremor, stuttering, strabismus, physical conditioning, or skin diseases such as acne.[12-14] Periodontal diseases with non-aesthetic features such as tooth mobility and loss, halitosis, gingival bleeding, and gingival recession can negatively affect the physical appearance of an individual.[15]

This suggests that periodontal diseases may affect the individual's self-confidence and behavior in the social environment. The purpose of this study was to determine the level of social anxiety in patients with periodontal disease, and to examine its relationship with socio-demographic variables and the clinical characteristics of periodontal disease.

MATERIALS AND METHODS

Study participants

The study protocol was approved by the Ethics Committee for the Use of Human Subjects in Research, Gaziantep University, Gaziantep, Turkey (Protocol No. 19.03.2013/125) and the study was performed pursuant to the Declaration of Helsinki. Patients who applied to the Department of Periodontology, Faculty of Dentistry, Gaziantep University for treatment and examination between April 2013 and March 2014 were informed about the content of the study. Patients who consented to take part in the study were included**.** The study included 200 patients (109 males, 91 females) ranging in age from 21 to 65 years. Periodontal examinations were performed before periodontal treatments were planned for the patients, and clinical periodontal indexes were recorded by a single researcher (A.S).

Power analysis was performed for this study. To detect a significant difference (Cohens d=0.80) for large effect size between groups, minimum sample size for each group was determined as 26 (α=0.05, 1-β=0.20)

Patients were asked to complete the Liebowitz Social Anxiety Scale and a questionnaire that assessed anamnesis data such as demographic data, frequency of visiting the dentist, and smoking status as well as patient complaints while waiting in the waiting room.

Evaluation of periodontal parameters

Clinical periodontal parameters of the patients, including pocket depth (PD), periodontal attachment loss (CAL), bleeding on probing (BOP-%), plaque index (PI), and gingival index (GI) scores were recorded using the Williams periodontal probe (Hu-Friedy, Chicago, IL, USA). These parameters were measured from six areas (mesial-buccal, disto-buccal, mid-buccal, mesial-lingual, mid-lingual, disto-lingual) of the teeth. At least 15 teeth were present in the mouths of the patients. Patients without any clinical attachment loss and with PD $\leq$3 mm and BOP <25%[16] were included in the group of periodontally healthy[17], patients without any clinical attachment loss with PD $\leq$ 3 and BOP $\geq$ 25% were included in the gingivitis group;[17] and patients with at least four teeth with PD $\geq$5 mm, CAL $\geq$ 2 mm

were included in chronic periodontitis groups.[18] Patients with interproximal attachment loss affecting the most 2 permanent teeth other than the first molars and incisors were included in localized aggressive periodontitis, and generalized interproximal attachment loss affecting at least 3 permanent teeth other than the first molars and incisors were included in generalized aggressive periodontitis in the <35 years of age people.[19]

Patients were classified according to their index values into four groups: periodontally healthy (PH), gingivitis (G), chronic periodontitis (CP) and aggressive periodontitis (AP).

Liebowitz Social Anxiety Scale

The Liebowitz Social Anxiety Scale (LSAS) was originally developed by Michael R. Liebowitz to determine a person's degree of anxiety and avoidance in socially relevant and performance states.[2] The validity and reliability of the questionnaire for treating of patients with social anxiety are accepted.[21] The reliability of the scales in Turkey was evaluated by Soydan *et al.*[22]

The LSAS consists of 48 questions; 24 on anxiety and 24 on avoidance. Each group of 24 questions is composed of 11 socially-related and 13 performance-related questions. Anxiety and avoidance were scored from 0 to 3 (anxiety: 0: absent, 1: weak, 2: moderate, 3: serious; avoidance: 0: never, 1: rarely, 2: frequently, 3: usually); scores ranged from 0 to 72 for each subsection, and the total score was between 0 and 144. The recommended cutoff score was 25 for each subscale and 50 for the total score.

LSAS scores were shown in seven sub-items including the Liebowitz total score, total anxiety, performance anxiety, socially-related anxiety, total avoidance, performance avoidance and socially-related avoidance.

Statistical analysis

We evaluated the normality of the distribution continuous variables using the Shapiro-Wilk test. Student' s t-test was used to compare two independent variable groups with a normal distribution, and post-hoc analyses of variance (one-way ANOVA) and least significant difference (LSD) test were used to compare more than two groups. The relationship between the categorical variables was assessed using the chi-square test. General linear regression analysis model was used to calculate adjusted means of the LSAS scores for age. Descriptive statistical parameters are presented as frequencies, percentages (%) and means± standard deviations. SPSS for Windows version 22.0 was used for statistical analyses, and p value <0.05 was considered statistically significant.

RESULTS

Demographic data for the individuals included in the study are shown in Table 1.

Table 1. Distribution of demographic data by group

Variable* n(%)		PH (n:45)	G (n:67)	CP (n:60)	AP (n:28)	p*
Sex	Male	24(53.3%)	37(55.2%)	32 (53.3%)	16 (56.1%)	0.985
	Female	21(46.7%)	30(44.8%)	28 (46.7%)	12 (43.9%)	
Age	< 30	24(53.3%)	33(49.3%)	14(23.3%)	18(64.3%)	0.001†
	30-50	11(24.4%)	26(38.8%)	38(63.3%)	10(35.7%)	
	>50	10(22.2%)	8(11.9%)	8(13.3%)	0(0%)	
Education Levels	Lower secondary education	0(%0)	10(14.9%)	21(35%)	3 (10.7%)	0.001†
	High school	6(13.3%)	22(32.8%)	23(38.3%)	16(57.1%)	
	University	39(86.7%)	35(52.2%)	16(26.7%)	9(32.1%)	
Monthly Income	≤750 TRY	10(22.2%)	22(32.8%)	16(26.7%)	10(35.7%)	0.012†
	750-1.500 TRY	3(6.7%)	20(29.9%)	16(26.7%)	8(28.6%)	
	≥1.500 TRY	32(71.1%)	25(37.3%)	28(46.7%)	10(35.7%)	
Frequency of Going to the Dentist	Yes	45 (100%)	60(89.6%)	50(83.3%)	25 (89.3%)	0.006†
	No	0	7 (10.4%)	10(16.7%)	3 (10.7%)	
Smoking Status	Yes	33(73.3%)	48(71.6%)	48(81.4%)	25(89.3%)	0.214
	No	12(26.7%)	19(28.4%)	12(18.6%)	3(10.7%)	

* Chi-square test † Statistically. significant at p< 0.05

There were no statistically significant differences in terms of sex distribution among the groups (p: 0.989). Individuals were divided by age into three subgroups as: 1 (< 30 years), 2 (30-50 years) and 3 (>50 years). There was a significant difference in age between the groups with periodontal disease (p: 0.001). Middle age group patients were present in the CP group, and young patients in the AP group.

Educational status was classified as secondary education, high school and university. There was a significant difference in education level between the groups and the education levels of the PH and G groups were higher (p:0.001). Monthly income was categorized as ≤ 750 TRY, 750-1,500 TRY, and ≥ 1.500 TRY. There was a significant difference among the groups income level, where the PH group

contained more patients from the ≥ 1,500 group. There was also a significant difference among the groups, in patients visiting the dentist (p: 0.006). The healthy group was under dental control. There were no significant differences among the groups in smoking status (p: 0.189).

Demographic data for the patients and the results of comparison with LSAS scores are provided in Table 2.

Table 2. Comparison of demographic data and LSAS scores

Variable* n(%)		PH (n:45)	G (n:67)	CP (n:60)	AP (n:28)	p*
Sex	**Male**	24(53.3%)	37(55.2%)	32 (53.3%)	16 (56.1%)	0.985
	Female	21(46.7%)	30(44.8%)	28 (46.7%)	12 (43.9%)	
Age	**< 30**	24(53.3%)	33(49.3%)	14(23.3%)	18(64.3%)	0.001†
	30-50	11(24.4%)	26(38.8%)	38(63.3%)	10(35.7%)	
	>50	10(22.2%)	8(11.9%)	8(13.3%)	0(0%)	
Education Levels	**Lower secondary education**	0(%0)	10(14.9%)	21(35%)	3 (10.7%)	0.001†
	High school	6(13.3%)	22(32.8%)	23(38.3%)	16(57.1%)	
	University	39(86.7%)	35(52.2%)	16(26.7%)	9(32.1%)	
Monthly Income	**≤750 TRY**	10(22.2%)	22(32.8%)	16(26.7%)	10(35.7%)	0.012†
	750-1.500 TRY	3(6.7%)	20(29.9%)	16(26.7%)	8(28.6%)	
	≥1.500 TRY	32(71.1%)	25(37.3%)	28(46.7%)	10(35.7%)	
Frequency of Going to the Dentist	**Yes**	45 (100%)	60(89.6%)	50(83.3%)	25 (89.3%)	0.006†
	No	0	7 (10.4%)	10(16.7%)	3 (10.7%)	
Smoking Status	**Yes**	33(73.3%)	48(71.6%)	48(81.4%)	25(89.3%)	0.214
	No	12(26.7%)	19(28.4%)	12(18.6%)	3(10.7%)	

***** Mean ± standard deviation †Student's t test ‡ Statistically. significant at p< 0.0

No significant differences were observed when the Liebowitz scores were evaluated according to the sex, the total anxiety and socially related avoidance levels in women were significantly higher. When we compared age and LSAS scores, we found that scores increased as age decreased: Total score (p:0.007 and 0.002 respectively), total anxiety (p: 0.016 and 0.013 respectively), socially related anxiety (p: 0.002 and 0.017 respectively), total avoidance (p: 0.008 and 0.001 respectively), performance avoidance (p: 0.026 and 0.003 respectively) and socially related avoidance (p: 0.003 and 0.009 respectively) levels in the < 30 age group were statistically higher than in the 30-50 and >50 age groups, and performance anxiety levels of the < 30 and 30-50 age groups were higher than those of the >50 age group individuals (p: 0.001 and 0.009, respectively). Due to the increased educational level, the Liebowitz total (p: 0.028 and 0.005, respectively), total anxiety (p: 0.027 and 0.004, respectively), performance anxiety (p: 0.018 and 0.03, respectively), total avoidance (p: 0.025 and 0.016, respectively) scores of the groups studying at the high school and university levels were significantly higher, and the performance avoidance scores showed a statistically significant increase in the group studying only at university compared to the group with secondary education (p: 0.036). Due to the decrease in monthly income level, there was a significant increase in the Liebowitz total, total anxiety and socially related avoidance scores of the group with ≤750 TL monthly income compared to the group with ≥1.500 TRY monthly income, while there was a statistically significant increase in total avoidance (p: 0.002 and 0.024, respectively) and performance avoidance (p:0.001 and 0.0, respectively) in the groups with ≤750 TL and 750-1.500 TRY monthly income compared to the group with ≥1.500 TRY monthly income.

Patient complaints recorded in the patient's anamnesis were divided into six subgroups: gingival bleeding, tooth sensitivity, halitosis, aesthetic problems, mobility and abscess (Table 3).

Table 3. Distribution of patient complaints by group

Variable* (n. %)		PH (n:45)	G (n:67)	CP (n:60)	AP (n:28)	p*
Halitosis	**Yes**	8 (17.8%)	46 (68.7%)	43 (71.7%)	27 (96.4%)	0.001†
	No	37 (82.2%)	21 (31.3%)	17 (28.3%)	1 (3.6%)	
Aesthetic Problems	**Yes**	19 (42.2%)	35 (52.2%)	45 (75%)	26 (92.9%)	0.001†
	No	26 (57.8%)	32 (47.8%)	15 (25%)	2 (7.1%)	
Mobility	**Yes**	4 (8.9%)	26 (38.8%)	33 (55%)	27 (96.4%)	0.001†
	No	41 (91.1%)	41 (61.2%)	27 (45%)	1 (3.6%)	
Gingival Bleeding	**Yes**	9 (20.0%)	22 (32.8%)	44 (73.3%)	26 (92.9%)	0.001†
	No	36 (80.0%)	45 (67.2%)	16 (26.7%)	2 (7.1%)	
Tooth Sensitivity	**Yes**	2 (4.4%)	13 (19.4%)	31 (51.7%)	25 (89.3%)	0.001†
	No	43 (95.6%)	54 (80.6%)	29 (48.3%)	3 (10.7%)	
Abscess	**Yes**	3 (6.7%)	24 (35.8%)	16 (26.7%)	27 (96.4%)	0.001†
	No	42 (93.3%)	43 (64.2%)	44 (73.3%)	1 (3.6%)	

*Chi-square test †Statistically. significant at p< 0.0

There was a significant difference among the groups in patient complaints (p:0.001). Although these complaints were most prevalent in the AP group, the CP group had more complaints than the PH and G groups. A comparison of patient complaints and LSAS scores is shown in Table 4.

Table 4. Comparison of patient complaints and LSAS scores

Variable*		Liebowitz Total score	Total Anxiety	Performance Anxiety	Socially Related Anxiety	Total Avoidance	Performance Avoidance	Social Related Avoidance
Halitosis	**Present**	84.81±25.32	43.67±12.96	23.67±7.53	22.53±5.89	41.17±12.64	23.81±7.24	21.15±6.11
	None	76.96±17.45	39.49±9.44	22.53±5.89	19.76±7.04	37.50±9.21	21.15±6.11	17.29±5.66
	P	0.014‡	0.012‡	0.232	0.023‡	0.005‡	0.055	0.055
Aesthetic Problems	**Present**	86.23±22.20	44.39±11.75	24.27±6.95	20.22±6.50	41.56±11.29	23.83±6.84	17.65±5.17
	None	74.65±19.51	38.29±10.03	21.79±6.20	17.02±5.26	36.69±10.19	20.84±6.36	15.41±4.47
	P	0.001‡	0.001‡	0.008‡	0.001‡	0.002‡	0.002‡	0.001‡
Mobility	**Present**	87.97±24.46	45.59±12.69	25.32±7.05	20.79±6.74	42.55±11.78	24.18±6.69	18.23±5.73
	None	76.38±18.80	39.05±9.80	21.78±6.15	17.45±5.42	37.28±10.12	21.34±6.61	15.62±4.22
	P	0.001‡	0.001‡	0.001‡	0.001‡	0.001‡	0.004‡	0.001‡
Gingival Bleeding	**Present**	82.15±24.013	41.94±12.361	23.64±7.056	18.77±6.523	40.39±11.855	23.54±7.108	16.88±5.312
	None	77.79±16.935	40.43±9.418	22.07±5.961	18.41±5.441	37.13±9.198	20.41±5.688	16.00±4.302
	P	0.167	0.362	0.107	0.682	0.042‡	0.001‡	0.225
Tooth Sensitivity	**Present**	81.79±20.440	42.38±10.600	23.32±6.288	19.28±5.811	39.89±10.256	22.76±6.344	16.70±4.530
	None	78.33±23.528	39.69±12.350	22.57±7.330	17.56±6.508	37.92±12.141	21.67±7.404	16.28±5.627
	P	0.275	0.105	0.446	0.054	0.222	0.269	0.56
Abscess	**Present**	86.14±25.438	44.24±13.152	24.63±7.335	20.00±7.207	42.07±12.443	24.44±6.852	17.51±5.934
	None	77.45±18.728	39.82±9.934	22.18±6.177	17.90±5.338	37.58±9.855	21.22±6.465	16.02±4.282
	P	0.013‡	0.015‡	0.013‡	0.034‡	0.01‡	0.001‡	0.066

* Mean ± standard deviation †Student's t test ‡ Statistically. significant at p< 0.05

The Liebowitz total score and total anxiety, socially related anxiety and total avoidance levels of patients with halitosis complaints were found significantly higher. Liebowitz scores for patients with complaints of aesthetics and tooth mobility were significantly higher for all seven sub-items. Total avoidance and performance avoidance values were significantly higher in patients with complaints of gingival bleeding. No significant differences were found for any Liebowitz sub-item

in patients with tooth sensitivity, although all sub-items (except social related avoidance) were found significantly higher in patients with abscess complaints.

A comparison of LSAS scores among periodontal disease groups is shown in Table 5.

Table 5. Comparison of LSAS scores among all groups

Variable* (n)	PH (n:45)	G (n:67)	CP (n:60)	AP (n:28)	p	Adjusted p
Liebowitz Total Score	71.02±14.95	76.46±20.92	83.57±21.28	98.79±21.7	0.001‖. §. ¶. **.‡‡	p< 0.05‖. §. ¶. **.‡‡
Total Anxiety	36.93±7.9	39.19±11.01	42.80±11.07	50.64±11.91	0.001‖. §. ¶. **	p< 0.05‖. §. ¶. **.‡‡
Performance Anxiety	20.82±4.89	22.24±6.97	23.07±6.5	28.4±6.27	0.001‖. §. ¶. **	p< 0.05‖. §. ¶. **
Socially Related Anxiety	16.78±5.34	17.31±5.13	19.28±6.01	23.39±7.2	0.001‖. §. ¶. **	p< 0.05‖. §. ¶. **.‡‡
Total Avoidance	34.38±8.72	37.57±10.37	40.6±10.7	47.5±11.48	0.001‖. §. ¶. **	p< 0.05‖. §. ¶. **.‡‡
Performance Avoidance	18.56±4.75	21.79±6.44	23.55±6.81	27.21±6.69	0.001‖. §. ¶. **.††	p< 0.05‖. §. ¶. **.††.‡‡
Socially Related Avoidance	14.78±4.1	15.99±4.7	16.75±4.52	20.29±5.87	0.001‖. §. ¶. **	p< 0.05‖. §. ¶. **

* Mean ± standard deviation † One-way ANOVA and LSD post-hoc tests ‡ Statistically. significant at p< 0.05
‖: PH versus CP §: PH versus AP ¶: G versus AP **: CP versus AP ††: PH versus G ‡‡:G versus CP

All scores including the Liebowitz total score, total anxiety, performance anxiety, socially related anxiety, total avoidance, performance avoidance, and socially related avoidance were higher in the AP and CP groups compared to the PH group and higher in the AP group than in the CP and G group (p: 0001). In the G group, the performance-related avoidance level was significantly higher than in the PH group (p: 0.001). Adjusted P values calculated for age are the same with these results, except Liebowitz total score, total anxiety, socially related anxiety, total avoidance, and performance avoidance were higher in the CP group compared to the G group (p<0.05).

