Official Publication of
Istanbul University
Faculty of Dentistry

European Oral Research

Volume 56 ▪ Issue 3 ▪ September 2022

ISSN print 2630-6158 ▪ ISSN online 2651-2823

EOR

eor.istanbul.edu.tr

Istanbul University Press

European
Oral Research

Official Publication of
Istanbul University
Faculty of Dentistry

INDEXING AND ABSTRACTING

SCOPUS
WEB OF SCIENCE - EMERGING SOURCES CITATION INDEX (ESCI)
PUBMED Central
PROQUEST
EBSCOHOST
DIRECTORY OF OPEN ACCESS JOURNALS (DOAJ)
OPEN AIRE
CHEMICAL ABSTRACTS
GOOGLE SCHOLAR
TUBITAK ULAKBIM TÜRKİYE ATIF DİZİNİ

European
Oral Research

Official Publication of
Istanbul University
Faculty of Dentistry

CORRESPONDENCE ADDRESS

Istanbul University, Faculty Of Dentistry
Prof. Dr. Cavit Orhan Tütengil Sokak No. 4 Vezneciler-Fatih-İstanbul
Phone: +90 (212) 440 00 00 / 12100
E-mail: eor@istanbul.edu.tr
https://dergipark.org.tr/tr/pub/eor
https://iupress.istanbul.edu.tr/tr/journal/eor/home

PUBLISHER

İstanbul University Press
İstanbul University Central Campus,
34452 Beyazit, Fatih / İstanbul, Turkiye,
Phone: +90 (212) 440 00 00

PRINTED BY

İlbey Matbaa Kağıt Reklam Org. Müc. San. Tic. Ltd. Şti.
2. Matbaacılar Sitesi 3NB 3 Topkapı/Zeytinburnu, İstanbul, Turkiye
E-mail: www.ilbeymatbaa.com.tr
Certificate No: 17845

The publication languages of the journal is English.

This is a scholarly, international, peer-reviewed and open-access journal published triannually in January, May and September.

Publication Type: Periodical

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

EDITORIAL MANAGEMENT BOARD

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

EDITORIAL ADVISORY BOARD

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

AUTHOR GUIDELINES

General information

European Oral Research (Eur Oral Res) is an open access, peer-reviewed international title and it is the official scientific publication of Istanbul University Faculty of Dentistry. Eur Oral Res does not charge authors or authors' institutions for submitting, processing or publication of articles. There is no fee for extra pages or color images.

Basic and clinical research papers, case reports and review articles on the main topics of oral and maxillofacial surgery, oral diseases, oral and dental health, oral and maxillofacial radiology, biomaterials, restorative dentistry, periodontics, pedodontics, orthodontics, endodontics, prosthodontics, oral biology, epidemiology, geriatric dentistry and dental education may be submitted for consideration. Letter to the Editor section is also available for authors who wish to comment on previously published articles in the journal. Authors should take collective responsibility for their work and for the content of their publications. Editor-in Chief or the Editorial Board reserves the right to change the format, grammar or sentence structure of any part of the manuscript to comply with the guidelines to fit the standard format and style of Eur Oral Res and scientific journals in general.

Who is an author ?

Eur Oral Res adheres to the International Committee of Medical Journal Editors (ICMJE) standards to define the qualifications of authorship and recommends that it should be based on the following 4 criteria: substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND drafting the work or revising it critically for important intellectual content; AND final approval of the version to be published; AND agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Before you begin

Disclaimer and copyright

Submission of a manuscript implies that the work described has not been published before; that it is not under consideration for publication anywhere else entirely or partially, nor will it be submitted for consideration of publication anywhere else until a final publication decision concerning this manuscript has been made by the Editor(s) of the Journal; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities at the institute where the work has been carried out. The publisher cannot be held legally responsible should there be any claims for compensation.

Eur Oral Res provides free access to and allows free download of its contents from the journal's website (http://eor.istanbul.edu.tr/tr/_). Both anonymous or registered users can read and/or download articles for personal use. Unless otherwise indicated, the articles and journal content are licensed under Creative Commons License Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) license (https://creativecommons.org/licenses/by-nc/4.0/). Users must give appropriate credit, provide a link to the license, and indicate if changes were made. Users may do so in any reasonable manner, but not in any way that suggests the journal endorses its use. The material cannot be used for commercial purposes. If the user remixes, transforms, or builds upon the material, he/she may not distribute the modified material. No warranties are given. The license may not give the user all of the permissions necessary for his/her intended use. For example, other rights such as publicity, privacy, or moral rights may limit how the material can be used.

Articles may not be published elsewhere, in whole or in part, electronically or in print, without written permission from the Editor-in-Chief. The responsibility of the content(s) and/or opinion(s) provided in the articles which are published in the print and/or online versions of the journal, belong exclusively to their respective author(s). The publisher/editor/editorial board/reviewers cannot be held responsible for errors, scientific or otherwise, in the contents or any consequences arising from the use of information contained therein. The opinions expressed in the articles published in this journal are purely those of their respective authors and in no way represent the opinions of the publisher/editor/editorial board/reviewers of the journal.

Publication ethics and avoiding allegations of plagiarism

Please refer to http://eor.istanbul.edu.tr/en/content/about/publication-ethics-and-publication-malpractice-statement to consult Eur Oral Res Publication Ethics and Publication Malpractice Statement. By submitting their manuscripts to Eur Oral Res, authors also accept that their manuscripts may be screened for signs of plagiarism using any means necessary and available; including, but not limited to, the use of plagiarism detection software.

Ethical approvals

Experimentation involving human subjects should be conducted in full accordance with the Helsinki Declaration of World Medical Association (http://www.wma.net/en/30publications/10policies/b3/index.html) and legal requirements of the country where the research had been carried out. Manuscript must include a statement indicating that the informed consent was obtained from all participants. A statement confirming that the study has been reviewed and approved by an ethical or advisory board should also be included. The patient's privacy should not be violated. Identifying information such as names, initials, hospital numbers, unnecessary details in photographs should be omitted from the submission. When detailed descriptions, photographs and/or videos of faces or identifiable body parts that might permit a patient to be identified must be included in the submission, authors must obtain written

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

informed consent for its publication from the patient or his/her parent/guardian.

Experiments on laboratory animals must comply with the Guidelines of the European Communities Council Directive 2010/63/EU and with local laws and regulations. A statement confirming that the study has been reviewed and approved by an ethical or advisory board should also be included (http://www.eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0063).

Clinical trials

Randomized controlled clinical trials should be reported in full accordance with the guidelines available at http://www.consort-statement.org. The CONSORT checklist must be provided in the submission documents. Following free public clinical registries can be used to register clinical trials: http://www.clinicaltrials.gov, http://clinicaltrials.ifpma.org/clinicaltrials/, http://isrctn.org/ . Registration number and project name will be published in the article.

DNA Sequences and Crystallographic Structure Determinations

Manuscripts reporting protein or DNA sequences and crystallographic structure should provide Genbank or Brookhaven Protein Data Bank accession numbers, respectively.

Submission forms

Authors who are willing to submit their manuscripts to Eur Oral Res are required to complete and sign Manuscript Submission Form, Copyright Transfer Agreement form and Disclosure of Potential Conflict of Interest Form. Please send these forms electronically when submitting your manuscript. Article evaluation process cannot be started until all documents are received.