DISCUSSION

In this study, the possible effects of periodontal disease on social anxiety level were investigated. Although previous studies have explored levels of social anxiety in patients with diseases such as acne, halitosis, and strabismus, to the best of our knowledge no study has evaluated the social anxiety frequency and related disability in patients with periodontal diseases.[13, 14, 23] The present study is the first to evaluate of the effects of periodontal diseases on social anxiety.

When we evaluated the groups' demographic data, we found no significant differences in terms of sex. Individuals younger than 30 years of age were common in the AP group, which agrees with previous reports.[18]

In terms of education level, we found that the education level of the individuals in the PH and G groups was high whereas patients in the CP and AP groups were more commonly educated to the secondary or high school level. These results support the claim that education level increases the power of the individuals to engage in self-care.[24] In terms of the monthly income, the healthy group contained higher monthly income individuals than the other groups. This suggests that a higher income may confer advantages to individuals in developing oral care habits and gaining access to oral and dental health services. When we examined dental visits and education level, we found that the highest level reaching 100 % was observed in the healthy group, similar to the results for monthly income. These results are consistent with studies reporting that oral hygiene habits and regular dental visits increase with increasing education levels.[25]

No significant differences were observed among the groups in cigarette smoking rates. Although studies investigating the effects of smoking on periodontal disease suggest that cigarette smoking increases the risk of periodontal disease.[26, 27] Our study results contradict these data. Possible explanations for these inconsistencies failure to account for risk factors other than smoking among the periodontal disease groups and the small number of individuals included in the study.

The LSAS is considered the gold standard for determining the level of impact of a social anxiety disorder on individuals by the International Depression and Anxiety Association.[28] When we examined LSAS scores according to sex, we found that female patients showed significantly higher levels in all subgroups. These results are inconsistent with studies reporting that men have higher values based on scales such as dental anxiety,[29] although they are consistent with studies reporting that women have a greater tendency toward social anxiety disorders.[23, 30] This can be explained by the more intense emotional state in women and sex-related perceptual differences. In addition, our study found an increase in the level of social anxiety in younger age groups. Zaitsu *et al.*[23] observed higher anxiety scores in the middle age group when they classified age into three subgroups whereas other studies have shown higher levels in younger individuals, in accordance with the results of the current study.[31, 32] The discrepancy with the work of Zaitsu *et al.* may be due to methodological differences such as the high number of women in the middle age group. Decreased levels of anxiety with increased can be attributed to patients' reduced anxiety over their outward appearance and their skills for coping with societal problems as their age.[33] A positive relationship was found between education level and LSAS scores in the current study. Yolaç Yarpuz *et al.*[33] reported that social anxiety and education showed a negative correlation whereas Gültekin *et al.*[34] reported that the level of social anxiety in university students was considerably higher in accordance with the results of the present study. This suggests that individuals in a more perfectionist social environment with increasing levels of education may be more anxious about possible problems. In our study, LSAS scores increased as monthly income decreased. Ergin *et al.*[35] reported that power to engage in self-care was low in individuals with low socioeconomic status. According to these results, the power of individuals to meet their needs and solve problems decreases as their income decreases.

When the complaints of the patients related to the symptoms of periodontal disease were evaluated by the anamnesis forms, it was observed that the patient complaints were higher in the AP and CP group. Some of the periodontal healthy individuals reported abscesses and mobility in their mouths. This may indicate that the patient's intra-oral perception is not always consistent with professional periodontal examination results. Symptoms of periodontal disease (gingival inflammation, tooth loss, toothache, halitosis, and so forth) are among the oral health issues that have negative effects on quality of life. [4] In the current study, when LSAS sub-scores and patient complaints were compared, there was significant increase in LSAS sub scores in the presence of complaints that could cause feelings of physical deformities in the social environment such as halitosis, aesthetic problems, mobility, and abscesses. There were no significant results when LSAS scores were compared with some complaints that are health problems but are difficult for other people to perceive as a physical deformity such as gingival bleeding and tooth sensitivity. Ng *et al.*[4] discussed the fact that symptoms of periodontal disease such as dental pain that can originate from gingival infection, dental mobility, halitosis, and dental abscess affect quality of life by causing physical disabilities. Zaitsu *et al.*[23] did not observe a significant difference between the BOP index and low (-59) –or high (60-) LSAS scores in their study although a significant decrease in LSAS scores was observed after halitosis treatment. The results of the current study are consistent with the data in these previous reports.

In our study, for all subgroups of LSAS scores, values for the CP and AP groups were significantly higher than those for the S and G

groups (Total anxiety and socially related avoidance did not include these results, for G versus CP groups); and values for the AP group were higher than those for the CP group. The present study results imply that the CP and AP groups (periodontal disease groups), may perceive a deformity in physical appearance due to symptoms such as abscess, halitosis, and dental mobility as well as aesthetic problems related to tooth loss and localization changes in the teeth. This may result in limited avoidance and increased levels of anxiety in the social environment. In addition, reason of LSAS values for the AP group higher than those for the CP group may explained with more severe and rapid periodontal damage in AP. Previous studies have compared specific medical situations that affect physical appearance to high rates of social phobia. Bez *et al.*[14] showed that LSAS scores of patients with acne vulgaris were higher than those of a control group without acne vulgaris. Zaitsu *et al.*[23] emphasized the awareness of halitosis among patients with high LSAS scores compared to patients with low LSAS scores. Stein *et al.*[36] diagnosed social phobia in 75% of individuals who participated in their study on stuttering, whereas Gundel *et al.*[37] found that social phobia was common in patients with spasmodic torticollis. Schneier *et al.*[38] reported that social anxiety scores were high in two different studies conducted by Topcuoglu *et al.*[39] In our study, the high social anxiety scores in the presence of periodontal diseases, which show symptoms that patients may experience as a negative perception of their physical appearance, are consistent with previous reports.

Limitations of this study are: the LSAS scores before and after periodontal treatment weren't evaluated, and the possibility of social anxiety as a source of stress increasing which might affect the severity of periodontal disease wasn't assessed. Another limitation of current study is small sample size.

Further studies are needed with larger patient groups and with different design including periodontal treatment to evaluate the relationship between periodontal disease and social anxiety.

CONCLUSIONS

According to our results, chronic periodontitis and aggressive periodontitis may have negative effects on the psychological and emotional states of patients. Thus, periodontal treatment may have a positive effect on the emotional state of patients with social anxiety.

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CONFLICTS OF INTEREST

None

Periodontal Hastalıkların Sosyal Kaygı Düzeyi Üzerindeki Etkilerinin Değerlendirilmesi

ÖZ

Amaçlar: *Bu çalışmanın amacı, periodontal hastalığa sahip bireylerde sosyal anksiyete düzeyini belirlemek, sosyal anksiyetenin sosyo-demografik veriler ve periodontal hastalığın klinik karakteristiği ile ilişkisini incelemektir.* ***Gereç ve Yöntemler:*** *200 hastanın (109 erkek, 91 kadın) dâhil edildiği çalışma kesitsel olarak planlandı. Çalışma kapsamında hastaların sosyo-demoğrafik verileri, klinik periodontal parametreler ve hasta şikayetleri kaydedildi. Hastalar klinik periodontal indeks değerlerine göre kronik periodontitis (KP), agresif periodontitis (AP), gingivitis (G), ve periodontal sağlıklı (PS) olmak üzere 4 gruba ayrıldı. Hastaların sosyal anksiyete düzeyleri Liebowitz Sosyal Kaygı Ölçeği (LSKÖ) ile değerlendirildi.* ***Bulgular:*** *LSKÖ skorları ile yaş arasında negatif ilişki, eğitim seviyesi ile arasında pozitif ilişki saptanmıştır ($p<0,05$). Halitozis şikâyeti olan hastalarda Liebowitz total skor, total anksiyete, sosyal ilişkili anksiyete ve total kaçınma anlamlı derecede yüksek bulunmuştur ($p<0,05$). Estetik ve mobilite şikâyeti olan hastalarda LSKÖ skorları 7 alt grupta da anlamlı derecede yüksekti ($p<0,05$). Dişeti kanaması olan hastalarda total kaçınma ve performans kaçınma skorları anlamlı derecede yüksekti ($p<0,05$). Tüm LSKÖ skorlarının KP ve AP gruplarında PS ve G gruplarına, AP grubunda KP grubuna nazaran anlamlı düzeyde yüksek olduğu görülmüştür ($p<0,05$). Performans ilişkili kaçınma seviyenin G grubunda, PH grubundan anlamlı seviyede yüksek olduğu saptanmıştır*

(p<0,05). ***Sonuçlar:*** *Periodontal hastalıklar, dental hastaların psikolojik ve duygu durumları üzerinde olumsuz etki gösterebilirler.* ***Anahtar Kelimeler:*** *Anksiyete, periodontal hastalıklar, sosyal fobi.*

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Original research

ASSESSMENT OF BUCCAL BONE THICKNESS IN THE ANTERIOR MAXILLA: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

ABSTRACT

Objectives: The aim of this study was to evaluate buccal bone thickness by cone beam computed tomography (CBCT) in patients in both genders and in different age groups.

Materials and Methods: Our study included 186 anterior teeth and 62 patients with CBCT images. Buccal bone thickness was measured at the crest level, and at a distance 1 and 2 mm apical to the crest level. The t-test and ANOVA test were used in analyzing data.

Results: It was found out that age and gender were not significantly associated with the buccal bone thickness of anterior teeth ($p>0.05$). The mean buccal bone thickness was the highest as 1.91 mm around the right canines and it was the lowest as 0.35 mm surrounding the right lateral incisor.

Conclusions: Our study demonstrated that the mean buccal bone thickness increased towards the apical region for all three teeth types. CBCT precisely measures the maxillary bone thickness and may facilitate the planning process for placing implants and scheduling other types of surgeries correctly.

Keywords: Alveolar bone loss, cone-beam computed tomography, maxilla

*Alaettin Koç[1],
İdris Kavut[2],
Mehmet Uğur[2]

ORCID IDs of the authors:
A.K.0000-0001-9984-6900
İ.K.0000-0003-2033-4676
M.U.0000-0003-0019-7811

[1] Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Van Yüzüncü Yıl University, Van, Turkey
[2] Department of Prosthetic Dentistry, Faculty of Dentistry, Van Yüzüncü Yıl University, Van, Turkey

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***Corresponding Author**

Van Yüzüncü Yıl University, 65080, Zeve Campus, Tuşba/Van, Turkey.
Phone: +90 432 2251744 **Fax:** +90 432 2251747 **E-mail:** alttnkc@gmail.com

INTRODUCTION

The alveolar process is located adjacent to periodontal ligament, supporting teeth eruption continuously from the cortical layer to all the way to the bone. Facial and lingual/palatal aspects of the alveolar process may depend on the root dimension, angle, and location of erupting teeth.[1] The alveolar bone displays a physiological remodeling response to external forces. The remodeling process occurs in the periodontal ligament, in the periosteum of the buccal and lingual cortex, and in the endosteal surface of the bone marrow.[2]

Alveolar bone remodeling is controlled by local and systemic factors. Local effects include functional requirements of the tooth and age-related changes in osteocytes. Systemic effects are controlled by hormones (e.g. parathyroid hormone, calcitonin, and vitamin D).[2] Osteopetrosis may develop due to age-related hormonal changes; however, the mechanism of these effects on the jaw has not been clarified yet. It was reported that the duration of implant survival was not related to menopause or age-related osteoporosis.[3] Physiological or pathological resorption of the alveolar bone is an important problem, complicating the dental rehabilitation process.[4] Deformities and defects in the tissue can develop; resulting from periodontal diseases, traumas, developmental alveolar clefts, odontogenic cysts, and tumors.[5]

Cone-beam computed tomography (CBCT) provides detailed images of the bone in order to evaluate diseases of the jaw, dentition, and the structure of the facial bones, nasal cavity, and sinuses. Compared to conventional computed tomography (CT) technique, it does not provide diagnostic information of soft tissue structures such as muscles, lymph nodes, glands, and nerves; however, CBCT has the advantage of exposure to lower levels of radiation.[6]

Several studies in the literature have reported that dimensions of the alveolar crest are subject to changes after tooth extraction. Following the completion of the healing process of the alveolar crest, bone loss of the marginal segment becomes more apparent at the facial aspect compared to the marginal bone loss at the lingual/palatal aspect. The observed differences in the quantified healing outcomes may be related to the presence of a thinner layer of bone at the buccal aspect compared to its palatal equivalent. The clinical consequences of bone loss at the buccal aspect may be critical since they may complicate implant placing and restorative aesthetics.[7]

Previously, it was believed that immediate implant placement could alleviate buccal bone resorption and help maintain the original shape of an extraction socket.[8] However, it has been observed that when an implant is placed immediately, gingival recession occurs leading to aesthetic impairments in patients with thin layers of bone in the buccal region. It is recognized that there should be at least one millimeter of healthy buccal bone layer present so that the aesthetic appearance would be sustained fairly after an immediate implant placement.[9]

In this present study, the thickness of buccal bone layers of anterior teeth from individuals in various age groups and in either gender was compared and the mean values of buccal bone thicknesses were evaluated.

MATERIALS AND METHODS

The present study was conducted in the Department of Oral and Maxillofacial Radiology after obtaining the approval of the respective Ethics Committee. CBCT images of a total of 186 anterior teeth belonging to 29 males and 33 females in the age range from 19 to 60 years were included in the study. Buccal bone thicknesses of the included teeth were measured on sagittal sectional images in CBCT at the crest level, and at distances 1 and 2 mm apical from the crest level (Figure 1). The patients with excessive alveolar bone loss, apical pathologies, and CBCT images with inadequate quality were excluded.

Figure 1. Measurement of buccal bone thickness on sectional CBCT image

The CBCT images of patients were acquired by means of a KaVo 3D eXam (Biberach, Germany) tomography device. The eXamVision (KaVo Dental GmbH, Biberach, Germany) software was used to analyze the acquired images. All measurements were performed by the same investigator, experienced in analyzing CBCT images for three years. The evaluation process of the CBCT images was performed in the consecutive order of the central incisor, lateral incisor, and canine teeth on the right side.

In order to evaluate the intra-rater reliability, the intraclass correlation coefficient (ICC) value was estimated by measuring the buccal thickness of randomly selected 51 anterior teeth at the crest level, and at distances 1 and 2 mm apical from the crest level twice in a one-month interval.

SPSS (IBM SPSS Statistics 20.0; IBM Co., Armonk, NY, USA) software was used for the statistical analysis of the collected data. The student's t-test and one-way ANOVA test were used for data analysis. The study was conducted at the significance level of $p<0.05$. The ICC value was used to assess intra-rater reliability.

RESULTS

The thinnest buccal bone layer was 0.32 mm at the 2 mm apical distance from the crest level of the right lateral incisor, and the thickest bone layer was 2.07 mm at the 2 mm apical distance from the crest level of the right canine. Comparison of the age groups revealed that the lowest mean thickness of the bone layer was 0.35 mm surrounding the right lateral incisor in the 30-49-year-age group and the highest of this value was 1.91 mm around the right canine in the 30-49-year-age group. Furthermore, we found out that the mean thickness of bone gradually increased towards the apical region associated with all types of anterior teeth (Table 1).

Table 1. Mean±standard deviation values of buccal bone thickness of related teeth at selected levels (mm)

Tooth type	N	At the crest level	At 1 mm apical from the crest level	At 2 mm apical from the crest level
Right central	62	0.69±0.16	0.74±0.18	0.76±0.21
Right lateral	62	0.74±0.19	0.81±0.23	0.85±0.29
Right canine	62	0.97±0.26	1.04±0.30	1.06±0.35

N: Number

No significant effects of gender (p=0.483, p=0.988, p=0.905, respectively) and age (p=0.838, p=0.382, p=0.953, respectively) were observed on the buccal bone thickness of the central incisors, lateral incisors, and canine teeth (Table 2, 3). In regards to the intra-rater reliability, ICC values were above 0.80 and there was good reliability between repeated measurements.

Table 2. Comparison of mean buccal bone thickness according to gender (mm)

Tooth type	Gender	Mean±SD	T test (p value)
Right central	Male	0.71±0.17	0.483
	Female	0.74±0.17	
Right lateral	Male	0.80±0.23	0.988
	Female	0.80±0.22	
Right canine	Male	1.02±0.28	0.905
	Female	1.03±0.29	

SD: Standard deviation

Table 3. Comparison of mean buccal bone thickness of teeth according to age groups (mm)

Tooth type	Group (Age range)	Mean±SD	ANOVA test (p value)
Right central	19-29	0.75±0.14	0.838
	30-49	0.72±0.20	
	50-60	0.71±0.16	
Right lateral	19-29	0.78±0.22	0.382
	30-49	0.78±0.24	
	50-60	0.88±0.21	
Right canine	19-29	1.03±0.33	0.953
	30-49	1.02±0.28	
	50-60	1±0.22	

SD: Standard deviation

DISCUSSION

Sensitive measurements are of paramount importance in the anterior dental arc, where aesthetic considerations are the primary concern apparently during the follow-up period after periodontal therapies. Therefore, several studies have investigated the mean values of several parameters associated with the alveolar crest and gingiva in the search for obtaining precise conclusions.[10-12] Sagittal sections of CBCT images were used in several studies[8,9,10] similar to that of our study.

Kim *et al.*[3] measured mean buccal bone thicknesses in the central incisor, lateral incisor, and canine regions as 0.86, 0.83, 0.90mm respectively. Younes *et al.*[13] performed the measurements in the same regions, reporting the respective mean values as 1.07, 1.16, and 0.98 mm. Esfahanizadeh *et al.*[14] measured the mean bone thickness as 0.72, 0.70, and 0.66 mm respectively in the same regions. In this present study, mean thickness values were found to be 0.73, 0.80, and 1.02 mm, respectively. It is observed that there are discrepancies between the results of the studies. These observed discrepancies may be associated with ethnical differences, the use of different methodologies, and variations in teeth positioning.[15]

We found that the mean bone layer thickness increased towards the apical region at the buccal aspects of each tooth in our study but a few studies reported it decreasing towards the apical region.[3,16] However, another study reported similar results to those of our study, finding that the buccal bone thickness of maxillary incisors increased gradually towards the apices.[17] These results show that the nature of bone thickness, whether increasing or decreasing towards the apex, has not been clearly established yet.

Morais *et al.*[18] measured the bone thickness and bone height of the maxillary central incisors in 22 patients before and after orthodontic therapy. The thickness of the bone layers was measured at 3 mm and 6 mm apical from the crest level. The pre-treatment values were reported as 1 mm and 1.1 mm, and the post-treatment values were 0.8 mm and 1 mm, respectively. Comparison of the pre-treatment and post-treatment values demonstrated that although the quantified bone loss was different significantly at 3 mm apical from the crest, no significant differences were observed at 6 mm apical from the crest.

Crespi *et al.*[19] placed 96 implants immediately into fresh sockets in the anterior maxillary region. Patients were divided into two groups as the ones with a bone thickness of>1 mm and the ones with a bone thickness of≤1 mm. The degree of bone loss was followed up in both groups at the end of treatment with CBCT images taken before the tooth extraction and the one taken 3 years later. The quantity of bone loss was reported to be significantly different when the measured values in these two specified time points were compared. However, the degree of bone loss did not differ significantly between the two patient groups in the follow-up period. One may argue that the amount of bone loss associated with implanting is not related to the measured bone thickness before tooth extraction.

Adıgüzel *et al.*[20] measured the buccal bone thickness of 451 maxillary premolar and molar teeth using CBCT and analyzed the relationship of age and gender to buccal bone thickness. The thinnest bone region was 2.11 mm in females and 2.02 mm in males. The thickest bone region was 9.87 in females and 10.71 mm in males. In contrast to our study, that study found that age and gender variables were significantly associated with the buccal bone thickness in the maxilla. Therefore, it can be suggested that age and gender may affect buccal bone thickness in the anterior and posterior regions differently.

There should be a minimum of 2 mm buccal bone thickness to achieve satisfying results in implant therapy to be performed in the anterior region.[21,22] Khoury *et al.*[16] reported that a 2 mm thickness was found in 11% of the patients in the buccal bone 4 mm apical to alveolar crest. Another study observed buccal bone thicknesses of more than 2 mm at distances 1, 2, 3, 4, and 5 mm apical to the alveolar crest level in the respective ratios of 0%, 0.5%, 1.5%, 2%, 2.5%, and 3%.[23] A study investigated buccal bone

thickness on 73 patients and reported that no values over 2 mm bone thickness were recorded.[8] In our study, at the crest level and 1 mm apical to the crest level, we found no values exceeding 2 mm bone thickness. However, at 3 mm apical to the crest level, we observed a 0.54% percent rate of bone thickness values exceeding 2 mm.

Fuentes *et al.*[24] investigated buccal bone thickness of the anterior teeth, reporting that bone thickness of the right incisors did not differ by the age and gender; however, the buccal thickness of the left incisors differed significantly by these variables. Even in the same patients in that study, the buccal bone thickness of right and left teeth were affected differently by the age and gender, therefore, it can be suggested that gender and age are not predictors for buccal bone thickness.

CONCLUSIONS

In the literature, it is reported that a 2 mm bone thickness in the anterior region is essential for a successful aesthetic implant therapy. This was observed to an extent in our study, too. Age and gender factors are not predictors to provide insight into the existing buccal bone thickness for planning an implant therapy. In conclusion, CBCT should be used for a better three-dimensional understanding of the implant site before starting the therapy, especially when the crest dimensions are not precisely known in the anterior region.

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None

CONFLICTS OF INTEREST

None

Anterior Maksilladaki Bukkal Kemik Kalınlığının Değerlendirilmesi: Konik Işınlı Bilgisayarlı Tomografi Çalışması

ÖZ

Amaçlar: *Farklı yaş gruplarındaki ve cinsiyetteki hastaların bukkal kemik kalınlıklarının konik ışınlı bilgisayarlı tomografi (KIBT) kullanılarak değerlendirilmesi amaçlanmıştır.* ***Gereç ve Yöntemler:*** *Çalışmamıza anterior 186 diş ve 62 hastanın KIBT görüntüleri dahil edilmiştir. Kret seviyesindeki, kret seviyesinden 1 ve 2 mm apikaldeki bukkal kemik kalınlıkları ölçülmüştür. Elde edilen veriler T testi ve One-way ANOVA testi kullanılarak analiz edilmiştir.* ***Bulgular:*** *Anterior dişlerdeki bukkal kemik kalınlığına yaş grupları ve cinsiyetin anlamlı bir etkisinin olmadığı anlaşılmıştır (p>0,05). En yüksek ortalama bukkal kemik kalınlığı sağ kanin bölgesinde 1,91 mm, en düşük ortalama bukkal kemik kalınlığı ise 0,35 mm değerinde sağ lateral kesici bölgesinde ölçülmüştür.* ***Sonuçlar:*** *Sonuçlara göre; her üç diş tipinde de ortalama bukkal kemik kalınlığı apikal bölgeye doğru artış göstermiştir. Maksiller bukkal kemik kalınlığını KIBT ile ölçerek dental implant planlamasında ve diğer cerrahi operasyonlar hakkında öngörü sahibi olmak daha kolay olacaktır ve aynı zamanda kesin ölçüm değerleri sağlanabilecektir.* ***Anahtar Kelimeler:*** *Alveoler kemik kaybı, konik ışınlı bilgisayarlı tomografi, maksilla*

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Original research

EFFICACY OF XP-ENDO FINISHER AND PASSIVE ULTRASONIC IRRIGATION ON MODIFIED TRIPLE ANTIBIOTIC PASTE REMOVAL

Ecehan Hazar[1],
*Baran Can Sağlam[2],
Sibel Koçak[3],
Mustafa Murat Koçak[4]

ORCID IDs of the authors:
E.H.0000-0002-7610-9622
B.C.S.0000-0002-2090-5304
S.K.0000-0003-2354-7108
M.M.K.0000-0003-3881-589X

[1] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[2] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[3] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.
[4] Department of Endodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak, Turkey.

ABSTRACT

Objectives: The aim of this study was to compare conventional needle irrigation (CNI), passive ultrasonic irrigation (PUI), and XP-endo Finisher (XPF) techniques in terms of modified triple antibiotic paste (mTAP) removal.

Materials and Methods: A total of 30 mandibular premolars were instrumented to a size F3 file. A mixture of mTAP was prepared by mixing 3 antibiotics, including 250 mg ciprofloxacin, 250 mg metronidazole, and 150 mg clindamycin, with 1 ml distilled water and applied into the root canals. The teeth were allocated into 3 equal groups, irrigation/agitation was performed and teeth were divided into two halves. The removal of mTAP was evaluated with a scanning electron microscope by using the 4 grade scoring system.

Results: In the apical thirds, significant difference was found between PUI and CNI groups ($p<0.05$), whilst no significant difference was found among the other irrigation activation regimens ($p> 0.05$). No statistically significant difference was found between all groups in the middle third. In the coronal thirds, XPF removed significantly more mTAP than the CNI group ($p<0.05$). However, no difference was recorded among other groups ($p>0.05$).

Conclusions: Passive ultrasonic irrigation and XPF file agitation demonstrated superior efficacy in removing mTAP from root canals compared to CNI.

Keywords: Root canal therapy, ultrasonics, root canal medicaments

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***Corresponding Author**
Zonguldak Bülent Ecevit University, Faculty of Dentistry, Department of Endodontics, Kozlu, Zonguldak, Turkey.
Phone: +90 5058743527 **E-mail:** barancansaglam@gmail.com

INTRODUCTION

Microorganisms are the main factors in initiation and progression of pulpal and periapical diseases.[1] Unfortunately, biomechanical preparation and conventional irrigation of the root canals are unable to achieve removal of microorganisms completely.[2] Thus, using of intracanal medication with calcium hydroxide or antibiotic pastes becomes a necessity for disinfection of root canals. During the root canal treatment, intracanal medication is important to eliminate the microorganisms and their remnants.[3]

Antibiotic pastes have been specially used for revascularization treatment to obtain a disinfected root canal system and to induce the stem cells and growth factors.[4] The widely used antibiotic paste which was developed by Hoshino *et al*.[5] is called triple antibiotic paste (TAP) including metronidazole, ciprofloxacin, and minocycline. TAP was modified by removing the minocycline, which may cause discoloration of teeth; for this reason, clindamycin was added instead. Clindamycin containing modified triple antibiotic paste (mTAP) was accepted as a successful intracanal medicament for endodontic regeneration treatment.[6,7] The intracanal medicaments should be effectively removed to obtain a better adaptation of root canal obturation materials. Therefore, complete removal of antibiotic paste remnants is essential before root canal obturation.[8,9] It has also been reported that TAP was detrimental to the apical stem cells and affect to sealer setting and penetration.[10]

The conventional needle irrigation (CNI) technique is a commonly used method for removing any root canal content including root canal medicaments. However, CNI is unable to remove the TAP, completely.[11] For this reason, studies should focus on the improvement of TAP removal with irrigation activation techniques.

XP-endo Finisher file (XPF, FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) is a novel shape-memory nickel titanium file which has been developed for irrigation agitation. It is produced with a special alloy technology called Maxwire. When cooled, it is in martensite phase and the file has a straight form. At the body temperature, the instrument converts into a spoon shape due to the austenitic phase. During the rotation in the root canal, the instrument achieves a specific shape with a diameter of 3 mm in the last 10 mm. The movement of XPF file up and down for 7 to 8 mm is required inside the root canal, resulting in the contact of the instrument with the canal walls that provides the turbulence of irrigation solutions.[12,13]

According to our knowledge, no study evaluated that removal of mTAP by using XPF file. The present study compared the efficacy of CNI, passive ultrasonic irrigation (PUI), and XPF agitation techniques on mTAP removal. The null hypothesis was that different irrigation/agitation techniques did not affect the removal of mTAP.

MATERIALS AND METHODS

Thirty non-carious human mandibular premolars with similar morphology and mature apices were selected. Periapical radiographs were taken to determine the presence of single and straight root canal anatomy. The crowns were removed with a diamond burr under water coolant to adjust a standardized length of 14 mm. The working length was established by subtracting 1 mm from the length which was recorded by using an inserted 10 K file visible at the apical foramen.

The root canals were instrumented with ProTaper Universal system (Dentsply Maillefer, Ballaigues, Switzerland) to a size F3 file (30/.09). Irrigation was performed using 2 ml of 2.5% sodium hypochlorite (NaOCl) after each file. The teeth were embedded in Eppendorf vials (Labosel, İstanbul, Turkey) with a silicone impression material (Optosil; Heraeus Kulzer, Hanau, Germany). After setting time, the roots were removed from the Eppendorf vials and split longitudinally into 2 halves with a diamond disk avoiding any damage on the root canal dentin. The specimens were reassembled and peripheries of the roots were covered with wax and then placed in the Eppendorf vials. 2 ml of 2.5% NaOCl and 2 ml of 17% ethylenediaminetetraacetic acid was used as final irrigant for 2 min, for each.

mTAP Application

A dense mixture of mTAP was prepared by mixing 3 antibiotics, including 250 mg ciprofloxacin, 250 mg metronidazole, and 150 mg clindamycin, with 1 ml distilled water.[14] The application of mTAP mixture was performed with a lentulo spiral, and a completely filling was performed when the medicament was visible at the apical foramen. The access cavities were temporarily sealed (Cavit G, ESPE, Seefeld, Germany), and the teeth were stored at 37 ^{0}C with 100% humidity for 21 days. The specimens were divided into 3 groups according to the irrigation/agitation protocol (n = 10);

Group 1 conventional needle irrigation (CNI): 27 G needle was inserted 1 mm shorter than the working length. Irrigation was performed with 6 ml 2.5 % NaOCl for 60 seconds.

Group 2 passive ultrasonic irrigation (PUI): 6 ml 2.5 % NaOCl was agitated using an ultrasonic size 25 file (Acteon Satelec, Merignac, France) with an ultrasonic handpiece (VDW Ultra, Satelec, France). Ultrasonic tip was inserted 1 mm shorter than the WL by avoiding any contact to the canal walls. The tip was activated at power setting 6 for 1 min, and the irrigation was continued by another researcher at the same time.

Group 3 XP-endo Finisher (XPF): The XPF file was used at 800 rpm with 1 Ncm. The root canal was irrigated with 6 ml 2.5% NaOCl warmed at 37°C for 60 seconds. XPF was used for 1 minute at 1 mm shorter than WL. Parietal movements and continuous irrigation were applied during the procedure.

Scanning Electron Microscopy (SEM) evaluation

The roots were disassembled for SEM evaluation. SEM images were provided from three surfaces of roots, including coronal, middle, and apical thirds at×1000 magnification.

Criteria for the degree of mTAP removal and cleanliness of the dentinal walls were established by modification of the scoring system described by Salgado *et al.*[15]

0 = Total cleanliness

1 = Good cleanliness (up to 20%)

2 = Partial cleanliness (20–60%)

3 = No cleanliness (more than 60%) (Figure 1).

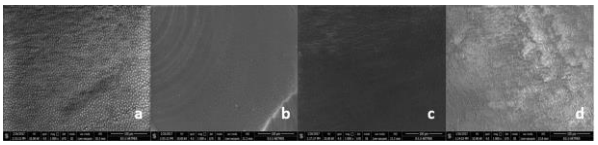

Figure 1. Representative SEM images of mTAP removal scores; score 0 (a), score 1 (b), score 2 (c) and score 3 (d).

Statistical Analysis

Statistical analysis was performed with SPSS 19.0 software (SPSSInc., Chicago, IL, USA). Variables were expressed as mean ± standard deviation. Groups were compared with the Kruskal-Wallis test. The Dunn's test was used for post-hoc test after Kruskal-Wallis test. *p* value of less than 0.05 was considered statistically significant for all tests.

RESULTS

Table 1 presents the mean and standard deviation values of each group.

Table 1. The mean, standard deviation, minimum and maximum values of each group.

Region	Group	N	Mean	Standard deviation	Minimum	Maximum
Apical Third	NI	10	2.50	.527	2	3
	PUI	10	1.70	.675	1	3
	XPF	10	1.90	.738	1	3
Middle Third	NI	10	1.50	.707	1	3
	PUI	10	1.10	.568	0	2
	XPF	10	1.20	.632	0	2
Coronal Third	NI	10	1.40	.516	1	2
	PUI	10	.90	.316	0	1
	XPF	10	.60	.516	0	1

For the apical thirds, a statistically significant difference was found between PUI group and CNI group ($p<0.05$), whilst no significant difference was found among the other groups ($p>0.05$). In the middle third, no significant difference was found among all groups ($p>0.05$). In the coronal thirds, XPF group demonstrated the highest mTAP removal activity and a significant difference was found between XPF and CNI groups ($p<0.05$). However, no difference was found among the other groups ($p> 0.05$).

The comparison of root thirds of each group demonstrated significant differences between coronal and apical thirds, and between middle and

apical thirds in the CNI group ($p<0.05$). PUI and XPF groups demonstrated significant differences between apical and coronal thirds for mTAP removal ($p<0.05$). There was no significant difference between coronal and middle thirds in any group ($p>0.05$).