All three documents are available for download at:

http://dishekimligi.istanbul.edu.tr/wp-content/uploads/2015/04/JIUFD-submission-forms.zip

Manuscript preparation

Language

Authors should write their manuscripts in US English. Spelling and phrasing should conform to standard usage and be consistent throughout the paper. Authors whose native language is not English are encouraged either to consult with a native speaker or to collaborate with a colleague whose English skills are more advanced. Authors may also use professional translation services at their own expense. Please note that using language editing services does not imply that the article will be selected for peer-review or be accepted by Eur Oral Res.

Style and format

Use A4 page format in Microsoft Word® software, custom margins (top & bottom 3 cm, left& right 2.5 cm), Times New Roman Font, Font size 12, double line spacing for main text and single line spacing for "References" section. US English grammar check option should be enabled. Words and abbreviations in Latin should be written in italics: "*et al., in vivo, in vitro, in utero, in situ, ad libitum, clostridium perfringens, Staphylococcus aureus*".

Unit abbreviations

Abbreviations used for units, prefixes, and symbols should comply with the International System of Units (SI) (http://physics.nist.gov/Pubs/SP330/sp330.pdf). If this is not possible, SI equivalents must be presented between parentheses. The complete names of individual teeth must be given in the main text (e.g. maxillary right central incisor). FDI 2-digit system should be used in table and figure legends (e.g. 11 for maxillary right central incisor).

Title page

Main title of the manuscript should not exceed 150 characters (including spaces) and it should be written in Times New Roman font, in bold capital letters of 12 font size. A running title not more than 50 characters (including spaces) written in lower case letters must also be provided below the main title. Names, surnames and affiliations of all authors should appear below the running title. Use superscript numbers "1,2,3" for authors from different institutions, do not use any numbers if all authors are from the same department. Name, surname, postal address, phone, fax and e-mail of the corresponding author should be mentioned separately. If the paper has been previously presented in a scientific meeting either orally or as a poster, the title of the manuscript should be followed by an asterisk (*), which refers to a footnote indicating the name of the organization, location and date of its presentation. Please do not use page numbers for this page.

Abstract & Keywords page

This page should start with main and running titles of your manuscript. It should not contain author names, affiliations or any citations. This section must describe the main objective(s) of the study, explain how the study was done without giving too much methodological detail and summarize the most important results and their significance. It should be as clear and concise as possible. Start numbering from this page on and place it at the lower right-hand corner of the page footer. Abstracts should not exceed 250 words for original research papers and should be structured to include Purpose, Materials and Methods, Results, Conclusion headings written in bold letters. Abstracts of case reports and review articles are limited to 150 words and should be unstructured.

If not absolutely necessary, do not include names of statistical tests or software in the Materials and Methods. In Results section, Provide p values between parentheses at the end of the sentence before the period. If p value is lower than 0.05 or 0.01 or higher than 0.05 (not significant), then provide its exact value using a maximum of three digits after the decimal point. If it is lower than 0.001, then use only less-than sign, e.g. p=0.078, p=0.048, p=0.009, p<0.001.

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

A maximum of five keywords should follow the abstract, preferably chosen from the Medical Subject Headings (MESH) terms (http://www.ncbi.nlm.nih.gov/mesh).

In-text citations

Eur Oral Res recommends the use of reference management software to ensure that the citations are correctly formatted. In-text citations should be numbered consecutively in the order of appearance with Arabic numerals between parentheses and be placed immediately after the author(s)' name(s).

Articles with two authors are cited using their last names separated by "and":

"John and James (1) demonstrated...".

For articles with three or more authors, use the first author's last name followed by "et al.": "James *et al*. (2) showed...".

Multiple quotations used within the same sentence should be cited immediately after each author(s)' name(s).

"John and James (1) and James *et al*. (2) have suggested…"

If author(s)' name(s) are not to be used, the citation number(s) should be placed at the end of the sentence before the period. Use number ranges for consecutive citations.

"The validity and reliability of dental anxiety scales have been evaluated previously (7) or (4, 6, 8) or (12-19)."

Original research articles

Original research articles are limited to 15 pages including main text, references, tables and figures. They should be organized into the following sections:

- Title page
- Abstract & Keywords
- Introduction
- Materials and Methods (or Subjects and Methods)
- Results
- Discussion
- Conclusion
- Acknowledgements (optional)
- Source of funding
- Conflict of Interest
- References

Introduction should provide a concise account of the research problem and introduce the reader to the pertinent literature. The objective(s) and/or hypothesis of the study should be clearly stated in the last paragraph. Writing style of this section should allow the readers outside the field of your expertise to understand the purpose and significance of the study.

Materials and Methods section should describe the study population/sample or specimens, the variables and the procedures of the study with sufficient detail to ensure reproducibility. Standard methods already published in the literature could be briefly described and the original reference should be cited. If your research includes direct involvement with human subjects, use 'Subjects and Methods' heading instead of 'Materials and Methods'.

Feel free to use sub-headings written in italic letters (but not bold) to improve readability of your manuscript such as Population characteristics, Immunohistochemical staining, Experimental protocols or Light microscopy evaluation.

Include ethical approvals for clinical trials and animal studies in the first paragraph of this section. Provide the name of the responsible organization, year of approval and project number:

This project has been reviewed and approved by the Ethical Committee of Istanbul University, Faculty of Medicine (2012/891-1085).

Include Brand name, Manufacturer, City, (state abbreviation for USA), Country details for each material used in the experimental protocol:

DNA was extracted using a MagNA Pure-Compact DNA Isolation Kit (Roche Diagnostics GmbH, Mannheim, Germany)

Bone grafts were fixed with 2 mm bioresorbable screws (Inion CPS system, Inion OY, Tampere, Finland).

Statistical analysis sub-heading must be included as the last paragraph of this section. Authors should provide the name of the statistical software, report which types of descriptive statistics were used to summarize the data, indicate how the distribution of the data was tested for normality assumptions (if applicable), which tests were employed to answer each hypotheses, the confidence interval and p values to determine the level of significance. Consult SAMPL guidelines for more detailed information on statistical reporting in biomedical journals: http://www.equator-network.org/wp-content/uploads/2013/07/SAMPL-Guidelines-6-27-13.pdf

Provide Name, Version, Company, City, (state abbreviation for USA), Country for statistical software:

GraphPad Prism version 3.0 statistical analysis software (GraphPad Software Inc., San Diego, CA, USA)

The following paragraph is a sample for statistical analysis section; please alter the paragraph so that it fits your study:

The collected data from all groups were imported to Statistical Package for Social Sciences (SPSS) for Windows software, version 16.0 (SPSS Inc., Chicago, IL, USA). The standard descriptive methods such as the mean, standard deviation, median, frequency, minimum and maximum were applied to determine the characteristics of the sample. The chi-square test was used to compare the categorical demographic variables among the groups. Because the distribution of the data did not meet the requirements for normality and homogeneity of variances assumptions, the nonparametric Kruskal-Wallis one way analysis of variance by ranks and Mann-Whitney U tests were used for the multiple and pairwise comparisons, respectively. The correlations between at least two continuous variables were examined using Pearson's correlation coefficient. Stepwise regression analysis was performed to understand the statistical dependence of the DFS and MDAS scores in the general population. Covariance analysis was used to determine whether the difference between the mean DFS and MDAS

scores of the groups was statistically significant under a predefined effect. The confidence interval was set to 95% and $p < 0.05$ was considered statistically significant.

Results should be written clearly without subjective interpretation and be supported with tables and figures when necessary. Text should complement any figures or tables but it should not repeat the same information. When reporting your findings, follow the same order you have used in "Materials and Methods" section.

Use a maximum of two digits after the decimal point for descriptive statistics such as mean and standard deviation: "45.66±23.48". If the last digit is 0 then use : "45.6±23.4".

Provide p values between parentheses at the end of the sentence before the period. if p value is lower than 0.05 or 0.01 or higher than 0.05 (not significant) then provide its exact value using a maximum of three digits after the decimal point. If it is lower than 0.001, then use only less-than sign, e.g. (p=0.078), (p=0.048), (p=0.009), (p<0.001).

In the **Discussion** section, authors should state major findings, their meanings and clinical relevance, present any contrasts with the results of similar studies, describe unavoidable limitations in the study design and make suggestions for further research within the limits of their data. When discussing your findings, use the same logical order as in the Results section.

Conclusion should be supported by results and must be consistent with the objectives of the research.

Case reports/Case series

Case reports/Case series should not exceed 7 pages and a maximum of 6 tables or figures. They should make a significant contribution by presenting unusual occurrences of rare entities and/or highlight the need for revision of current therapeutic options. This type of manuscript should be organized as follows:

- Title page
- Abstract & Keywords
- Introduction
- Case report (or case series)
- Discussion
- Conclusion
- Acknowledgements (optional)
- Source of funding
- Conflict of Interest
- References

Narrative or systematic reviews and meta-analyses

Narrative review articles are limited to 10 pages including the main text, references, tables and figures. The manuscripts should summarize the current state of understanding on a particularly important topic in dentistry based on previously published data, preferably written by authoritative figures of that field. A minimum of 50 references must be cited. Authors are encouraged to use headings of their own choosing between Introduction and Conclusion sections.

This type of manuscript should be organized as follows:

- Title page
- Abstract & Keywords
- Introduction
- Conclusion
- Acknowledgements (optional)
- Source of funding
- Conflict of Interest
- References

Authors who are willing to submit a systematic review or a meta-analysis may use the same manuscript design as for the original research articles.

Letter to the Editor

Letters to the Editor are short articles (limited to 500 words and 5 references) in which readers can share their opinions and comment on articles published in the past 12 months. Authors should clearly cite the article to which they are referring. Letters will be evaluated by the Editor-in-Chief and, if accepted for publication, the author(s) of the original paper will be invited to submit a reply.

Acknowledgements

This section is optional. Authors must acknowledge all individuals who do not fulfill the requirements for authorship but who had contributed to the preparation of the manuscript by providing assistance in writing, literature search, data analysis and/or supply of materials.

Source of funding

This section is mandatory to be filled out. Financial support from any institutional, private or corporate sources must be disclosed. Clearly state the name of the funding organization, year and the project number:

"This study has been supported by a research grant from XXX foundation, university, government etc.. (project number: 2012/828128)

If you have no source of funding declaration to make, please write "None declared".

Conflict of Interest

This section is mandatory to be filled out. Any financial or personal activities (royalties, grants, consultancy fee, patent registration, ownership, employment) that could be perceived as potential conflicts of interests must also be disclosed.

Clearly state the names of the author(s) and organization(s) and the type of payment(s):

"Dr. Smith is a consultant for the company X / receives a consultancy fee from the company X." or "Until recently, Dr. Smith was in an employment relationship with the company Z." .

If you have no declaration to make, please write "None declared".

References

Eur Oral Res recommends the use of reference management software to ensure that the references are correctly formatted. All authors must be included in this section, in contrast to the in-text citations. Journal abbreviations should be formatted according to the PubMed - NLM Journal Title Abbreviations (http://www.ncbi.nlm.nih.gov/journals). Au-

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

thors are advised to consult a recent issue of the journal. Use single line spacing for this section. Please do not cite unpublished articles, abstracts, personal communications, non-scientific websites or documents such as pamphlets.

AUTHORS ARE RESPONSIBLE FOR SENDING THE FULL TEXT VERSIONS OF ANY CITED PAPER OR TEXTBOOK AS PER THE REQUEST OF THE EUR ORAL RES EDITORIAL BOARD AND/OR THE REVIEWERS.

AUTHORS ARE RESPONSIBLE FOR SENDING THE PROFESSIONAL ENGLISH TRANSLATION OF ANY NON-ENGLISH PAPER OR TEXTBOOK AS PER THE REQUEST OF THE EUR ORAL RES EDITORIAL BOARD AND/OR THE REVIEWERS.

Journal Article in Print

1. Burrow MF, Tagami J, Negishi T. Early tensile bone strengths of several enamel and dentin bonding systems. J Dent Res 1994; 74: 522-8.

Journal Article Electronic Publication Ahead of Print

2. McKeage K. Tobramycin inhalation powder: a review of its use in the treatment of chronic pseudomonas aeruginosa infection in patients with cystic fibrosis. Drugs 2013; [Epub ahead of print] Available from: http://link.springer.com/article/10.1007%2 Fs40265-013-0141-0

Book

3. Mueller HJ, Freeman D. FT-IR spectrometry in materiolography. 2nd Ed., Ohio: American Society for Metal 1994, p.51-56.

Chapter in a book

4. Alexander RG. Considerations in creating a beautiful smile. In: Romano R, editor. The art of the smile. London: Quintessence Publishing, 2005, p.187-210.
5. Hudson FB, Hawcroft J. Duration of treatment in phenylketonuria. In: Seakins J, Saunders R, editors. Treatment of inborn errors of metabolism. London: Churchill Livingstone, 1973, p.51-56.

Thesis

6. Maden I. Effect Of Nd:YAG Laser Treatment In Addition To Scaling And Root Planning. Doctoral Dissertation, Istanbul University Institute of Health Sciences Periodontology Department, 2009.

Tables, Figures and Legends

Please set table format to custom borders, no vertical lines, no shades, no background colors, 3 pt line for top and bottom borders, 1 pt horizontal row lines, cell alignment center. Tables should be numbered consecutively with Arabic numerals in the order mentioned in the text. All tables must be included in the main body of the article and be placed near their first mention in the text. All tables should be self-explanatory. Please provide full explanation for abbreviations even if they were presented in the main text. Legends should be written in Times New Roman Italic font and be positioned right above the table.

Figures (photographs, graphs, charts, drawings, pictures, etc.) should be numbered consecutively with Arabic numerals in the order of mention in the text. High quality pictures with 300 dpi resolution in JPEG JPG, BMP, TIFF, PNG or PSD file formats are generally acceptable for publication. Drawings and shapes should be in vector format. All figures must be included in the main body of the article and be placed near their first mention in the text. Legends should be written in Times New Roman Italic font and be positioned below the figure.

Figure 1. Panoramic radiograph of the patient taken 6 months after surgery, note irregular borders of the lesion.

Submission checklist

1. "Manuscript Submission Form" signed by the corresponding author.
2. "Copyright Transfer Agreement Form" signed by all authors.
3. "Disclosure of Potential Conflict of Interest Form" signed by all authors.
4. Title page
5. Abstract & Keywords page
6. Main text
7. Tables, figures and their legends should be embedded in the main text and are not to be sent separately.