DISCUSSION

Root canal treatment aims to disinfect the root canal system completely. Antibiotic pastes are used for this purpose, especially in revascularization treatment. In order to eliminate adverse effects, the removal of pastes is essential after the disinfection procedures.[8,9] Previously published studies have reported that complete removal of antibiotic pastes was not possible.[16,17] In the present study, three techniques were compared for removal of mTAP in 3 root canal regions, including apical-middle-coronal.

In previous studies, different antibiotics such as cefaclor or clindamycin were used instead of minocycline due to its discoloration effect.[7,18] In the current study, a clindamycin-modified triple antibiotic paste consisting ciprofloxacin, metronidazole, and clindamycin was used since this combination achieve efficient root canal disinfection and is biologically safe.[19] The clindamycin-modified triple antibiotic paste has a clinically proven efficacy. Lin *et al.*[20] used clindamycin-modified triple antibiotic paste in 69 regenerative endodontic treatments, 12-months follow-up revealed healing of all periapical lesions without any symptoms.

Various measuring techniques were used in recent studies such as stereomicroscope, SEM analysis or photographs to measure the amount of residual antibiotic paste.[15,18,21] In the current study, the amount of residual antibiotic paste was measured with the scoring system which was described by Salgado *et al.*[15] using SEM images. The remnants of antibiotic pastes were examined at an×20 magnification with a stereomicroscope.[16] The present study evaluated the removal of mTAP in dentin tubules at ×1000 magnification using SEM.

Removal of TAP from root canals was evaluated with different irrigation agitation techniques such as needle irrigation, sonic irrigation, PUI, EndoVac (SybronEndo, Coppell, TX), CanalBrush (Coltene/Whaledent GmbH+ Co KG, Langenau, Germany), and EndoActivator (Dentsply, Tulsa, OK, USA).[16,18,22] Additionally, XPF was used to remove the antibiotic paste in a recent study.[23] When using the XPF file in root canal, the instrument become a spoon shape in its austenite phase and this shape provides more contact of the file to the root canal dentin, which may obtain higher cleaning efficacy.[12] The asymmetric structure of XPF results in a streaming effect of the irrigation solution when used with high speed. The streaming was also reported to be effective far from the surface of the files in the biofilm removal from the artificial grooves.[24] According to our results, XPF group showed better scores than the conventional needle irrigation group for cleaning efficacy in all thirds of the root canal. This finding also supported some previous results.[23,25] Similarly, Türkaydın *et al.*[23] compared the removal of TAP using CNI, PUI, and XPF in the apical thirds and reported that XPF removed TAP mixture more efficiently than the needle irrigation and PUI groups, albeit significantly. However, no difference was obtained between the needle irrigation and PUI groups.

In the middle and apical thirds, no significant differences were found between conventional irrigation and XPF. Similarly, Göktürk *et al.*[16] reported that in the apical third, no significant difference was seen between conventional needle irrigation and XPF. Only PUI presented significantly better cleaning efficacy in comparison with conventional needle irrigation. The superiority of PUI activation in the apical third could be explained with the higher velocity of irrigant flow and its efficiency in a flushing out loose mTAP from root canals.[26] XPF group showed significantly better cleaning efficacy than the other groups in the coronal third of the root canals. Although lower scores were obtained in the PUI group than the conventional needle irrigation in the coronal third, no significant difference was found. These findings could be related to the specific shape of the XPF instrument during rotation, and a relative reduction in the effectiveness of PUI from the apex to the coronal thirds.[27]

According to the results of the intragroup comparisons among the root canal thirds, the apical showed significantly higher scores than coronal thirds

in all groups. Thus, we may conclude that the cleaning of the apical third is more difficult than other root canal thirds. Based on our results, PUI and XPF were superior to the NI and the cleanliness of root canal third was affected by irrigation systems. Consequently, the null hypothesis was rejected. Nevertheless, none of the irrigation methods could render the root canal systems free of mTAP.

CONCLUSIONS

Compared to needle irrigation passive ultrasonic irrigation and XPF file agitation were found to be more effective in removing mTAP from root canals.

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None

CONFLICTS OF INTEREST

None

XP-Endo Finisher ve Pasif Ultrasonik İrrigasyonun Modifiye Üçlü Antibiyotik Patını Uzaklaştırma Etkinliği

ÖZ

Amaç: *Bu çalışmanın amacı klasik şırınga irrigasyonu (CNI), pasif ultrasonik irrigasyon (PUI) ve XP-endo Finisher (XPF) tekniklerinin modifiye üçlü antibiyotik patını (mTAP) uzaklaştırması açısından karşılaştırılmasıdır.* ***Gereç ve Yöntemler:*** *Otuz adet alt çene küçük azı dişi F3 eğe boyutuna kadar prepare edildi. mTAP, 250 mg siprofloksasin, 250 mg metronidazol, and 150 mg klindamisin içeren karışımın 1ml distile su ile karıştırılması ile hazırlandı ve kök kanallarına uygulandı. Dişler üç eşit gruba ayrıldı, irrigasyon/aktivasyon uygulandı ve dişler iki eşit parçaya ayrıldı. mTAP uzaklaştırılması trama elektron mikroskobu ile 4 aşamalı skorlama metodu ile değerlendirildi.* ***Bulgular:*** *Apikal üçlüde CNI ile PUI grupları arasında anlamlı fark bulunmasına rağmen (p<0,05), diğer irrigasyon aktivasyon yöntemleri arasında anlamlı fark bulunmadı (p>0,05). Orta üçlüde tüm gruplar arasında istatistiksel olarak anlamlı bir fark bulunmadı (p>0,05). Koronal üçlüde, XPF CNI grubundan anlmalı derecede daha fazla mTAP uzaklaştırdı (p<0,05). Ancak diğer gruplar arasdına anlamlı fark görülmedi (p>0,05).* ***Sonuçlar:*** *Pasif ultrasonik irrigasyon ve XPF eğe aktivasyonu, klasik şırınga irrigasyonuna göre kök kanallarından mTAP'ın uzaklaştırılmasında daha üstündür.* ***Anahtar kelimeler:*** *Kök kanal tedavisi, ultrasonik, kök kanalı ilaçları*

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Original research

EVALUATION OF CAFFEIC ACID PHENETHYL ESTER ADMINISTRATION IN CHRONICALLY STRESSED RATS WITH EXPERIMENTAL PERIODONTITIS

ABSTRACT

Objectives: The aim of the present study was to investigate the therapeutic effects of systemic caffeic acid phenethyl ester treatment on oxidative stress and alveolar bone destruction in lipopolysaccharide (LPS)-induced periodontitis (EP) group in chronically stressed rats.

Materials and Methods: Fourty male Sprague Dawley rats (EP-CS-CAPE) group were divided into four groups: 1) control group, 2) experimental periodontitis (EP), 3) EP and chronic stress (CS) group (EP-CS), and 4) EP-CS treated with CAPE (EP-CS-CAPE). To induce periodontitis, LPS was administered into the buccal gingiva of the test groups, and pure saline was administered for the interleukin (IL)-1β levels were control group. Two test groups were exposed to restraint stress and one group of these groups was treated with only a single dose of CAPE (10 mmol/kg). Likewise, saline was administered in the control, EP, and EP-CS groups. After 14 days, serum samples were collected from the heart, and all rats were sacrificed for analyses. Oxidative stress and interleukin (IL)-1β were investigated. The receptor activator of the nuclear factor kappa B ligand (RANKL) and alveolar bone loss were determined by immunohistochemical analysis.

Results: The oxidative stress, alveolar bone loss, IL-1β and RANKL levels were found significantly higher in the EP-CS group compared with control and EP groups ($p<0.05$). However, the administration of RANKL level CAPE significantly reduced oxidative stress and IL-1β in the EP-CS-CAPE group compared with the EP-CS group ($p<0.05$). Also, CAPE treatment significantly reduced RANKL and alveolar bone loss in the EP-CS-CAPE group compared with the EP-CS group ($p<0.05$).

Conclusions: The present results indicated that CAPE may inhibit alveolar bone loss by modulating the immune response and inflammatory process.

Keywords: Alveolar bone loss, antioxidants, periodontitis

*Alper Kızıldağ[1]
Taner Arabacı[2]
Mevlüt Albayrak[3]
Ufuk Taşdemir[4]
Mukaddes Mergen Dalyanoğlu[5]
Canan Aksu Kızıldağ[6]

ORCID IDs of the authors:
A.K.0000-0002-1630-3140
T.A.0000-0003-0476-1010
M.A.0000-0001-8673-6577
U.T.0000-0002-0631-1665
M.M.D.0000-0002-5862-7792
C.A.K.0000-0002-2687-7551

[1] Department of Periodontology, Faculty of Dentistry, Pamukkale University, Denizli, Turkey.
[2] Department of Periodontology, Faculty of Dentistry, Atatürk University, Erzurum, Turkey.
[3] Medical Laboratory Department, Health Services Vocational Training School, Ataturk University, Erzurum, Turkey.
[4] Department of Maxillofacial Surgery, Faculty of Dentistry, Pamukkale University, Denizli, Turkey.
[5] Department of Phsiology, Medical School, Pamukkale University, Denizli, Turkey.
[6] Department of Orthodontics, Faculty of Dentistry, Pamukkale University, Denizli, Turkey.

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***Corresponding Author**
Pamukkale University, Faculty of Dentistry, Department of Periodontology 20070, Denizli, Turkey
Phone: +90 258 296 17 63 **E-mail:** alperkizildag@hotmail.com

INTRODUCTION

Inflammatory periodontitis leads to the destruction of tooth-supporting tissues and to alveolar bone loss. Factors including genetic predisposition, environmental factors, and the association between pathogenic bacteria and the host immune response increase the severity and progression of periodontitis.[1] In recent years, psychologic factors, such as anxiety, stress, and depression, have been suggested as playing a critical role in periodontal disease.[2,3] Studies have reported that stress accelerates alveolar bone resorption and periodontal attachment loss and impairs tissue wound healing.[4,5]

Stress can activate the hypothalamic–pituitary–adrenal (HPA) axis, and activation of the HPA axis stimulates glucocorticoid hormones from the adrenal cortex.[6-8] These corticoid hormones increase proinflammatory cytokines levels.[9] Additionally, activation of the HPA axis elevates the brain corticosterone level, and this corticosterone stimulates the overproduction of glutamate in the cortical and limbic areas.[10] The stimulation of glutamate release enhances the metabolic rate by disrupting mitochondrial activity.[11] The increased metabolic rate causes breakdown of the balance between the anti-oxidant defense system and the reactive oxygen species (ROS) level by overproduction of free radicals.[12] Furthermore, especially in chronic stress (CS)-depressed humans, the immune response is altered by reducing immunoglobulin A and G, impairing neutrophil activity, and suppressing cytokine production.[13]

CAPE is an antioxidant and has anti-inflammatory and antitumoral effects.[14] Gremy *et al.* reported that CAPE regulated the immune response by preventing the apoptosis.[15] Recent reports have suggested that CAPE improves tissue wound healing, avoids osteoclastogenesis by induced the receptor activator of the nuclear factor kappa B ligand (RANKL), decreases ROS and oxidative stress, and contributes to bone healing.[14, 16-21]

Experimental studies have confirmed that stress increases the severity and progression of periodontal disease, and several agents have been advocated to prevent stress-induced periodontitis.[22-24] However, data on the efficacy of CAPE in periodontitis with stressed animals are lacking. We hypothesized that administering CAPE on stressed rats may reduce alveolar bone loss and oxidative stress in periodontitis. Hence, the present study was designed to evaluate the effect of CAPE on experimental periodontitis with stressed rats.

MATERIALS AND METHODS

Animals

Fourty male Sprague Dawley rats (12 weeks of age) weighing approximately 250 g were used in the present study. All rats were housed five per cage at the ideal room temperature of 21°C ± 2°C with 12-h light and dark cycle and were fed rat pellets and water ad libitum. The rats were assigned randomly to four groups as follows: control, rats with experimental periodontitis (EP), rats with EP and CS (EP-CS), and rats with EP-CS treated by CAPE (EP-CS-CAPE). The experimental protocols were approved by Pamukkale University Ethics Committee for Animal Experimentation (PAUHADYEK-2017/07). Study procedures were applied at the Pamukkale University Laboratory of Experimental Animals Research Centre.

Induction of Experimental Periodontitis

Periodontitis was induced in rats by an lipopolysaccharide (LPS) procedure (10 µL Esherichia coli E, serotype 055: B5, L2637; Sigma Chemical Co., St. Louis, MO, USA; 1mg/mL).[25-27] General anesthesia was performed with mixture solutions of xylazine (10 mg/kg) and ketamine (40 mg/kg). Under general anesthesia, an LPS solution was administered into the vestibular gingival sites between the upper right first and second maxillary molars. This procedure was applied every other day for five days. Pure saline was administered in the control animals using the same procedure.

Protocol of Chronic Stress

Restraint stress was applied according to a previous study[24], using a flexible plastic mesh (30×30 cm), after which the rats were placed in plastic pipes (10 ×30 cm) for 12 hours. These animals did not receive food or water during this period. Other groups were fed limited food and water (pair feeding), but the restraint procedure was not applied. All animals were returned to their cages at

the end of the day. These protocols were performed daily for 15 days before LPS injection and 14 days after LPS injection.

Antioxidant Treatment

After the LPS injection, CAPE was administered intraperitoneally at a daily rate of 10 mmol/kg in the EP-CS-CAPE group during the last 14 days as previously described.[19, 21, 28] The solution of CAPE was injected at the same time every day for standardization during the trials. Pure saline solutions were administered to the control, EP, and EP-CS groups using the same method.

Sample Collection

After the rats had been anesthetized intramuscularly, blood samples from the heart were collected via cardiac puncture, and the rats were decapitated. The blood samples were centrifuged at 2358 g for 10 min at 4°C to obtain serum. The serum samples were frozen at -80°C for biochemical analyses. Additionally, the maxillae of all rats were removed and fixed in 10% neutral formaldehyde solution for histological evaluation to detect alveolar bone loss.

Biochemical Assay

Serum interleukin-1β (IL-1β) concentrations were analyzed by rat-specific enzyme-linked immunoassay (ELISA) kit (Fine Biotechnology, Wuhan, China) according to the manufacturer's instructions.

Commercially available ELISA kits (Rel Assay Diagnostics, Gaziantep, Turkey) were used to evaluate the serum total antioxidant status (TAS) and serum total oxidant status (TOS) levels according to the manufacturer's recommended protocols. The results were stated as millimolar Trolox equivalent per liter (mmol Trolox Eq/L protein) for TAS. The results were also stated as micromolar hydrogen peroxide equivalent per liter (mmol H2O2 Eq/L protein) for TOS. In the present study, the oxidative stress index (OSI) was calculated as described in a previous study and expressed as the percentage ratio of TOS to TAS.[29]

Histologic Procedures

The fixed jaws (10% neutral buffered formaldehyde) were decalcified with 6% nitric acid solution for 7 days. These maxillary tissues were stored at room temperature, and the nitric acid solution was replaced daily. At the end of this process, the decalcified tissues were kept in alcohol for dehydration and were embedded in paraffin buccolingually. Eight slides (5-mm thicknesses) were obtained for each rat by a microtome (Leica RM2125RT, Leica Instruments, Nubloch, Germany). The sections were stained using Crossman-modified Mallory triple and photographed by a light microscope with a camera attachment (Nikon Eclipse i50; Nikon, Tokyo, Japan). In the present study, the attachment level of the maxillary molars was determined by stereological analyses. The proportions of distal periodontal bone support (DPBS) and mesial periodontal bone support (MPBS) (%) were evaluated using a triocular light microscope attached to analyzing software (Kameram SLR, 1.4.1.0, Mikro Sistem, Istanbul, Turkey). To analyze the bone support, the distance between the epithelial attachment and root apex was divided by the distance between the crown tip and root apex.

Immunohistochemical Staining

For immunohistochemical analyses, the tissue sections were stained using with anti-RANKL kit (1:50 dilution) (Santa Cruz Biotechnology, Santa Cruz, CA.) according to the manufacturer's protocols. The binding of antibodies was imaged with a high-power light microscope (Eclipse i50, Nikon, Tokyo, Japan.) to evaluate the immunopositive cell intensity. The stereologic optical fractionator method was applied to determine the numeric density values of RANKL- positive cells in 10 sections of alveolar bone for each animal. A stereology workstation, which consisted of stereology software (Stereo-Investigator, v.9.0, Microbrightfield, Williston, VT.) and a modified light microscope (Leica DM4000B, Leica Instruments.), was used to perform the stereologic analyses.[30]

Statistical Analysis

All data had a normal distribution and the coefficient variation was less than 20%. For this reason, one-way ANOVA and the Duncan post hoc test were used with statistical software (SPSS v.17.0, IBM, Chicago, IL.) to estimate the differences among the groups. The results are

expressed as mean ± SD for each group. $p<0.05$ was considered significant.

RESULTS

The biochemical results for each group are shown in Table 1. The serum OSI level increased significantly in the EP group compared with the control group ($p<0.05$). However, the CAPE treatment significantly reduced the OSI level in the EP-CS-CAPE group compared with that of the EP-CS group ($p<0.05$).