How to submit ?

Eur Oral Res is only accepting electronic submissions. Manuscripts may be submitted by registering at https://mc04.manuscriptcentral.com/eores

Need assistance ?

Please contact editorial office by sending an e-mail to: dentistryeditor@istanbul.edu.tr or disdergi@istanbul.edu.tr

Postal address: İstanbul Üniversitesi Diş Hekimliği Fakültesi Dergisi İstanbul Üniversitesi Diş Hekimliği Fakültesi Kütüphanesi Dergi Yayın Kurulu Odası 34093 Çapa-Fatih, İSTANBUL/TURKEY

Phone: +90 212 414 20 20 (extension 30348)
Fax: +90 212 414 25 70

What's next ?

If you have successfully submitted your forms and manuscript, please continue reading this document to know about the Eur Oral Res editorial process.

General information

Peer-review evaluation and publishing of articles submitted to Eur Oral Res are managed electronically through the online system via e-mail correspondence. Corresponding authors will be notified by e-mail upon receipt of a new manuscript and will have further information regarding the editorial process. It is the responsibility of the corresponding author to communicate with the other participants of the study about the submission of the manuscript, its content and authorship requirements.

Who makes the decisions ?

Eur Oral Res Editorial Board oversees the manuscript evaluation process. The Editor-in-Chief is the only person who can officially accept a paper.

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

Initial examination

Editor-in-Chief and editorial assistants check the submission files to confirm the availability of the required documents. Please note that the Manuscript Submission Form, Copyright Transfer Agreement Form and Conflict of Interest Disclosure Form must be included in the original submission. Corresponding authors of incomplete submissions will be notified via e-mail. Editorial process cannot proceed until all relevant documents are signed and submitted electronically.

Careful manuscript preparation is the crucial part of peer-review process. Editorial assistants will evaluate the manuscript to ascertain conformity to the following standards: consistency to journal style, clear and concise writing, proper use of English grammar and spelling, technical quality, correct formatting of references and documentation of ethical conduct. All eligible manuscripts will also be scanned with anti-plagiarism software.

Manuscripts that fail to conform to journal expectations in any of the above mentioned issues will be returned to authors without review. This is a frequent cause of delay in the publication of articles and may even result in immediate rejection. All issues regarding the outline of the manuscript should be resolved before further evaluation. Manuscripts which pass the initial examination are presented to the Editorial Board by the Editor-in-Chief.

Peer-review

Eur Oral Res operates a double-blind peer review system. Identities of the Editorial Board members who perform the initial examination and those of the reviewers who evaluate the manuscript remain unknown to the authors. All manuscripts are treated as privileged information. Editorial Board members and reviewers are instructed to exclude themselves from reviewing any manuscripts that might involve a conflict of interest.

Editorial Board requests the opinion of, at least, two independent expert reviewers. Those who accept the invitation are expected to provide written critical reviews of the submission within 21 days of receipt. If one of the reviewers gives a negative feedback while the other's response is positive, Editor-in Chief or Editorial Board invites a third reviewer. Editor-in-Chief and Editorial Board reserve the right to obtain reports from biostatistics experts of their choosing at any time during the process, who might also suggest corrections in the manuscript.

21 day time limit will apply for the correction of the manuscript, at the end of which the corresponding author must return a revised version of the documents. Changes should be highlighted in red in the revised manuscript to facilitate reading. Authors should also provide itemized, point-by-point responses to reviewers' comments in a separate file. The manuscript will be automatically rejected if no answer has been received from the authors. If authors submit the revised paper after the time limit is reached, it will be treated as a new submission. Revised manuscripts will be re-evaluated by Editor-in-Chief and Editorial Board and will be sent back to reviewers.

Acceptance for publication requires at least, but not limited to, final positive responses from two reviewers. In light of their recommendations, the Editor-in-Chief and the Editorial Board members choose between the following options: "accept submission", "revisions required", "resubmit for review" or "decline submission".

"Accept submission" indicates that the manuscript can be published as is. If there are "revisions required", all major changes in the manuscript must be confirmed by the reviewer who had originally suggested the revisions. In some cases, editorial team may think that your manuscript deserves re-evaluation after substantial changes which cannot be completed within reasonable time limits. Therefore, the editor may encourage authors to re-submit their manuscript by selecting "resubmit for review". Such conditions include, but not limited to, increasing the sample size, performing more statistical tests or correcting multiple errors that impede understanding. Re-submitted manuscripts will be treated as new submissions. On the other hand, if the "decline submission" decision has been reached, your manuscript has been found unsuitable for publication and you cannot submit the same manuscript to this journal.

An e-mail notification that includes the formal letter of approval will be sent to the corresponding author. Rejection e-mail will include reviewers' comments and suggestions. Accepted manuscripts will be forwarded to the publisher.

Table 1. *Concise explanation of the table contents (SD: standard deviation, CTA: cartilage tissue area, NBA: new bone area).*

	Control group (Mean % ± SD %)	First group (Mean % ± SD %)	Second group (Mean % ± SD %)
CTA	21.41 ± 4.2	2.5 ± 2.4	11.42 ± 4.2
NBA	11.48 ± 0.2	21.41 ± 14.22	11.41 ± 4.2

After acceptance

Production department transforms the manuscript files into an article and sends the galley proofs to the corresponding author via e-mail. All authors should carefully check the final PDF proof version of the article for minor punctuation or spelling errors, correct presentation and positioning of the tables, figures and their captions. Corrected page proofs should be returned via e-mail within 7 days of receipt. Major changes such as adding new paragraphs, changing the title or the name order of the authors and modifying visual elements will not be allowed at this stage.

Publication

Articles will normally appear in the order in which they were accepted as publication,

however, Editor-in-Chief and Editorial Board reserve the right to modify this schedule in the presence of critical scientific issues.

To speed up the process, articles will be first published online, followed by the print version of the journal. Both versions will have identical page numbers. Therefore, no change can be made in the article in between the online and in print publication steps.

DOI number

Digital Object Identifier (DOI) number is a unique alphanumeric identifier assigned by a registration agency. Once it is assigned to an article, the DOI will never change, therefore, it is ideal for citing and linking electronic documents. Your article will be assigned a DOI number provided by the CrossRef registration agency, immediately after it is published online.

Changes to authorship

This statement concerns the addition, deletion, or rearrangement of author names in the authorship of accepted manuscripts. Requests to add or remove an author or to rearrange the author names must be sent to the Editor-in-Chief from the corresponding author of the accepted manuscript. This document must include: the reason the name should be added or removed, or the author names rearranged and written confirmation (e-mail, fax, letter) from all authors that they agree on the addition, removal or rearrangement. In the case of addition or removal of authors, written confirmation from the author being added or removed must be included. Requests that are not sent by the corresponding author will be forwarded by the Editor-in-Chief to the corresponding author, who must follow the procedure as described above. Production of the accepted manuscript is suspended until authorship has been agreed. The name and the order of the authors cannot be changed once the article is published online or in print.

Data access and retention

Authors may be asked to provide the raw data of their investigations during the editorial process or after publication of the article. Such materials include, but not limited to, original submission files, unedited versions of the printed and/or digital radiographs, unedited versions of the printed and/or digital photographs, histologic slides, original outputs from clinical and/or experimental diagnostic and/or interventional devices, original data sheets of statistical software and technical data sheets of any substance used in the research project. Authors should retain such materials for a reasonable period of time after the publication of their paper.