Table 1. Comparison of Immunohistochemical and Biochemical Results

	MPBS (%)	DPBS (%)	IL-1β	OSI	RANKL
Control	59.63±6.18*	58.27±5.95*	60.12±7.13*	2.13±0.88*	0.0000431*
EP	48.79±4.51**	49.33±4.92**	89.94±8.35**	9.39±2.40**	0.0000619**
EP-CS	39.41±3.76$^{\#}$	38.17±3.62$^{\#}$	115.52±12.82$^{\#}$	21.59±5.61$^{\#}$	0.0000825$^{\#}$
EP-CS-CAPE	46.94±4.38**	47.05±4.49**	94.71±10.42**	15.86±4.72$^{\#\#}$	0.0000648**

Footnote: Values are expressed as mean±SD. Symbols (*,**,$^{\#}$,$^{\#\#}$) in the same column indicate significant differences among groups; $p< 0.05$.

The serum IL-1β level in the EP group was significantly higher than that in the control group ($p<0.05$). Furthermore, CAPE administration reduced the serum IL-1β level in the EP-CS-CAPE group significantly more than in the EP-CS group ($p<0.05$).

Immunohistochemical results

The level of the RANKL-positive osteoclastic cells was determined to be significantly higher in the test groups compared with the control group ($p<0.05$). The increase of the RANKL-positive osteoclastic cells was more significant in the EP-CS group than in the EP group ($p<0.05$). CAPE treatment significantly reduced the level of RANKL-positive osteoclastic cells in the EP-CS-CAPE group compared with the EP-CS ($p<0.05$) (Table 1).

Bone Support

MPBS and DPBS was significantly lower in the disease groups compared with the control group ($p<0.05$). MPBS and DPBS were significantly higher in the EP group compared with the EP-CS group ($p<0.05$). In addition, CAPE treatment significantly decreased the loss of MPBS and DPBS in the EP-CS-CAPE group compared with that in the EP-CS group ($p<0.05$) (Table 1).

DISCUSSION

Stress is one of the factors leading to periodontitis and the effects of stress on periodontal destruction have been established.[24] In this study, alveolar bone loss was significantly higher in the EP-CS group than in the EP group, confirming that stress increases the severity of periodontitis.[24, 31] Different agents have been used to prevent alveolar bone loss caused by stress-induced periodontitis.[22,23] However, to the best of our knowledge, this is the first study to evaluate the positive effects of CAPE on CS-induced periodontitis. Kazancıoglu *et al.*[19] showed that CAPE significantly increased bone healing in calvarial defects. In an another study, CAPE was reported to decrease alveolar bone loss significantly in experimental periodontitis.[32] The present findings showed that CAPE significantly prevented alveolar bone loss in the EP-CS-CAPE group compared with the EP-CS group, and these results confirmed that CAPE reduces bone loss and enhances bone healing.[19,32]

RANKL controls bone formation by osteoclast cells activity and is associated with periodontal bone loss.[33] In the present study, RANKL levels were significantly higher in the EP group than in the control group, confirming that periodontitis increases the RANKL level.[30,33] In addition, stress can stimulate a rise in the RANKL level. Wang *et al.*[34] reported that stress causes myocardial injury by improving the RANKL level. Additionally, Peruzzo *et al.*[24] reported that CS elevates the RANKL level in periodontitis. Our results revealed that CS significantly increased the RANKL level, and these findings confirmed those of the previous studies.[24,34] CAPE prevents osteoclastogenesis by decreasing the RANKL level.[17] The results showed that the RANKL level was significantly lower in the EP-CS-CAPE group than in the EP-CS group, and the present results in this study confirmed that CAPE

may improve bone healing by reducing RANKL-induced osteoclast activity.[17]

Oxidative stress causes the destruction of periodontal tissues. OSI is defined by TOS/TAS status, and we used OSI to evaluate oxidative stress. A study reported that periodontitis significantly altered OSI levels by elevating the TOS level and reducing the TAS level.[35] Similar to the previous study, the present results indicated that OSI was significantly higher in the EP group than in the control group. The CS can increase the OSI level by disturbing the balance of oxidant and antioxidant activity. Samarghandian *et al.*[36] determined that CS increased oxidative markers and decreased antioxidant markers. Our findings indicated that CS significantly increased the OSI level in the EP-CS group compared with the EP group. The present results confirmed that CS increases the ROS level and oxidative markers.[36, 37] Antioxidant agents have been used to inhibit oxidative damage. A study reported that CAPE treatment significantly reduced oxidative stress in rats with periodontitis.[32] In the present study, these findings show that CAPE treatment significantly decreased the OSI level in the EP-CS-CAPE group compared with the EP-CS group and these results are consistent with those of the previous study.[32] The decrease in the OSI level may be related to CAPE preventing the activation of the HPA axis and decreasing the brain corticosterone levels.

Proinflammatory cytokines have a critical role in the inflammatory process and on bone loss. Serum IL-1β levels have been used to evaluate the severity of periodontitis. Agarwal *et al.*[38] reported that LPS induces the secretion of IL-1β. Kose *et al.*[39] indicated that periodontitis significantly elevated the serum IL-1β level in rats. The present findings showed that the serum IL-1β level was significantly higher in the EP group compared with the control group, and these findings are consistent with those of previous studies.[38,39] Psychological factors can change the production and secretion of proinflammatory cytokines, especially IL-1. Gomes *et al.*[23] suggested that stress significantly increases the hippocampal IL-1β level in the brain; however, in the periodontium, they did not determine significantly different IL-1β levels in the stress-induced group compared with the control group. In another study, Peruzzo *et al.*[24] suggested that CS significantly elevated proinflammatory cytokines in rats with EP. Data from the present study showed that CS significantly increased serum IL-1β levels in the EP-CS group compared with the EP group, and these results confirmed those of the previous study.[24] In addition, CAPE treatment significantly decreased serum IL-1β levels in the EP-CS-CAPE group compared with the EP-CS group. CAPE has an anti-inflammatory effect and may modulate the expression of CS-induced proinflammatory cytokines.

CONCLUSIONS

Immunohistochemical and biochemical analyses showed that CS accelerates alveolar bone loss in periodontitis by stimulating the inflammatory response and oxidative stress. However, CAPE significantly prevented alveolar bone loss by reducing CS-induced RANKL, oxidative stress, and proinflammatory cytokines. The present study provided a new insight in terms of understanding effect of CS on periodontal destruction. Also, CAPE may supply antioxidant and anti-inflammatory agents to prevent the destructive effect of CS on periodontitis. However, additional studies are necessary to verify the present data and to investigate the role of other pathways in periodontitis after CS.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Deneysel Periodontitis Oluşturulan Kronik Stresli Sıçanlarda Kafeik Asit Fenetil Ester (KAFE) Uygulamasının Değerlendirilmesi

ÖZ

Amaç: *Bu çalışmanın amacı sistemik kafeik asit fenetil ester (KAFE) uygulamasının lipopolisakkarit (LPS) ile periodontitis oluşturulan kronik stresli sıçanlarda oksidatif stres ve alveolar kemik kaybı üzerine terapötik etkisinin değerlendirilmesidir.* ***Gereç ve Yöntemler:*** *Çalışmamızda 40 adet Sprague Dawley sıçan kullanıldı ve bu sıçanlar dört gruba ayrıldı: 1) kontrol grubu, 2)*

deneysel periodontitis (DP) grubu, 3) DP ve kronik stres (KS) grubu (DP-KS) ve 4) KAFE ile tedavi edilen DP-KS grup (DP-KS-KAFE). Periodontitis oluşturmak amacıyla LPS test gruplarında bukkal dişetine uygulandı ve aynı yöntemle kontrol grubuna salin verildi. Bununla birlikte test gruplarından ikisine kısıtlama stresi uygulandı ve bu gruplardan biri de günlük tek doz KAFE ile tedavi edildi (10 mmol/kg). Benzer şekilde kontrol ve interlökin (IL)-1β seviyeleri incelendi. DP ve DP-KS gruplarına da salin uygulandı. 14 gün sonra, hayvanların kalbinden serum örnekleri toplandı ve bütün hayvanlar analiz için sakrifiye edildi. Oksidatif stres, interlökin (IL)-1β incelendi. Reseptör aktivatör nükleer faktör kappa B ligand (RANKL) ve alveolar kemik kaybı immünohistokimyasal olarak değerlendirildi. ***Bulgular:*** *Oksidatif stres, alveoar kemik kaybı, IL-1β ve RANKL seviyeleri DP-KS grubunda kontrol ve DP gruplarına göre anlamlı bir şekilde yüksek bulundu ($p<0,05$). Ancak, KAFE uygulaması oksidatif stres ve IL-1β seviyelerini DP-KS-KAFE grubunda DP-KS grubuna göre anlamlı olarak azalttı ($p<0,05$). Bununla birlikte yine KAFE tedavisi RANKL ve alveolar kemik kaybını DP-KS-KAFE grubunda DP-KS grubuna göre anlamlı olarak azalttı ($p<0,05$).* ***Sonuçlar:*** *Bu sonuçlar KAFE'nin immün cevabı ve enflamatuvar olayları düzenleyerek alveolar kemik kaybını önleyebileceğini göstermiştir.* ***Anahtar Kelimeler:*** *Alveolar kemik kaybı, antioksidanlar, periodontitis*

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Original research

EFFECT OF SURFACE FINISHING METHODS AND AGING ON SURFACE ROUGHNESS AND OPTICAL PROPERTIES OF ZIRCONIA-REINFORCED LITHIUM SILICATE GLASS-CERAMIC

*Gülce Alp
Gülce M. Subaşı

ORCID IDs of the authors:
0000-0003-1751-9207
0000-0002-2510-9745

[1] Department of Prosthetic Dentistry, Faculty of Dentistry, Istanbul Okan University, İstanbul Turkey.
[2] Department of Prosthetic Dentistry, Faculty of Dentistry, Kütahya Sağlık Bilimleri University, Kütahya, Turkey.

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ABSTRACT

Objectives: The effects of three different surface finishing methods and aging on the surface roughness and optical properties of zirconia-reinforced lithium silicate (ZLS) glass-ceramic were investigated.

Materials and Methods: Rectangular specimens (0.6 mm thickness) were sliced from ZLS blocks (N=36). Three different types of surface finishing [glazing combined with crystallization (ZLS-CF) or after crystallization (ZLS-G) and polishing (ZLS-P)] (n=12) and 5000 thermocycles were applied. Three sets of measurements were performed before and after aging to determine the color coordinates and surface roughness (Ra) by using a colorimeter and profilometer, respectively. The mean surface roughness (Ra) values were calculated. Color differences and translucency parameter (TP) values were calculated using the color difference ΔE_{ab} and TP formulas. One-way ANOVA was used to analyze the color difference, translucency, and surface roughness values (α=.05).

Results: Significant differences in the ΔE values were not observed (p=.736) for specimens with different types of surface finishing. A significant difference was observed between the translucency values for different surface finishing groups before aging (p<.001). A significant difference in the surface roughness data between samples with different kinds of surface finishing was observed both before and after aging (p<.001). The ZLS-P group exhibited lowest surface roughness values before and after aging (p<.001). A positive significant correlation between the ΔE and translucency change values was observed in both the ZLS-G (p=.005) and ZLS-P (p<.001) groups.

Conclusions: The surface finishing type did not affect the color change of ZLS glass-ceramic. The translucency values for different surface finished ZLS glass-ceramic specimens changed before aging. After aging, the surface finishing did not affect the translucency of ZLS glass-ceramic. All tested groups exhibited surface roughness values higher than the plaque accumulation threshold (Ra=0.2 mm).

Keywords: Ceramics, color, surface properties

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***Corresponding Author**
Istanbul Okan Üniversitesi Diş Hekimliği Fakültesi Protetik Diş Tedavisi ABD Tuzla Yerleşkesi, Akfirat Tuzla Istanbul, Turkey.
Phone: +90 505 4538813 **E-mail:** gulce165@hotmail.com

INTRODUCTION

Clinical selection of appropriate restoration material is essential for ensuring clinical success.[1] Monolithic computer-aided design and computer-aided manufacturing (CAD-CAM) materials are presented to satisfy demand for esthetically acceptable restorations with better optical and physical properties.[2-4] Zirconia, glass ceramics (feldspathic, lithium disilicate, and zirconia-reinforced lithium silicate), and ceramic/glass polymer materials are some monolithic CAD-CAM materials that are currently available.[4]

Among these materials, zirconia-reinforced lithium silicate glass-ceramic (ZLS) was introduced as a novel monolithic CAD-CAM material for the construction of crowns, implant suprastructures, inlays, and onlays.[5-7] Currently, two different ZLS glass-ceramics (VITA Suprinity PC and Celtra Duo) are available with different sizes of lithium metasilicate crystals.[8] Both of these ZLS glass-ceramics claimed to combine the optical properties of glass ceramics (56-64% silica content) and mechanical properties of zirconia (8-14% zirconia content).[5,8,9] These materials have a fine-grained (0.5-0.7 μm)[5] and uniform microstructure[10] with characteristic needle-shaped crystals.[11] The crystal phase content of ZLS glass-ceramics (40–50%) is lower than that in lithium disilicate glass ceramic (70%).[12,13] In addition, these materials have optical and physical properties that are comparable to those of lithium disilicate[12,13] and fulfill the esthetic requirements through their enhanced translucency and different shade options.[11]

The roughness, smoothness and surface quality of a restoration material is important for ensuring a desired esthetic appearance and long-term clinical succes[14,15] because rough surfaces have an impact on discoloration[16], shade matching[17], plaque accumulation, wear against opposite restoration materials or teeth,[18] and the tactile perception of the patient.[19] Well-finished surfaces were reported to cause fewer technical and esthetic problems by providing the material with tougher, glossier, and more stable translucency[3] and color.[20,21] In addition, the light reflects and diffuses from an irregular and rough surface, which alters the restoration color.[22] The surface roughness of the restoration materials is affected by different factors and conditions.[17,18] A clinically acceptable Ra threshold for prostheses was reported to be 0.2 μm.[23] Excessive microbial adhesion and plaque formation occur when Ra>0.2 μm.[23]

Optical characteristics like color stability, translucency, and opalescence must be considered during the selection of materials for maintaining esthetics.[6,24] The optical characteristics of restoration materials were reported to be affected by the material structure and surface texture, thickness, material and background shade, manufacturing technique, luting agent,[24,25] and aging.[26] Color changes throughout the functional lifetime negatively affect the survival and quality of restorations,[27] thus restoration materials must be stain resistant for long-term use.[15] Optimal translucency is also required for the restorations to provide a natural appearance and the desired esthetic outcome.[3,28] Knowledge of the translucency of restoration materials is clinically important, especially when rehabilitating discolored teeth.[28] Therefore, knowledge of the translucency and color stability of ZLS glass-ceramic is required in order to achieve clinical success.[3,28]

Restoration surfaces can be finished by using various glazing and polishing techniques.[15] Although manufacturers recommend different glazing procedures combined with crystallization or after crystallization and polishing for ZLS glass-ceramics, it is uncertain whether glazing combined with crystallization or after crystallization or polishing provide more appropriate color stability, translucency, and surface roughness. Therefore, this study aimed to evaluate the effects of three different surface finishing methods (glazing combined with crystallization or after crystallization and polishing) and aging on the surface roughness, color stability, and translucency of ZLS glass-ceramic. The first null hypothesis was that the type of surface finishing would not affect the color stability of ZLS glass-ceramic. The second

null hypothesis was that the type of surface finishing, and aging would not affect the translucency of ZLS glass-ceramic. The third null hypothesis was that the type of surface finishing and aging would not affect the surface roughness of ZLS glass-ceramic.

MATERIALS AND METHODS

The color stability, translucency, and surface roughness values of zirconia-reinforced lithium silicate glass-ceramic (Vita Suprinity PC, VITA Zahnfabrik, Bad Sackingen, Germany) (ZLS) (Table 1) (N=36) were evaluated before and after aging.

Table 1. Materials used

Material	Code	Manufacturer	Lot No.
VITA Suprinity PC	ZLS	VITA Zahnfabrik, Bad Sackingen, Germany	36851
VITA AKZENT Plus GLAZE LT	GLZ-P	VITA Zahnfabrik, Bad Sackingen, Germany	51800
VITA AKZENT Plus GLAZE LT SPRAY	GLZ-S	VITA Zahnfabrik, Bad Sackingen, Germany	E65960
VITA SUPRINITY Polishing Set Technical	POL	VITA Zahnfabrik, Bad Sackingen, Germany	E42530

ZLS: zirconia-reinforced lithium silicate glass-ceramic.

ZLS glass-ceramic blocks were sliced into rectangular specimens (0.6±0.03 mm in thickness) under water (Vari/cut VC-50, Leco Corporation, St Josephs, MI, USA). According to the manufacturer's advice, the specimens were cleaned (15 minutes) with distilled water (Sultan 600 ProSonic 600-MTH, Mexico) in an ultrasonic cleaning device and dried. The specimens were then separated in three surface finishing groups: Group 1: glazing combined with crystallization (ZLS-combination firing, ZLS-CF), Group 2: glazing after crystallization (ZLS-glazed, ZLS-G), and Group 3: polishing (ZLS-polished, ZLS-P). All surface finishing procedures were applied to the top surface of each specimen by the same operator (G.A.).