Correction, Retraction & Removal

A formal correction will be issued in the journal by the Editor-in-Chief, if only a small portion of otherwise reliable article is flawed in a way that does not severely affect the findings reported in it (such as mistakes in the spelling of a drug, miscalculation of a formula, mismatch between images and their captions or incorrect author list). Online articles will not be corrected directly. An erratum (for publishing error) or a corrigendum (for author error) will be published in the next issue of the journal.

Articles may be retracted by its authors or by the Editor-in-Chief under the advice of the scientific community. If authors are willing to retract an article before it is published (accepted or under review), requests must be sent to the Editor-in-Chief from the corresponding author of the manuscript. This document must include: the reason the article should be retracted and written confirmation (e-mail, fax, letter) from all authors that they agree on the retraction. Reasons for editorial retraction include, but not limited to, unreliable publications as a result of misconduct or honest error, redundant publication, major plagiarism, copyright infringement and unethical research. A formal retraction announcement written by the Editor-in-Chief will be published in the print edition of the journal. For online articles, the PDF pages remain with a watermark on each page to notify it is retracted.

In rare circumstances, an article can be completely removed from the online database. Such conditions include, but not limited to, defamation, infringement of legal rights, court orders and claims in the article that might pose serious health risks. Title and author names will remain in the web page while the text will be replaced by a notification indicating that the article has been removed for legal reasons.

European Oral Research

Official Publication of Istanbul University Faculty of Dentistry

Contents

Original Research Articles

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 110-116

Original research

Periodontal status of mandibular second molar after extraction of impacted mandibular third molars- a prospective clinical trial

Swathi Singh[1], **Sruthima Naga Venkata Satya Gottumukkala**[1], **Konathala Santosh Venkata Ramesh**[1], **Gautami Subhadra Penmetsa**[1], **Chinnaswami Doraiswami Dwarakanath**[1], **Vivek Bypalli**[1]

Purpose

Mandibular third molar (M3) extraction is the common surgical procedures carried out; however, one of the complications is development of periodontal disease in adjacent second molars (M2). Hence the purpose of this study was to evaluate the effect of extraction of M3 on the periodontal status of M2.

Materials and Methods

Study included 120 sites with mandibular M2 adjacent to the impacted M3. Plaque index(PI), gingival index(GI), probing pocket depths(PD), clinical attachment levels(CAL), Gingival recession(GR) and alveolar bone height(ABH) before and 9-12 months after surgical extraction of M3 were assessed. Patients perception was assessed using dichotomous rating. Four types of impactions(IMP) were included along with surgical cofactors like degree of impaction, flap design, bone removal, tooth sectioning.

Results

At baseline mesioangular and horizontal IMP showed greater PPD and CAL. After extraction of M3 there was significant decrease in PPD & CAL. 14% cases showed significant increase gingival recession at the distobuccal of M2. Although 10.9% of patients had an alveolar bony defect(ABD) distal to the M2, there was considerable improvement in ABH from baseline. The ABDs are mostly associated with mesioangular and horizontal IMP.

Conclusion

Extraction of impacted M3 proves to be beneficial on periodontal status of M2. However, occasionally, mesioangular and horizontal IMP are likely to develop ABD distal to M2 and hence can be followed by regenerative procedures to prevent the formation of ABD.

Keywords: *Alveolar bone defect, impacted tooth, mandibular third molar, mandibular second molar, tooth extraction*

Introduction

An impacted tooth, especially mandibular third molar (M3) which has higher impaction prevalence, requires surgical interventions more frequently (1). One common indication for surgical extraction of M3, is the prevention and/or improvement of periodontal defects in adjacent second molar(M2) (2). Several previous studies have shown that fully erupted M2 that are in close proximity to impacted M3 showed greater prevalence of periodontal disease due to colonization by periodontal pathogens (3-5). Blakey *et al.* (6) in a longitudinal study has shown that almost 25% of patients with retained and asymptomatic wisdom teeth had probing depths of at least 5 mm on the distal of the M2 and the mesial of the M3. However, surgical removal of wisdom teeth has been associated with the risk of having persistent or developing new periodontal defects at the distal aspect of the mandibular M2 (7-9).

ORCID IDs of the authors: S.S. 0000-0001-7522-8323; S.N.V.S.G. 0000-0002-7126-5829; K.S.V.R. 0000-0001-7022-0023; G.S.P. 0000-0002-8744-1452; C.D.D. 0000-0002-0506-5191; V.B. 0000-0003-3040-4148

[1]*Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India*

Corresponding Author: Konathala Santosh Venkata Ramesh

E-mail: ksv006@gmail.com

Received: 8 September 2021
Revised: 7 October 2021
Accepted: 22 December 2021

DOI: 10.26650/eor.2022992668

How to cite: *Swathi S, Gottumukkala SNVS, Ramesh KSV, Penmetsa GS, Dwarakanath CD, Bypalli V. Periodontal status of mandibular second molar after extraction of impacted mandibular third molars- a prospective clinical trial. Eur Oral Res 2022; 56(3): 110-116. DOI: 10.26650/eor.2022992668*

Conflicting reports exist regarding the influence of M3 removal on the periodontal status of the adjacent M2. Previous studies assumed the patients age, the type of impaction (IMP) and the periodontal baseline situation as the primary factors affecting periodontal healing (8,9,10). However, Coleman *et al.* (9) some have shown improvement of periodontal health distal to the M2, while others have demonstrated loss of alveolar bone with reduction of alveolar bone height(ABH) (8,10). Other studies on periodontal healing have revealed that the removal of M3 is followed by spontaneous wound healing and attachment gain even without the use of any extraneous materials (11-13).

Although several studies have addressed the problem of effect of mandibular M3 extraction, both periodontal and surgical literature lacks evidence of support to make any straight statements. The current literature calls for further studies comparing the periodontal health and extraction of M3. The hypothesis of the current study is that extraction of M3 improves the periodontal condition of adjacent M2. Hence, this study was aimed to evaluate the periodontal status of mandibular M2 after the extraction of adjacent impacted mandibular M3. The null hypothesis tested in the present study is that the removal of M3 does not affect any of the variables regarding the periodontal status of M2.

Material and Methods

Study design and ethical approval

This was a prospective clinical trial conducted at Vishnu Dental College, in accordance with Helsinki Declaration and Good Clinical Practice guidelines after obtaining ethical clearance (IEC No: IEC/VDC/MDS15 PERIO 04). Informed consent was obtained before their enrollment in the study.

Sample size estimation and study population

Sample size analysis was done using G Power 3.1 software based on an effect size of 0.67 with an alpha level of 0.05 and 20% dropout rate, it was estimated to be 154 sites. A total of 140 patients requiring unilateral (n-126) or bilateral impactions (n-14), were included after fulfilling the study requirements. Each mandibular molar was considered as a site and subjects with bilateral impactions were considered as two sites (Figure 1) 34 patients were lost to post-operative follow-up due to various reasons and hence were dropped from the study. The remaining 120 sites were assessed.