ZLS-CF group (n=12): Glaze spray (VITA AKZENT Plus GLAZE LT SPRAY, VITA Zahnfabrik, Bad Sackingen, Germany) was shaken thoroughly before being applied to each specimen and was sprayed on the top surface of the specimens at a distance of 10-15 cm as a single layer, according to the manufacturer's recommendations. Combination firing was subsequently performed (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes).

ZLS-G group (n=12): These specimens were fully crystallized (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes). After crystallization firing, glaze material (VITA AKZENT Plus Glaze LT powder, VITA Zahnfabrik, Bad Sackingen, Germany) was applied as a single thin layer and glaze firing was performed (800 °C, 60 seconds).

ZLS-P group (n=12): These specimens were fully crystallized (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes). The specimens were then manually polished with a handpiece at slow-speed using recommended 2-stage (pink and gray) diamond-coated laboratory polishing burs (VITA Suprinity Polishing Set Technical, VITA Zahnfabrik, Bad Sackingen, Germany). First, the specimens were pre-polished with a pink assortment (10000 rpm) and then polished with a gray assortment (7000 rpm) to produce higher gloss. All polishing assortments were handled in one direction under mild force.

A caliper (Model number NB60; Mitutoyo American Corporation, Providence, RI, USA) was used to measure the ultimate thickness of each ZLS specimen. Afterwards, the specimens were kept in distilled water (37 °C) for 24 hours before measuring the baseline color and surface roughness. Baseline color measurements were gathered using the color parameters acquired from the CIELab (Commission Internationale De L'éclairage L*, a*, b*) color space relating to D65 CIE illumination and CIE Standard Human Observer (2°) with a colorimeter (Minolta CR 321, Konica Minolta, Tokyo, Japan).[29] L*, a*, and b* values were measured on two different backings. The CIE values were L*=19.74, a*=-0.78, and b*=0.11 on a black backing and the CIE values were L*=78.02, a*=-6.0, b*=-0.5) on a white backing for wavelengths ranging from 400 to 700 nm.[30] The colorimeter was calibrated before gathering measurements for each specimen (CIE L*=93.05, a*=-4.85, and b*=6.95), and the color measurements were gathered from the

middle of each ZLS specimen. Measurements were repeated three times consecutively for each ZLS specimen, and the average L*, a*, and b* values were recorded.

The color difference (ΔE) for each ZLS specimen on the white backing after aging was calculated using the following CIELab formula:[29]

$$\Delta E_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

ΔL*, Δa*, and Δb* represent the difference in lightness or darkness, red-green axis, and yellow-blue axis, respectively.

The color difference values over a black and a white backing were used in the following equation to calculate the translucency parameter (TP):[31]

$$TP=[(L_B^*-L_W^*)^2 + (a_B^*-a_W^*)^2 + (b_B^*-b_W^*)^2]^{1/2}$$

B represented the color coordinates over a black backing and W represented the color coordinates over a white backing.

Ultrasonic cleaning was applied again (Sultan 600 ProSonic 600-MTH, Mexico) (10 minutes) before gathering surface roughness measurements. The surface roughness was measured 3 times for all specimens with a contact profilometer (Mitutoyo Surftest SV-2100, Mitutoyo Corporation, Minatoku, Japan) after calibration (5.5 mm tracing length, 0.8 mm cut-off length, and 1 mm/s stylus speed). The average Ra values were calculated.[32]

Following baseline color and surface roughness measurements, an aging procedure consisting of 5000 thermocycles was applied to all ZLS specimens (MTE-101, Moddental, Esetron Smart Robotecnologies, Ankara, Turkey; distilled water, 5 °C/55 °C, 30 seconds dwell duration, 10 seconds bath transfer duration).[6] Color, translucency, and surface roughness measurements were gathered again for all ZLS specimens after thermocycling.

The color difference, translucency, and surface roughness values were analyzed statistically (SPSS Statistics for Windows v17.0, IBM SPSS Statics, New York, USA). The color difference values, translucency, and surface roughness were analyzed using the one-way analysis of variance (ANOVA). Post-hoc analysis was computed with Tukey's honest significant difference (HSD) test. Correlations between color difference, translucency, and surface roughness values were computed using Spearman correlation analysis (α=.05).

RESULTS

According to the 1-way ANOVA results (Table 2), no statistically significant difference was observed between the ΔE values for two different surface finishing groups (p=.736).

Table 2. ΔE values for groups with different types of surface finishing

Group	Mean ±SD
ZLS-G	2.90 ±1.56[a]
ZLS-P	3.04 ±1.45[a]
ZLS-CF	3.43 ±2.01[a]
P (1-way ANOVA)	.736

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Superscripts indicate that there is no significant difference between groups (*p*>.05) based on 1-way ANOVA results.

According to the 1-way ANOVA results (Table 3), there was a statistically significant difference between the translucency values for groups with different types of surface finishing before aging (p<.001), whereas there was no statistically significant difference between the translucency values for groups with different types of surface finishing after aging (p>.05).

Table 3. Translucency values for groups with different types of surface finishing

Group	Before aging Mean ±SD	After aging Mean ±SD	*p*[*]
ZLS-G	9.23 ±2.50[a1]	10.37 ±0.80[a1]	.182
ZLS-P	12.98 ±0.59[b1]	10.49 ±1.12[a2]	.002
ZLS-CF	7.83 ±1.45[a1]	11.55 ±2.54[a2]	.002
p (1-way ANOVA)	.000	.177	

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Different superscript numbers in the same row and different superscript letters in same column indicate significant differences between the surface finish values in these groups (*p*<.05) based on 1-way ANOVA results. [*]Wilcoxon test.

The ZLS-P group exhibited statistically significant higher translucency values than the ZLS-G and ZLS-CF groups (p<.001) before aging. The translucency values of the aged and unaged samples were compared; the ZLS-P group showed statistically lower translucency values after aging (p=.002), whereas the ZLS-CF group showed statistically significant higher translucency values after aging (p=.002).

According to the 1-way ANOVA results, a statistically significant difference between the surface roughness values for groups with different kinds of surface finishing was observed before and after aging (p<.001) (Table 4). The ZLS-P group exhibited statistically significant lower surface roughness values than the ZLS-G and ZLS-CF groups before and after aging (p<.001). Regarding surface roughness, the ZLS-G (p=.003) and ZLS-CF (p=.017) groups showed statistically significantly higher surface roughness values after aging.

Table 4. Surface roughness (μm) values for groups with different types of surface finishing

Group	Before aging Mean ±SD	After aging Mean ±SD	*p**
ZLS-G	0.78 ±0.16^{b1}	0.93 ±0.13^{b2}	.003
ZLS-P	0.27 ±0.08^{a1}	0.33 ±0.14^{a1}	.266
ZLS-CF	0.64 ±0.31^{b1}	0.73 ±0.34^{b2}	.017
p (1-way ANOVA)	.000	.000	

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Different superscript numbers in the same row and different superscript letters in same column indicate significant differences between the surface finish values in these groups (p<.05) based on 1-way ANOVA results. *Wilcoxon test.

With respect to the Spearman correlation analysis results, a positive significant correlation was observed between the ΔE and translucency change values (before and after aging) for the ZLS-glazed (p=.005) and ZLS-polished (p<.001) groups. No significant correlation was observed between the ΔE and roughness change values (before and after aging) and between the translucency (before and after aging) and roughness changes (before and after aging) in all groups (p>.05).

DISCUSSION

The first null hypothesis was accepted because the type of surface finishing (glazing combined with crystallization or after crystallization and polishing) had no significant effect on the color differences (p=.736). ZLS glass-ceramic contains 56%-64% glass content, which did not change after crystallization.[24] A possible explanation for not finding color differences is the color stability of the material with different types of surface finish, which can be attributed to the homogenous, fine crystalline structure of crystallized ZLS.[6]

The type of surface finishing affected the translucency values before aging (p<.001), and the ZLS-P group presented the highest translucency values (p<.001). The translucency values for the ZLS-P group significantly decreased after aging (p=.002), whereas the values for the ZLS-CF group significantly increased after aging (p=.002). Therefore, the second null hypothesis was rejected. In the ZLS-G (p=.005) and ZLS-P (p<.001) groups, a positive, statistically significant correlation between the ΔE and translucency change values (before and after aging) was observed. The difference in TP values due to glazing and polishing may be due to the glaze material and its application. Although controversial results were reported in the literature, the glaze material was reported to affect the TP and ΔE values.[15] In addition, the number of firings was reported to affect the TP and CIELab values.[33] In the present study, the specimens (except the ZLS-G group) were fired once. Although there was some difference in the number of firings, microstructure, grain size, and chemical composition among the glaze materials, no significant difference between the ZLS-CF and ZLS-G groups was observed in terms of the TP values before and after aging.

The type of surface finishing affected the surface roughness values before and after aging (p<.001). ZLS-P group presented the lowest surface roughness values before and after aging (p<.001). The surface roughness values of the ZLS-G (p=.003) and ZLS-CF (p=.017) groups significantly increased after aging. Therefore, the third null hypothesis was rejected.

Fully crystallized ZLS glass-ceramics can be cemented after milling and glazing or polishing,

whereas pre-crystallized ZLS glass-ceramics require a further crystallization firing process combined with glazing, additional glazing, or polishing to reach its final esthetic and physical properties.[34] Studies reported in the literature investigated the surface characteristics and optical properties (glazing or polishing) of ZLS glass-ceramics.[6,11] However, data on the glazing efficiency with or without crystallization are limited.[6] Therefore, this study proposed that the effect of the combined firing process be evaluated.

Alp *et al.*[6] reported clinically acceptable color differences (<CIEDE2000 50% acceptability threshold, 1.8 units) for different surface-finished (glazing or polishing) ZLS glass-ceramics after coffee thermocycling. Kilinc and Turgut[15] also reported clinically acceptable color changes in ZLS glass-ceramics regardless of the type of surface finishing (control, manual polishing, or glazing). In parallel with these studies, the type of surface finishing did not affect the color change results in this study. The color change values were below the clinically acceptable limit for all groups (<3.7 ΔE units).[35] In addition, Kilinc and Turgut[15] reported that manual polishing techniques could produce similar results as glazing in terms of color stability, in parallel with the present study. In the light of these studies,[6,15] glazing combined with crystallization or after crystallization and polishing may be the surface finishing method of choice for ZLS glass-ceramics because all groups exhibited similar color changes.

Although translucency has clinical importance in the esthetics and natural appearance of restoration materials,[3,36] few studies have investigated TP values for ZLS glass-ceramic.[3] Sen *et al.*[28], Awad *et al.*[3], and Caprak *et al.*[37] evaluated the TP values for different CAD-CAM materials; Vita Suprinity (ZLS) showed the highest TP values in all of these studies. According to Awad *et al.*[3], better TP values for ZLS ceramic might be due to the high glass content that results from smaller silicate crystals in the lithium silicate glassy matrix.[3] Bahgat *et al.*[38] reported that the higher translucency of ZLS glass-ceramic might be due to its lower (0.5 μm) and more homogeneous crystalline structures (2 types). Riquieri *et al.*[34] also reported many differences in the microstructure of ZLS glass-ceramics before and after crystallization firing; zirconia grains decreased and nanocrystalline lithium metasilicate peaks (Li_2SiO_3) were more intense in X-ray diffraction after the crystallization firing process (CFP). Although microstructural differences in the ZLS glass-ceramic were not evaluated in the present study, the difference in TP values may be due to microstructural changes in the ZLS glass-ceramic and the glazing materials during firing. According to previously published research, the durability of glaze materials was suspected,[39] and different glaze materials like glazing spray were less effective at smoothing the surfaces because they were to unable to uniformly coat all surface irregularities.[40]

Alp *et al.*[6] reported that the type of surface finishing did not affect the translucency of ZLS, whereas coffee thermocycling reduced the translucency. Even though the clinical effect of this difference was unclear, the translucency of the ZLS-P and ZLS-CF groups changed after aging in the present study, in parallel with Alp et al's[6] study. In contrast, the type of surface finishing had an effect on TP before aging in the present study.

Subasi *et al.*[41] reported that color changes in ZLS glass-ceramic were significantly affected by its thickness (0.5, 0.7, and 1 mm), and ZLS glass-ceramic with 0.5 mm thickness exhibited unacceptable color changes (>CIEDE2000 50% acceptability threshold, 1.8 units). In contrast with the present study, the translucency was not affected by coffee thermocycling, whereas it was affected by material type and thicknesses; translucency decreased when the thickness of the material increased. Gunal and Ulusoy[24] also reported that different thicknesses (0.5 and 1 mm) of ZLS ceramic presented statistically significant differences in translucency, and the reduced thickness resulted in a significant increase in translucency. In the present study, the thickness of ZLS was 0.6 mm and thermocycling was applied in distilled water. The difference between color changes and the TP values in the present study

and previous studies[24,41] might arise due to differences in the thickness of the ZLS material, different aging solutions, and different color measuring devices.

According to the manufacturer, zirconia dioxide particles in ZLS glass-ceramics provide good surface finishing and reinforce the ceramic structure by providing crack interruption through its small grains and homogeneously distributed structure.[11] Although various techniques and systems have been used to produce smooth ceramic surfaces, there is no standard protocol for optimal surface treatment of ZLS glass-ceramic[41], and conflicting results were reported in previous studies. It was repeatedly reported that the surface finishing[17], polishing, or glazing quality affect the surface roughness of ceramic materials differently.[21]

Vichi et al[21] evaluated the efficiency of different manual and furnace-based finishing systems on surface roughness and gloss of VITA Suprinity and IPS e.max CAD by applying glazing or polishing using the manufacturer's recommended polishing sets for 30 and 60 seconds, as well as paste and spray glaze materials. The researchers reported that polishing and glazing produced similar results with regard to roughness. However, lower roughness and higher gloss were produced in paste glazing than with spray glazing, and the polishing time affected the roughness. In contrast, no significant difference was found between surface roughness values of ZLS-CF and ZLS-G groups in the present study, in which glaze spray and powder were used, respectively. The ZLS-P group in the present study exhibited the lowest surface roughness values. This might be due to the higher content of zirconium dioxide, which was shown to allow the material to provide more effective polishing.[42] In addition, the type of surface finishing significantly affected the surface roughness of the ZLS glass-ceramic, and the surface roughness values increased with aging in the present study.

In contrast to the present study, Mota *et al.*[43] reported that glazed surfaces were smoother than polished surfaces based on their SEM and AFM images, and they recommended glazing after mechanical polishing for ZLS glass-ceramic. However, in parallel with the study of Vichi *et al.*[21], the mean surface roughness values were higher than the 0.2 μm thresholds, regardless of the type of surface finish. The ZLS-P group showed the lowest surface roughness values before and after aging, thus polishing may be preferred to glazing.

Different types of surface finishing were selected to mimic clinical conditions because there is no standard surface finishing procedure for ZLS glass-ceramic, and the manufacturer recommend all of these surface finishing procedures. The color change, translucency, and surface roughness of ZLS glass-ceramic were evaluated in this study, because all of these factors have an important effect on the esthetic success of a ceramic restoration.[41] Color values of ZLS material were measured using a colorimeter. A colorimeter is frequently used to measure ΔE values[44], but an edge-loss effect can be seen.[45] Similar to the study of Gürdal *et al.*[46], color changes and surface roughness were evaluated following 5000 thermocycles in distilled water, which corresponds to 6 months of aging.[47]

One of the limitations of the present study was that optical properties and surface roughness of ZLS glass-ceramic were not evaluated after coffee thermocycling. The coffee thermocycling might have a different effect on the color change of ZLS glass-ceramic. The color change of ZLS glass-ceramic may have been different from what can be observed in clinical conditions because no staining solution was used. The other limitation was that only one thickness was evaluated. One should recall that different thicknesses might also affect the color and translucency of the restoration. The third limitation was that the specimens were flat and no cementation procedure was applied. Color changes can be perceptible when cementation is applied. However, the effect of resin cements and underlying tooth color on the optical properties of ZLS glass-ceramic are other topics that should be investigated in further research.

CONCLUSIONS

The surface finishing type did not affect the color change of zirconia-reinforced lithium silicate glass-ceramic. The translucency values of zirconia-reinforced lithium silicate glass-ceramic with different types of surface finishing changed before aging, whereas after aging the type of surface finishing did not affect the translucency of zirconia reinforced lithium silicate glass-ceramic. The ZLS-CF group exhibited the lowest translucency values before aging, whereas this group exhibited the highest translucency values after aging. ZLS-P group exhibited the lowest surface roughness values, regardless of aging. The surface roughness values were higher than the plaque accumulation threshold (0.2 μm), regardless of the type of surface finish.

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CONFLICT OF INTEREST

None.