Inclusion criteria

Patient related criteria was being systemically healthy individuals in the age range of 18 to 35 years, Tooth related criteria were the presence of unilateral or bilateral impacted mandibular M3, periodontally healthy subjects (probing depths of 3mm or below and with no evidence of loss of attachment, but might be showing some signs of gingival inflammation with no bone loss confirmed by radiographs), not underwent any periodontal therapy/ use of medications in the previous 6 months

Exclusion criteria

Patient related criteria were having aggressive periodontitis, undergoing active periodontal therapy, patients undergoing orthodontic treatment, pregnancy, poor oral hygiene maintenance. Tooth related criteria were missing adjacent M2 or if the M2 is indicated for endodontic treatment, crown placement or extraction during the course of the study, presence of inflammatory changes in M3

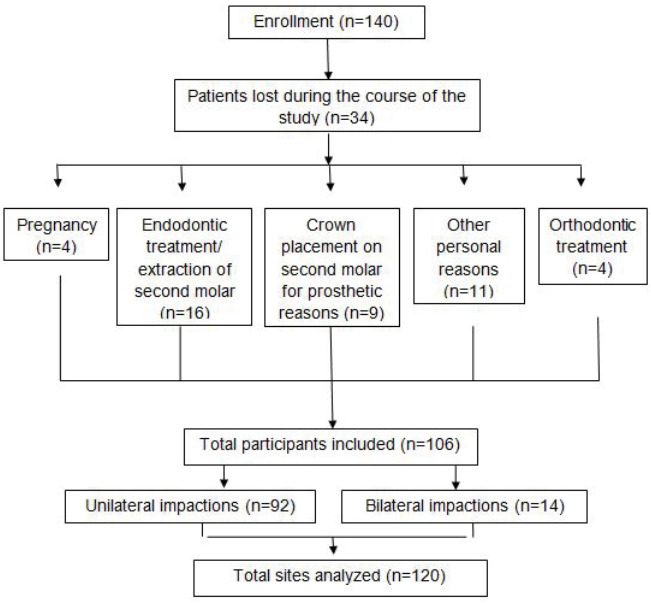

Figure 1. *Patient inclusion flowchart.*

Screening procedure

The preliminary examination included an assessment of medical and dental history including periodontal examination i.e. Plaque index (PI), Gingival index (GI), Community periodontal index (CPI), probing pocket depth (PD), Clinical attachment loss (CAL) and Gingival recession was carried out using UNC-15 probe in relation toM2 adjacent to the impacted M3 in the mandible (14,15,16). Patients perception of pain, discomfort, swelling, trismus and food lodgment were assessed as present or absent using dichotomous rating 4 weeks after M3 extraction.

Assessment of M3

A panoramic radiograph was taken at baseline to evaluate the position of the M3 (Completely or partially impacted) according to the classifications of Pell and Gregory with respect to the ascending ramus (classes I, II, and III) and with respect to the occlusal plane (types A, B, and C) (8). The difficulty index was determined with the help of Pederson's difficulty index (10).

Measurement of bone height

ABH was assessed using digital Intra Oral Periapical radiograph(IOPAR). The distance between the cemento-enamel junction (CEJ) to the crest of alveolar bone was measured using commercially available radiography measurement software AutoCAD 2015.

Surgical procedure

All the patients received scaling and oral hygiene instructions at baseline. The surgical procedure was performed by

an oral surgeon under local anesthesia with 2% lignocaine containing adrenaline (1:80,000). A triangular mucoperiosteal flap was elevated distal to the M2 providing access to the M3 from the buccal aspect using Wards or Modified Wards incision. Ostectomy was carried out with a rotary instrument followed by tooth sectioning if necessary. After extraction, the socket was inspected, curetted, and irrigated with sterile saline solution. Primary closure was achieved by placing simple interrupted sutures with 3-0 silk suture material.

0.2% chlorhexidine mouthwash (bid), Cap.Amoxicillin (500 mg, TID), Tab Diclofenac sodium (50mg, BID) were prescribedand oral hygiene instructions were reinforced. Suture removal was done 1 week after surgery. After 9 to 12 months all the clinical and radiographic parameters were evaluated. Patient perception was recorded at every follow up. Oral prophylaxis was performed one week before and 4 weeks after extraction of M3. No other periodontal procedures were performed in any of the patients.

Radiographic assessment of alveolar bone changes

Digital IOPAR were taken with long cone paralleling technique distal to M2 (17). Modified commercial film positioner Rinn XCP Instrument Kit was used to ensure the stability in the vertical and horizontal planes. An additional device was fabricated in the form of a hollow cylinder using acrylic and adapted to the positioner and the collimator to prevent unwanted movements and undesirable angulations. The measurements were done as described in a previous study (18**).**

Statistical analysis

Statistical analysis was done using SPSS 22.0 version (Armonk NY IBM, NY, USA). Student t-test for full mouth periodontal parameters at M2 region. Multiple correlation analysis between the impaction scores with other clinical parameters at M2, variables of surgical technique was done by Karl Pearson's correlation method.

Results

A total of 120 sites in 106 participants (49 males and 57 females) were taken for final data analysis. None of the patients included in the study experienced any untoward events/complications intra-operatively or post-operatively. The age of the participants in the study ranged from 18 years to 35 years with the mean age being 25.43 years. 49 males with mean age of 24.56 and 57 females with mean age of 26.32 were included.

Full mouth periodontal variables

At 9 to 12 months after M3 extraction all the clinical and radiographic parameters were evaluated. The full mouth mean PI and GI scores reduced considerably from baseline to revaluation period and the reduction was statistically significant (Table 1). A statistically significant drop in the CPI scores was observed when compared from baseline to revaluation period (Table 1).

M2 periodontal variables

For the mandibular M2 teeth there was a significant improvement in mean PD (0.87±0.67) at the distal site of M2(P<0.001) (Table 2). The PDs were observed to decrease for 54 sites (45.37%) from baseline to revaluation period. The remaining 65 sites (54.62%) exhibited no change in the PD at the end of nine months to one year after surgical extraction of impacted M3. The overall difference was seen to be statistically significant. Similarly, the CAL improved for 53 sites (44.53%) and remained unchanged for the remaining 66 sites (55.46%) post-operatively by 9-12 months which was statistically significant (Table 2).

17 sites (14.28%) showed increase in GR of which 15 sites showed 1mm increase in recession depth whereas the remaining 2 sites showed 2mm increase in recession depth. This increase was found to be statistically significant. However, no significant correlation was found between IMP and GR (Table 3).

Table 1: *Comparison between baseline (B) and 9 months to 1-year evaluation (R) in full mouth variables.*

Variables	Time period	Mean	Mean Difference	% of Mean change	P value
PI	Baseline	1.17±0.37	0.44±0.08	-37.61	<0.001*
	Re-evaluation	0.73±0.29			
GI	Baseline	1.18±0.40	0.53±0.09	-44.92	<0.001*
	Re-evaluation	0.65±0.31			
CPI	Baseline	2.66±0.90	1.43±0.43	-53.76	<0.001*
	Re-evaluation	1.23±1.33			

*Statistically significant if P<0.05.

Table 2: *Comparison between Baseline (B) and 9 months to 1-year revaluation (R) in M2 of interest variables***.**

Variables	Time period	Mean	Mean Difference	% of Mean change	P value
PI	Baseline	1.23±0.39	0.54±0.08	-43.90	<0.001*
	Re-evaluation	0.69±0.31			
GI	Baseline	1.25±0.43	0.63±0.11	-50.40	<0.001*
	Re-evaluation	0.62±0.32			
PD	Baseline	3.68±1.26	0.87±0.67	-23.64	<0.001*
	Re-evaluation	2.81±0.59			
CAL	Baseline	3.71±1.30	0.80±0.59	-21.56	<0.001*
	Re-evaluation	2.91±0.71			
GR	Baseline	0.05±0.26	0.22±0.28	440.00	<0.001*
	Re-evaluation	0.27±0.54			
ABH	Baseline	3.85±2.08	1.60±0.50	-41.56	<0.001*
	Re-evaluation	2.25±1.58			

*Statistically significant if P<0.05

The overall alveolar bone level improved at the distal aspect of M2 from before extraction to 9-12 months after extraction and this difference was statistically significant (Table 2, Figure 2,3). However, there were 13 sites (10.92%) which presented with a vertical bone defect at the distal aspect of M2, of which 7 sites were observed after extraction of mesioangular IMP (Figure 4) and 6 sites after horizontal IMP (Table 4, Figure 5).

IMP and surgical variables

The IMP was scored according to Pederson's difficulty index(DI). Out of 120 mandibular impacted M3, the spatial orientation of 50% of the M3 was mesioangular, 19% was distoangular, 17% was horizontal and 14% was vertical. The DI for the surgical extraction of the impacted molars ranged from 4-8. Higher pre-operative PD and CAL loss was seen in mesioangular and horizontal IMP followed by vertical and distoangular IMP (Table 5,6).

Multiple correlation analysis between the surgical variables including IMP, DI, presence or absence of alveolar bone defects (ABD), bone removed (BR) during extraction and tooth sectioning (TS) done or not, revealed a statistically significant correlation of ABD with BR ($P<0.05$) and TS ($P<0.05$). The sites which showed a residual alveolar vertical defect on distal aspect of M3 were associated with more bone removal and TS during the time of surgery. Also, the presence of ABD was associated only with the horizontal or mesioangular IMP among which only the latter showed statistically significant positive correlation between presence of an ABD and BR during surgery.

Table 3: *Correlation between type of impaction (IMP) and M2 of Interest variables.*

Variables	Correlation coefficient (r)	P value
IMP and B - PI	-0.158	0.147
IMP and R - PI	-0.111	0.308
IMP and B - GI	-0.169	0.119
IMP and R - GI	-0.117	0.284
IMP and B - PD	-0.329	0.002*
IMP and R - PD	-0.293	0.006*
IMP and B - CAL	-0.334	0.002*
IMP and R - CAL	-0.301	0.005*
IMP and B - GR	-0.078	0.476
IMP and R - GR	-0.134	0.220
IMP and B - ABH	-0.347	0.001*
IMP and R - ABH	-0.246	0.022*

B- Baseline; R- Revaluation *Statistically significant if P<0.05; IMP – Type of impaction

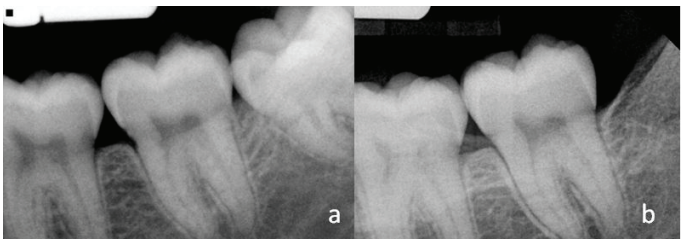

Figure 2. *Vertical IMP; a) Pre-operative radiograph; b) Post operative radiograph showing improved ABH at re-assessment period.*

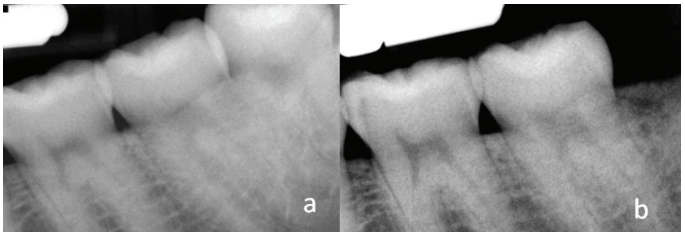

Figure 3. *Distoangular IMP; a) Pre-operative radiograph; b) Post operative radiograph showing improved ABH at re-assessment period.*

Table 4: *Multiple correlation analysis between the surgical variables.*

Variables	Correlation	IMP	DI	ABD	D	BR	TS
IMP	Pearson Correlation	1.000	0.918	0.197	0.000	-0.190	0.367
	P value		0.000*	0.069	0.997	0.080	0.001*
DI	Pearson Correlation	0.918	1.000	0.184	0.049	-0.173	0.349
	P value	0.000*		0.090	0.657	0.111	0.001*
ABD	Pearson Correlation	0.197	0.184	1.000	-0.155	-0.395	0.328
	P value	0.069	0.090		0.154	0.000*	0.002*
D	Pearson Correlation	0.000*	0.049	-0.155	1.000	0.359	-0.149
	P value	0.997	0.657	0.154		0.001*	0.172
BR	Pearson Correlation	-0.190	-0.173	-0.395	0.359	1.000	-0.598
	P value	0.080	0.111	0.000*	0.001*		0.000*
TS	Pearson Correlation	0.367	0.349	0.328	-0.149	-0.598	1.000
	P value	0.001*	0.001*	0.002*	0.172	0.000*	

*Statistically significant if P<0.05; IMP – Type of impaction; DI – Difficulty Index; ABD – Alveolar Bone Defect;D – Degree of impaction; BR – Bone removal;TS – Tooth sectioning

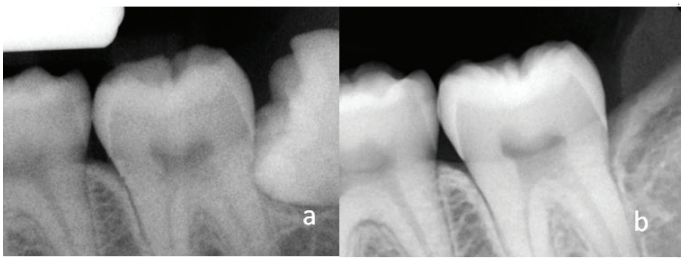

Figure 4. *Horizontal IMP; a) Pre-operative radiograph; b) Post operative radiograph showing angular defect distal to M2 at re-assessment period.*

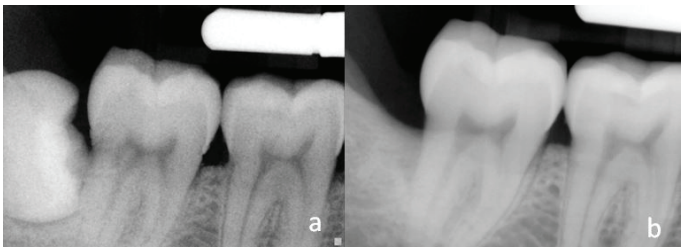

Figure 5. *Mesioangular IMP; a) Pre-operative radiograph; b) Post operative radiograph showing angular defect distal to M2 at re-assessment period.*

Table 5: *Multiple correlation analysis between the surgical variables in horizontal impaction.*

		Horizontal impaction				
		DI	**ABD**	**D**	**BR**	**TS**
DI	Pearson Correlation	1.000	-0.080	0.384	-0.283	0.423
	P Value		0.777	0.157	0.307	0.116
ABD	Pearson Correlation	-0.080	1.000	-0.185	-0.307	0.320
	P Value	0.777		0.510	0.265	0.245
D	Pearson Correlation	0.384	-0.185	1.000	0.482	-0.059
	P Value	0.157	0.510		0.069	0.834
BR	Pearson Correlation	-0.283	-0.307	0.482	1.000	-0.652
	P Value	0.307	0.265	0.069		0.008*
TS	Pearson Correlation	0.423	0.320	-0.059	-0.652	1.000
	P Value	0.116	0.245	0.834	0.008*	

*Statistically significant if P<0.05.