Yüzey Bitirme İşlemlerinin ve Yaşlandırmanın Zirkonya ile Güçlendirilmiş Lityum Silikat Cam-Seramik Materyalinin Optik Özellik ve Pürüzlülüğü Üzerindeki Etkileri

ÖZ

Amaç: *Bu çalışmanın amacı üç farklı yüzey bitirme yönteminin ve yaşlandırmanın, zirkonya ile güçlendirilmiş lityum silikat (ZLS) cam-seramiğin yüzey pürüzlülüğü ve optik özellikleri üzerindeki etkilerini araştırmaktır.* ***Gereç ve Yöntemler:*** *Dikdörtgen şeklindeki örnekler (0,6 mm kalınlıkta) ZLS bloklardan (N=36) kesildi. Üç farklı tipte yüzey bitirme işlemi [kristalizasyon ile birlikte glazür (ZLS-CF), kristalizasyon sonrası glazür (ZLS-G) ve polisaj (ZLS-P)] (n=12) ve 5000 termal siklus uygulandı. Yaşlandırma öncesi ve sonrasında üçer defa renk koordinatları ve yüzey pürüzlülüğü (Ra) ölçümleri kolorimetre ve profilometre cihazları kullanılarak yapıldı. Ortalama yüzey pürüzlülüğü (Ra) değerleri hesaplandı. Renk farklılıkları ve translusensi parametresi (TP) değerleri, ΔE_{ab} renk farklılığı ve TP formülleri kullanılarak hesaplandı. Renk farkı, translusensi ve yüzey pürüzlülük değerlerini analiz etmek için tek-yönlü ANOVA kullanıldı (α=,05).* ***Bulgular:*** *Farklı yüzey bitirme tiplerine sahip örneklerde ΔE değerlerinde anlamlı farklılıklar gözlenmedi (p=,736). Yaşlandırma öncesinde farklı tipteki yüzey bitirme gruplarında translusensi değerleri arasında anlamlı fark gözlendi (p<,001). Yaşlandırma öncesi ve sonrasında farklı tipteki yüzey bitirme gruplarında yüzey pürüzlülüğü verilerinde anlamlı fark gözlendi (p<,001). ZLS-P grubu yaşlandırma öncesi ve sonrası en düşük yüzey pürüzlülüğü değerlerini gösterdi (p<,001). Hem ZLS-G (p=,005) hem de ZLS-P (p<,001) gruplarında ΔE ve translusensi değişim değerleri arasında pozitif yönde anlamlı bir korelasyon bulundu.* ***Sonuçlar:*** *Yüzey bitirme tipi ZLS cam-seramiğin renk değişimini etkilemedi. Farklı yüzey bitirme işlemi uygulanan ZLS cam-seramik örneklerinde translusensi değerleri yaşlandırmadan önce değişirken, yaşlandırmadan sonra yüzey bitirme tipi ZLS cam-seramiğin translusensisini etkilemedi. Test edilen tüm gruplar, plak akümülasyon eşik değerinden daha yüksek yüzey pürüzlülüğü değerleri sergiledi (Ra=0,2 mm).*

Anahtar Kelimeler: *Seramikler, renk, yüzey özellikleri.*

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Case reports

GOLDENHAR SYNDROME –A CASE REPORT

ABSTRACT

Goldenhar Syndrome also called as facio-auriculo-vertebral dysplasia, is a ra re syndrome developing from first and second pharyngeal arches during blastogenesis. It was described by Maurice Goldenhar in 1952. It is characterised by presence of epibulbar dermoids, ear malformations, vertebral anomalies, unilateral facial hypoplasia, and sometimes internal systemic complications. As the molecular basis for Goldenhar Syndrome is unclear, early detection and screening for complications would help the patients to have a normal life. This is a case report of a case of 15 year old male patient with Goldenhar syndrome with epibulbar dermoids, microtia, syndactaly and micrognathia.

Key words: Goldenhar Syndrome, dermoids, microtia, mandible

*Vidya Holla[1]
Raghavendra Kini[1]
Prassana Kumar[1]
Roopashri Kashyap[1]
Devika Shetty[1]
Kamakshi Jha[1]

ORCID IDs of the authors:
V.H.0000-0003-1235-9208
R.K.0000-0002-3651-4535
P.K.0000-0002-8445-7897
R.K.0000-0003-1601-9278
D.S.0000-0001-6596-8037
K.J.0000-0002-6296-8581

[1] Department of Oral Medicine and Radiology, A J Institute of Dental Sciences, Mangalore.

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***Corresponding Author**

A J Institute of Dental Sciences Department of Oral Medicine and Radiology, Mangalore.

INTRODUCTION

Goldenhar syndrome (GHS) was first seen by Canton in 1861 and Von Arlt, in 1881 but however it went unnoticed.[1,2] Maurice Goldenhar, the Swiss ophthalmologist in 1952 recorded three new cases in addition to the sixteen cases which were previously recorded and later first precisely described the syndrome in detail. Thus, it came to be known as Goldenhar syndrome.[3] It consisted of preauricular appendages, fistulas, and epibulbar dermoids and a variant of hemifacial microsomia which used to affect aural, oral, and mandibular development having both unilateral and bilateral involvement.[1,4] In 1963, vertebral anomalies were also included by Gorlin et al as one of the manifestations of this syndrome and thus suggested the name oculoauriculo vertebral (OAV) dysplasia.[4,5] Smith in 1978, used the term facio-auriculo-vertebral sequence to include both Goldenhar syndrome and Hemifacial microsomia.[4] It is also known as Goldenhar- Gorlin syndrome, facio-auriculo-vertebral dysplasia, unilateral craniofacial microsomia, first arch syndrome, first and second branchial arch syndrome, lateral facial dysplasia, velo-cardio-facial syndrome, otomandibular dysostosis, unilateral mandibulo facial dysostosis, unilateral intrauterine facial necrosis, auriculo-branchiogenic dysplasia, facio-auriculo vertebral malformation complex.[1,4] In this article we report a case of 15 year old male patient with GHS.

CASE REPORT

A 15 year old male patient reported to our dental clinic with a complaint of multiple decayed teeth since 6 months as shown in Figure 1. The patient gave a medical history of reduced hearing, delayed speech since birth, diminution of vision since 4 years. The family history revealed that the mother has syndactayly in both upper and lower limbs. On examination, the patient's head was dolicocephalic, had a convex facial profile and incompetent lips as seen in Figure 1.

Figure 1. Absence of gross facial asymmetry

The patient had solitary round soft-tissue mass was seen in the right eye indicative of epibulbar dermoids seen in Figure 2, small prominent right ear or microtia seen in Figure 3 and syndactaly of the lower limbs as seen in Figure 4.

Figure 2. Epibulbar dermoids

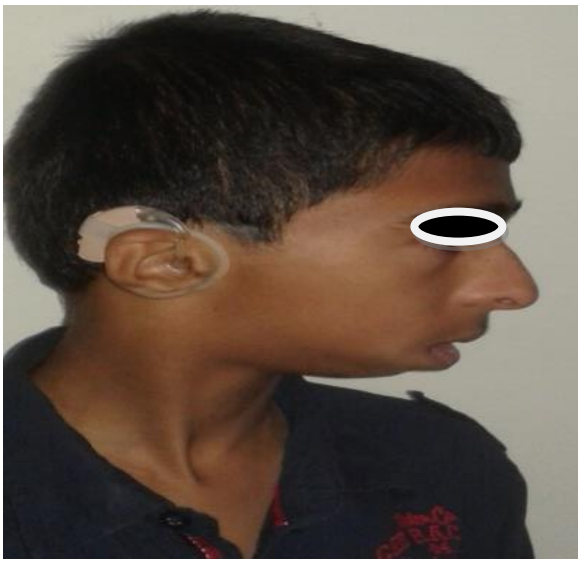

Figure 3. Microtia with hypoplastic mandible

Figure 4. Syndactly of the limbs

On intraoral examination, hypoplastic mandible, bimaxillary protrusion with multiple decayed teeth were present.

Based on the history and examination, a provisional diagnosis of Goldenhar Syndrome (GHS) was given, and Treacher-Collins syndrome and Townes–Brocks syndrome was considered as differential diagnosis.

On radiological investigation, the orthopantomogram, revealed bilateral absence of mandibular condyle, coronoid process in Figure 5 and lateral cephalogram revealed a hypoplastic mandible with bimaxillary protrusion in Figure 6.

Figure 5. OPG reveals bilateral absence of condyle and coronoid and presence of multiple decayed teeth.

Figure 6. Lateral cephalogram reveals hypoplastic mandible

DISCUSSION

The incidence of GHS is rare, with a male predominance.[6] GHS is an inherited condition, which has a multifactorial etiology along with various nutritional and environmental factors that can cause disturbances of blastogenesis.[7] Family history shows autosomal dominant or reccessive inheritance.[8] Gorlin and Pindborg in 1964 suggested that mesoblasts are affected by some abnormal process embryologically which, in turn, affects the branchial and vertebral systems, thereby resulting in the syndrome. It has also been suggested that there is a defect in branchial arch development late in the first trimester.[8, 10] Hereditary pattern was thought to be the causative agent by Krause. In the year 1971, Jong Bloet suggested that this condition might be a result of fertilization of an over ripe ovum. Goldenhar syndrome may be a sporadic event that occurs early in embryogenesis as stated by Baum and Feingold which may be explained by reduced penetrance, somatic mosaicism, or epigenetic

change.[9] Familial cases in successive generations having a history of consanguineous marriages have also been reported. Gomez et al. in 1984 speculated about the role of radiologic intervention (cholecystography practiced between the fourth and sixth weeks of pregnancy) as an etiologic mark of the syndrome.[4] The ingestion of some drugs such as cocaine, thalidomide, retinoic acid and tamoxifen by the mother and maternal diabetes were also related to the development of the disease.[8]

In a classic Goldenhar syndrome patient shows characteristic ocular, auricular facial and vertebral features as given in Table 1.[4]

Table 1. Characteristics of Goldenhar Syndrome

Ocular manifestations	Epibulbar dermoid or lipodermoid (mostly bilateral); colobomas of the upper eyelid, iris, chorioidea, and retina, or other eye anomalies (e.g. microphthalmia, anophthalmia, cataract, astigmatism, antimongoloid obliquity of palpebral fissures, and blepharophimosis)
Auricular manifestations	Preauricular skin tags or blind fistulas; microtia, or other external ear malformations (dysplasias, asymmetries, aplasias, and atresias of the external meatus); middle and internal ear anomalies.
Facial and oral manifestations	Unilateral facial hypoplasia, prominent forehead, hypoplasia of the zygomatic area, and maxillary and mandibular hypoplasia. Unilateral macrostomia (lateral facial cleft). Principal deformities of the Goldenhar syndrome are often combined with various malformations, such as: Cleft lip and/or palate, tongue cleft, and parotid gland aplasia.
Vertebral anomalies	Vertebral column anomalies (atlas occipitalization, synostosis, hemivertebrae, fused vertebrae, scoliosis, and bifid spine). Rib anomalies and anomalies of the extremities.
Miscellaneous anomalies	Congenital heart disease (ventricular septal defects), anomalies of the urogenital and gastrointestinal system (ectopic kidneys, uretropelvic junction obstruction, and imperforate anus), anomalies of the central nervous system (occipital encephalocele), and anomalies of the larynx and lungs (tracheoesophageal fistula, esophageal atresia). Complex retardation of mental development.

In this case of GHS, unilateral epibulbar dermoids and microtia were present. The patient presented with hearing, speech deficiency and diminution of vision. There was bilateral absence of the condylar, coronoid process with hypoplastic mandible, bimaxillary protrustion, syndactaly of the limbs were present. However, there were absence of other clinical features such as facial asymmetry, absence of spinal anomalies or systemic abnormalities.

OAV represents the mildest form of the disorder, GHS presents as most severe form and hemifacial microstomia appears to be an intermediate form. 10-30% have bilateral manifestations.[11] The phenotypic findings of this syndrome are variable due to heterogenous etiology. Preauricular skin tags seen in 90% of cases, microtia in 52%, hemifacial microsomia in 77%, epibulbar dermoid in 39% of cases. Vertebral anomalies were noted in 7% of cases. Cardiac manifestation are found in 39% of cases, while genitourinary anomaly was noted in 23% and various central nervous system anomalies are seen in 47% of cases.[8] The present case may represent a mild form of GHS.

There is an overall consensus that the diagnosis of this disease must not be only based upon radiologic or laboratory results but the clinical aspect as well.[8] Most authors consider the presence of anomalies of the ear (microtia) lower set than on the contralateral side and of appendices on the ear necessary for diagnosis.[11] The ossicles of the ear are derived from Meckel's cartilage the precursor of the mandible. Patients who have GHS routinely have hearing deficiencies on the affected side due to under development of the osseous components of the auditory system and a diminished or absent external auditory meatus.[12]

Radiographic examination of zygomatic bones shows a macroscopic deficiency and developmental symmetry. There is also a possibility of agenesis of these bones with lack of fusion of the zygomatic arch and agenesis of the palatine bones. Palatal cleft may be observed radiographically. Ophthalmologic and otorhinolaryngologic examination are also important for the final diagnosis.[11]

Syndromes considered for differential diagnosis for GHS are Treacher-Collins syndrome and Townes–Brocks syndrome. The presence of facial asymmetry and far less hypoplasia of the malar bones in GHS are important features to differentiate it from Treacher-Collins syndrome.

The Treacher-Collins syndrome affected patients presented downward and mandibular hypoplasia, partial absence of the lower eyelid cilia, and abnormalities of the ears. Townes–Brocks syndrome shows additional thumb anomalies, anal defects, and renal anomalies which are not seen in GHS.

The treatment of the patients with GHS depends on the age and presence of systemic complications. Management is usually cosmetic. Reconstructions can be done using rib bone grafts in patients with hypoplastic mandible. Bone distraction and osteogenesis may be used to lengthen the underdeveloped maxilla followed by orthodontic correction on completion of jaw growth. In patients with malformed or deformed external ear, reconstructive surgeries maybe performed at an age of 6–8 years. Epibulbar dermoids present in the eyes may be surgically excised. The prognosis for this condition is good in patients with no systemic complications.[12,13]

CONCLUSIONS

In summary, the molecular basis of GHS is still is unavailable. Patients with GHS can have multiple congenital anomalies, and they need particular attention to internal abnormalities and therefore should be duly diagnosed and screened for presence of any kind of systemic complications.[9,10] These patients may face difficulties in their regular social activities due to their hearing or speech deficiencies. The families of such patients should give moral support and counselling for accepting their kins and relatives with such conditions.

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CONFLICTS OF INTEREST

None

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Case reports

DENTAL TREATMENT OF A PATIENT WITH TREACHER COLLINS SYNDROME UNDER GENERAL ANAESTHESIA: A CASE REPORT

ABSTRACT

This article reports a case of Treacher Collins syndrome (TCS) in a five-year-old male patient treated in Kırıkkale University, Department of Pediatric Dentistry. We defined the clinic signs and symptoms of the case and suggested a treatment plan. Treatment procedures for malformations caused by the syndrome should be planned and performed specifically for the patient. In our patient with low treatment compliance, dental examination, filling and partial prosthesis treatment was successfully applied under general anesthesia.

Keywords: Treacher Collins Syndrome, pediatric dentistry, general anaesthesia

*Aslı Soğukpınar[1],
Merve Erkmen Almaz[2]

ORCID IDs of the authors:
0000-0002-1934-9945
0000-0001-6766-2023

[1] Fatma Kemal Timuçin Oral and Dental Health Hospital, Adana, Turkey
[2] Department of Pediatric Dentistry, Faculty of Dentistry, Kırıkkale University, Kırıkkale, Turkey.

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***Corresponding Author**
Fatma Kemal Timuçin Oral and Dental Health Hospital, Adana, Turkey,
Phone: +90 507 6014870 **E-mail:** aslisdt@gmail.com

INTRODUCTION

Treacher Collins syndrome (TCS) is an autosomal dominant disorder of craniofacial development and also called as mandibulofacial dysostosis The incidence of the syndrome is approximately 1:10,000 to1:50,000 livebirths.[2] The clinical features are formed as a result of loss of function and mutation of the TCOF1 gene located on chromosome 5q32.[1]

A patient with TCS syndrome presents with a peculiar, nearly pathognomonic face with ear malformations, downward slanting palpebral fissures, lower eyelid coloboma and partial absence of lower eyelashes. Patients with TCS may develop dental abnormalities such as missing teeth (tooth agenesis), discoloration of the teeth (enamel opacities), widely-spaced teeth, abnormal eruption of permanent teeth (ectopic eruption of maxillary first molars), malocclusion (improper positioning of the teeth and jaw).[2] Also heart, kidneys, vertebral column and extremities may be affected by the syndrome.[3] TCS is known to be associated with upper airway obstruction and difficult intubation during airway management for anesthesia because of mandibular micrognatia, small oral apertura and temporomandibular joint abnormality.[2]

The aim of this case report was to present a pediatric patient with Treacher Collins Syndrome (TCS) who underwent dental care under general anesthesia (GA).

CLINICAL CASE REPORT

A 5-year-old male patient, who was diagnosed as TCS, referred to Department of Pediatric Dentistry of Kırıkkale University with a complaint of dental pain. Clinically he had malar hypoplasia, external ear abnormalities, colobama, partial absence of lower eyelashes and lower lid with absent cilia and zygomatic arch hypoplasia (Table 1 and Figure 1). Intraoral examination revealed caries on primary insicors and molars on his upper and lower jaws (55, 53, 63, 65, 74, 75, 84, 85) and upper primary anterior and molar teeth were found to be missing (54, 52, 51, 61, 62, 64).

Table 1. The main clinical orofacial findings of TCS[12]

Clinical findings	Findings of our patient (+/-)
Mandibular hypoplasia	+
Colobama	+
Total or partial absence of lower eyelashes	+
External ear malformations	+
Hearing loss	-
Cleft palate	+
Shortened soft palate	+
Malocclusion	+
Anterior open bite	-
Enamel hypoplosia	-
Palpebral fissures	+
Zygomatic arch hypoplasia	+
Retrusive mandible	-
Missing teeth	+
Widely-spaced teeth	-
Abnormal eruption of certain teeth	-
Nasal deformity	-

Figure 1. Frontal view under general anesthesia

The patient had prior examination and treatment under GA and teeth #54, 52, 51, 61, 62, 64 were extracted (Figure 2A and 2B). The comprehensive treatment for the patient was planned as fillings for decayed teeth and a pediatric partial denture, but the patient did not comply with the dental treatment. Radiological examination such as panoramic film, lateral cephalometry or computed

tomography can not be performed because of the cooperation problem. We discussed the importance of the dental treatment with the parents and decided to treat the patient under GA after obtaining consent from parents.

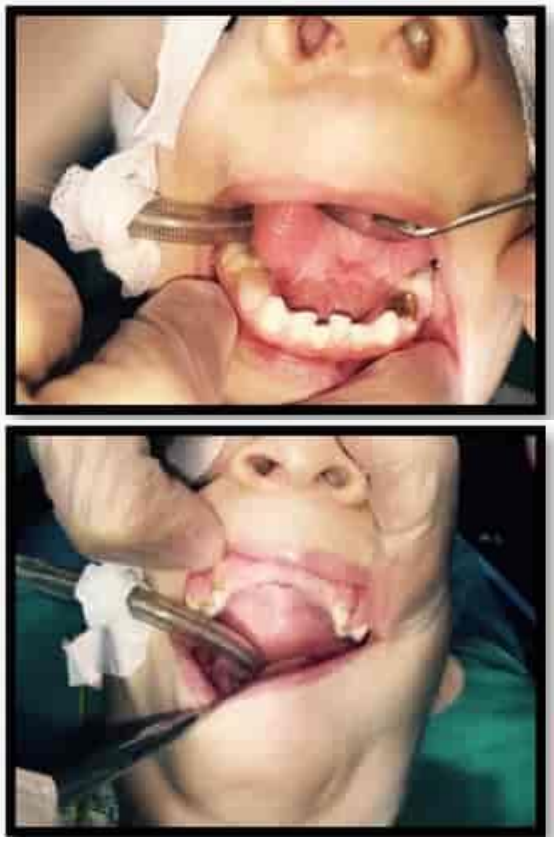

Figure 2A and 2B. Intraoral view of the upper and lower jaw before the operation

He had comprehensive dental care under GA. In the process of GA, despite the use of a fiber-optic airway instrument, intubation was extremely difficult due to the small mandible and its retroposition. All teeth were restored using self-etch bonding agent (3M Adeziv 200T, St. Paul, MN, USA) and compomer (DyractExtra A2, Dentsply, Konstanz, Germany). Following restorations, maxillary impression was taken using alginate (BluePrint X-creme, Dentsply International). Then topical fluoride therapy was applied using fluor varnish (Sultan, USA).

Acrylic denture teeth (TriadTruTray, Dentsply International) were used for proper lip support and proper plane of occlusion in the partial denture (Figure 3). The GA procedures as entubation, administration of anesthetic drugs and post-operative complications were managed with high-risk patient profile.

Figure 3. Frontal view of the partial denture

DISCUSSION

TCS is a genetic disorder affecting the whole facial region like eye bones, zygomas, maxillary and mandible, chin and ears which may be absent or malformed.[2] These organs all originate from the neural crest.[4]

Treacher Collins syndrome is usually diagnosed at birth by radiological data and molecular tests. Also molecular analysis (amniocentesis and chorionic villous sampling) can be performed prenatally.[5] Polyhydramnios, abnormal fetal swallowing, microcephaly, distorted facial characteristics like antimongoloid slanting palpebral fissures, malformation of the auricles, micrognathia can be shown by ultrasound.[6-8] The history of our patient revealed that the diagnosis of TCS was performed with the help of detailed clinical evaluation and molecular genetic tests. While 40% of the patients have genetic mutation, more than 60% of TCS cases have no family history.[9, 10] In this case the patient had no family history of TCS. Although the high incidence of obstructive sleep apnea (OSA) can be noticed in TCS patients;[11] in our case there is no OSA syndrome diagnosis according to the anamnesis taken from the parents. The case was clinically defined as TCS depending on the typical extra oral symptoms.[2] The patient had malar hypoplasia, external ear abnormalities, antimongoloid slant of the eyes and lower lid with absent cilia.

Our patient had dental pain because of caries. The conventional treatment can not be performed because of the patient's uncompliance; so the patient was treated under GA. Before the general

anesthesia protocol for pediatric patients[12], he had been sedated with intravenous midazolam because of uncooperative behaviour.

In the literature, TCS's signs of mandibular micrognathia and limitation of mouth opening was associated with difficult intubation under general anaesthesia.[2] Boku *et al.*[13] noticed that because of limitation of mouth opening, laryngeal mask airway and Glide Scope was not preferred; so fiberoptic tracheal intubation was used. In our case, due to the patient's mandibular hypoplasia and limitation of mouth opening, mask ventilation was carefully performed. While the patient is awakening from anesthesia, dyspnea and cyanosis were observed; it may be associated with restrictive airway pathology. Under general anaesthesia, dental treatment was quite successful. The patient's partial prosthesis was compatible with maxillary arch and after six months from the operation, his family noticed that he was using the partial prosthesis successfully. The patient is currently under regular follow-up.

CONCLUSIONS

Treacher Collins syndrome is a complex situation of mandibulofacial dysplasia, which requires a multidisciplinary management from birth to adulthood. Dental abnormalities need complex treatment modalities. With the impetidive features of the syndrome which make the procedures complicated, comprehensive treatment should be planned and performed with a multidiciplinary approach including general anesthesia.

ACKNOWLEDGEMENTS

None

CONFLICTS OF INTEREST

None

Genel Anestezi Altında Treacher Collins Sendromlu Bir Hastanın Diş Tedavisi: Vaka Raporu

ÖZ

Bu vakada Kırıkkale Üniversitesi Çocuk Diş Hekimliği Bölümü'nde tedavi edilen Treacher Collins Sendromlu 5 yaşındaki erkek hasta sunulmaktadır. Vakanın klinik semptom ve bulguları tanımlanmış ve tedavi planlaması yapılmıştır. Sendromun sebep olduğu malformasyonlar nedenli tedavi prosedürleri hastaya özel olarak planlanmalı ve uygulanmalıdır. Tedavi uyumu düşük olan hastamızda genel anestezi altında dental muayene ve dolgu ve parsiyel protez tedavisi başarılı bir şekilde uygulanmıştır. ***Anahtar kelimeler:*** *Treacher Collins sendromu, çocuk diş hekimliği, genel anestezi.*

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Case reports

PERIPHERAL GIANT CELL GRANULOMA AT AN EARLY AGE: 2 YEAR CASE FOLLOW-UP

ABSTRACT

Peripheral giant cell granuloma (PGCG) is a lesion which can be seen in all age groups and observed in the gingival and alveolar crest regions of the oral cavity. Although it is rare in children, it may show an aggressive character and cause pain, bleeding, localized swelling and displacement of teeth. The treatment and 2-year follow-up of a 6-year-old girl with PGCG is presented in this case report.

Keywords: Granuloma, giant cell, surgery, excision, child

*Alem Coşgun[1],
Halenur Altan[2],
Ahmet Altan[3]

ORCID IDs of the authors:
https://orcid.org/0000-0001-6586-6700
https://orcid.org/0000-0003-3648-5989
https://orcid.org/0000-0003-2041-6364

[1] Kayseri Nimet Bayraktar Oral and Dental Health Hospital, Clinic of Pediatric Dentistry, Kayseri, Turkey.
[2] Department of Pediatric Dentistry, Faculty of Dentistry, Gaziosmanpaşa University, Tokat, Turkey.
[3] Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Gaziosmanpaşa University, Tokat, Turkey.

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***Corresponding Author**
Kayseri Nimet Bayraktar Oral and Dental Health Hospital, Clinic of Pediatric Dentistry, Kayseri, Turkey.
Phone: +90 352 355 15 15 **E-mail:** alemcosgun@hotmail.com

INTRODUCTION

Giant cell granulomas were first described by Jaffe[1] in 1953, and they are generally non-neoplastic lesions observed in the mandible and maxilla.[2,3] These lesions are of periost, connective tissue or periodontal ligament origin and are considered as the hyperplastic, reperative connective tissue response of gingival tissue against injury and inflammation.[4,5] Giant cell granuloma is divided into two groups as peripheral and central according to the characteristic of the tissue from which it originates.[6]

Although its etiology is not fully understood, calculus, dental plaque, food accumulation, periodontal pockets, periodontal surgery, traumatic tooth extraction, malposed teeth, improper prosthesis and restorations, especially estrogen hormone activity and hyperparathyroidism of sex hormones are among the factors that cause the formation of peripheral giant cell granuloma (PGCG).[7-12]

The clinical appearance of PGCG is usually a painless and bleeding lesion with small, limited, dark red colored liver-tissue like focus, located on the gingival and alveolar crest, which may or may not be pedunculated or sessile.[13,14] PGCG is a soft tissue lesion, but it may cause resorption in the underlying bone tissue.[15] Superficial ulcerations can be observed in the lesions that are open to traumatic forces. The intraoral image may resemble pyogenic granuloma.[13]

Clinical, radiographic, biochemical, hormonal and histopathological evaluations should be taken into account while making diagnosis.[16] The definitive diagnosis is made by histopathological examination.[17] The mesenchymal cells and giant cells showing proliferation with a significant vascular increase are seen in histological examination. Mineralized tissue formation in the form of lamellar or woven bone has been reported in one third of the lesions.[13]

The elimination of local factors that cause PGCG, and then the surgical removal of the lesion from the mouth constitute the basis of the treatment.[18] The extraction of the teeth in the lesion content, the correction of root surfaces of teeth adjacent to lesion and the removal of dental plaque decrease the likelihood of recurrence of the lesion. Consequently, the reformation of the lesion can be prevented with a good periodontal treatment and surgical approach.[8] The treatment of PGCG in children is performed the surgical removal of the lesion and follow-up of the patient as in other gingival reactional lesions.[19]

CASE REPORT

A 6-year-old girl was admitted to our clinic due to swelling in her right lower jaw molar region. In the medical history taken with the help of her family, it was learned that no systemic disorder was present in the child and that she had swelling in the relevant region for 2 months. The patient had no pain, infection, and lympodenopathy. It was learned that the patient had difficulty during chewing because of swelling. In the intraoral examination, a surface swollen lesion was observed in the vestibule of the milk molar region of the lower right jaw. It was observed that there was excessive crown damage and poor oral hygiene in teeth 84 and 85 in the relevant region. The lesion had a sessile, non-ulcerated and hyperemic appearance. (Figures 1, 2)

Figure 1. Intraoral appearance

Figure 2. Occlusal appearance

The resorbed roots in the region were observed in the radiographic examination. (Figure 3) As a result of clinical and radiographic evaluation, the lesion was pre-diagnosed as pyogenic granuloma and PGCG.

Figure 3. OPG before operation

Periodontal treatment and surgical approach

As a first line treatment, the existing calculus and plaques in the patient were removed and the patient's oral hygiene habit was motivated. Then in the second session, it was ensured that oral hygiene was provided, teeth 84 and 85 were extracted under local anesthesia, and the lesion was removed with excisional incision. The region was primarily closed with silk suture. (Figures 4, 5) As a result of pathological evaluation, the lesion was diagnosed as PGCG.

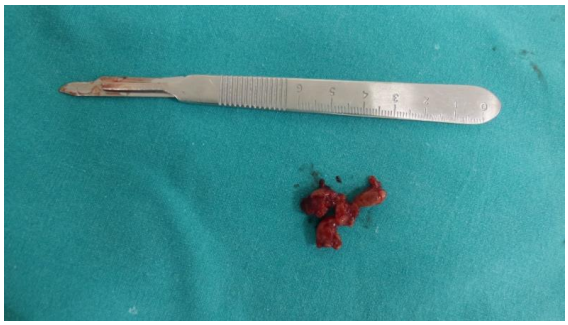

Figure 4. Excised lesion

Figure 5. Oral appearance immediately after surgery

The patient was called for control at 1 week, 1 and 6 months after the operation. As a result of clinical and radiographic evaluations in the patient's 2-year follow-up, it was observed that the operation area was recovered and that permanent premolar teeth were erupted. (Figures 6, 7, 8, 9)

Figure 6. Intraoral appearance 2 years after surgery

Figure 7. Occlusal appearance 2 years after surgery

Figure 8. Periapical film 2 years after surgery

Figure 9. OPG 2 years after surgery

DISCUSSION

PGCG is a lesion which can be seen in all age groups and observed in the gingival and alveolar crest regions of the oral cavity.[19] The incidence of the disease is higher in the elderly population in the 4th and 6th decade. However, only 20-30% of cases are seen in the 1st and 2nd decades.[16] In the literature, it has been reported that the incidence of the lesion is higher in women compared to men.[18,20] Although PGCG is relatively less seen in the child population, it can show an aggressive character.[19] In the presented case, the patient was 6 years old and in the first decade.

In a study carried out by Altan *et al.*[21], it was reported that PGCG was most common reactive lesion seen in the oral cavity. When the literature is reviewed, there are studies reporting similar results.[14] However, in a study carried out by Kashyap *et al.*[22], pyogenic granuloma was reported to be a more common reactive lesion.

When the localization of oral reactive lesions is examined, there are studies reporting that gingiva is the most commonly affected area.[14] PGCG is more common in the premolar and molar regions of the mandible, which is more suitable for food accumulation for the oral cavity.[12, 23] The localization of the lesion in our patient is the right molar and premolar region. In many case reports, the lesion was reported to have a diameter of 0.1-3 cm.[24] However, there are also cases where the lesion's diameter is 5 cm.[23] It was determined that the size of the lesion was 3 cm in our case.

The pain may cause localized swelling and displacement of the teeth although it depends on the localization of the lesion. Although it has a benign character, it may cause local destruction and can be seen in different forms from slow progression to aggressive growth.[25, 26] In this case report, an aggressive lesion resorbing the roots of milk teeth can be mentioned.

Along with lesion, sometimes bleeding and discomfort can be seen, which may cause anxiety in the patient and psychological trauma in parents. In a study carried out by Pandofi *et al.*[27], 16 cases with displacement of teeth and active bleeding during chewing were reported The physician should manage such a discomfort in young patients and prepare an appropriate management plan for the success of the treatment.[28] Our patient, whose oral hygiene was corrected, was consulted to the oral and maxillofacial surgery department, and a multidisciplinary approach was adopted in the treatment.

The factors associated with the patient should be taken into account while planning the treatment of the lesions in the mouth. The success of the treatment is possible by gaining oral hygiene habits of the patient, as well as the fact that he/she follows maintenance appointments.[29] In our case, the motivation of oral hygiene was fully achieved, and no recurrence was observed in the 2-year follow-up. In such cases, the incidence in the maintenance phase should be determined by taking into account the individual factors.[29]

Peripheral giant cell granulomas can be seen as an oral symptom of hyperparathyroidism, although they are rare. In a study carried out by Smith & Fowler[30], hyperparathyroidism was detected in 10% of PGCG patients In a study carried out by Giananti *et al.*[31], no relationship was found between hyperparathyroidism and PGCG. No hyperparathyroidism was found in our case. In a study carried out with 26 cases by Günhan *et al.*[8], it was reported that these lesions could be affected by sex hormones.

No malignant transformation has been reported in the literature. PGCG can be confused especially with the advanced form of pyogenic granuloma. Furthermore, peripheral ossifying fibroma and hemangioma observed in children are also other benign submucosal lesions that should be taken into account in terms of differential diagnosis.[32]

CONCLUSIONS

In conclusion, gaining oral hygiene habit to prevent recurrence, and the follow-up of the patient, as well as early diagnosis and treatment, are important to prevent bone destruction, advanced mobility in teeth or tooth loss due to this intraoral function, and the malfunction of phonation which may be caused by this disease, which is likely to show an aggressive character.

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None

CONFLICTS OF INTEREST

None

Erken Yaşta Görülen Periferal Dev Hücreli Granüloma: 2 Yılık Vaka Takibi

ÖZ

Periferal dev hücreli granüloma (PDHG) her yaş grubunda izlenebilen ve oral kavitenin dişeti ve alveolar kret bölgelerinde gözlenen bir lezyondur. Çocuklarda nadir görülse de agresif karakter gösterebilir, ağrı, kanama, lokalize şişlik ve dişlerde yer değiştirmeye neden olabilir. Bu olgu raporunda PDHG'ye sahip 6 yaşındaki kız çocuğunun tedavisi ve 2 yıllık takibi sunulmaktadır. ***Anahtar Kelimeler:*** *Granüloma, dev hücre, cerrahi, eksizyon, çocuk.*

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