Patient perception

Patients perception of pain and other symptoms were assessed as presence or absence with dichotomous rating. All the M3 sites that were included were symptomatic with the patient's chief complaint mostly being pain alone (58.09%) or associated with swelling and trismus (2.85%), caries (10.47%) and food lodgment (10.47%). All patients but one reported that their symptoms had resolved completely post extraction. However, 10 patients (9.52%) out of 106 participants developed post-operative sensitivity in the region of M2 adjacent to the extraction site and 3 (2.85%) patients complained of food lodgment post operatively in the same site.

Table 6: *Multiple correlation analysis between the surgical variables in mesioangular impaction.*

		Mesioangular impaction				
		DI	**ABD**	**D**	**BR**	**TS**
DI	Pearson Correlation	1.000	-0.005	0.074	0.164	0.044
	P Value		0.975	0.638	0.294	0.779
ABD	Pearson Correlation	-0.005	1.000	-0.068	-0.346	0.209
	P Value	0.975		0.665	0.023*	0.178
D	Pearson Correlation	0.074	-0.068	1.000	0.241	-0.200
	P Value	0.638	0.665		0.120	0.197
BR	Pearson Correlation	0.164	-0.346	0.241	1.000	-0.617
	P Value	0.294	0.023*	0.120		0.000*
TS	Pearson Correlation	0.044	0.209	-0.200	-0.617	1.000
	P Value	0.779	0.178	0.197	0.000*	

*Statistically significant if P<0.05.

Among the 106, 20 patients (19.04%) felt that the surgical procedure and sequelae was very uncomfortable and 17 patients (16.19%) of them refused to undergo the same treatment again. For another 59 patients (55.23%) sequel were a bit uncomfortable but within tolerable limits.

Discussion

Fully erupted M2 that are in close proximity to impacted M3often exhibit greater prevalence of periodontal disease (9,11,19). Factors influencing the post extraction periodontal status include the patient's age, IMP, the patient's periodontal status at baseline and various surgical cofactors including flap design and technique, the amount of bone removed, suturing material (10,20,21). However, the current literature makes no clear assertion as to whether the surgical removal of an impacted wisdom tooth is beneficial or a threat to the periodontal status (7). In the present study, nine months to one year was chosen as the follow-up period considering periodontal healing process distal to the M2 is completed after a minimum period of three months (22).

In this study, multiple IMPs i.e. vertical, mesioangular, horizontal and distoangular were included. It was observed that the maximum IMP were mesioangular (50%), followed by distoangular, horizontal and vertical. Mesioangular and horizontal IMP were associated with greater preoperative PD and CAL, due to food lodgment and poor accessibility (23,24).

Extraction of impacted M3 improved both full mouth and M2, PI and GI scores from baseline to the revaluation period which are in agreement with earlier studies, where an advantage in curettage and root planing distal toM2 showed improved periodontal health (25,12). Removal of M3 provided better access for easy maintenance of oral hygiene post operatively to the distal aspect of M2 throughout the follow-up. On contrary few other studies showed no change

in PI and GI, due to failure to supervise or enhance plaque control following extraction of M3 (10, 13).

The current study demonstrated periodontal healing post extraction with reduction in PD and gain in CAL distal to M2. A previous study, showed greater reduction in PD over a post-operative period of one year (1.9 mm) which may be due greater baseline PD (22,26). If the preoperative PD was <4 mm, no therapeutic changes occurred and no further periodontal treatment was required as observed in previous randomized controlled trials (9,13,27,28). However, these were retrospective studies whereas the present study is a prospective trial. In the above mentioned retrospective studies contra lateral tooth was used as the control group which might not represent the true changes of PD and CAL, whereas the pre and postoperative measurements recorded at the same site as in the present study would give more reliable results.

Though there was a significant improvement in the CAL, around 14% of patients experienced GR post M3 extraction which could be due to ward's incision which involves a sulcular incision that does not leave intact gingival collar. No attempt was made to use any different flap technique to preserve the marginal gingiva on the buccal and distal aspect of M2 as they are not related to the flap technique (29).

ABH improved significantly distal toM2 as a result of biological tooth socket healing which is in accordance with other studies where a clinically significant bone healing was observed (30,31). On the contrary, some studies showed significant alveolar bone loss distal toM2 which was in close proximity to the extracted impacted M3 (28). Even though the follow up period of these studies was much longer (36-58 months) the fact that the same site was examined pre and postoperatively, instead of using contralateral teeth makes the present study more reliable.

In the present study, out of 120 sites 13 sites exhibited ABD post-extraction distal to M2 and were found to be associated with mesioangular and horizontal IMP as more amount of bone is removed during the extraction. The surgical removal of a fully impacted tooth usually leaves a unilateral ABD due to the removal of partial buccal wall post extraction (4,32).

Studies showing greater bone loss post extraction included a sample of wider age range (20-60) than in the present study (18-32 years old) which also may be responsible for different outcomes of the study as young patients take benefit from early surgical M3 extraction, whereas in older patients' teeth are often more angulated requiring more invasive surgery increasing the risk for bone defects (12,32). Preoperative deep pockets and older age could be independent risk factors for and residual pocket formation after M3 extraction (33).

In this study no endeavors to regenerate the alveolar bone distal to M2 were made. However, the patients were reinforced on oral hygiene habits and maintenance once a month during regular follow up visits. The present investigation demonstrated significant bone gain in majority of sites with minimal exception (11% sites). Moreover, many studies comparing regenerative procedures with spontaneous healing of sockets after extraction of M3 in young adults have reported clinically (≤2 mm) and statistically insignificant differences (33,27). However, a small benefit can be derived from the use of such regenerative interventions where the bone defect is associated with deeper mesioangular or horizontal IMP. Therefore, use of regenerative procedures such as GTR, PRP etc. should be limited to deep bone defects with severe loss of CAL of the M2, mainly in mesioangular and horizontal IMP.

Although patients had experienced discomfort during the first 5-7days after M3 extraction chemical plaque control using 0.12% Chlorhexidine Gluconate enabled efficient oral hygiene maintenance. No severe post-operative complications were reported and majority (around 88%) could perceive the benefit from the extraction of the M3. However, 16% of patients felt that the procedure was traumatic, 12% complained of sensitivity and food impaction at the extraction site due to the occurrence of gingival recession and bone defects. Careful surgical extraction with minimal trauma is essential for periodontal healing of the tissues and better patient perception.

No attempt for regeneration of bone defects was made therefore; further long term studies and randomized controlled trials using regenerative materials and different flap designs to prevent the development of alveolar bone defects and damage to the marginal soft tissue around the M2.

Conclusion

Extraction of impacted M3 proved to be beneficial to the periodontal status of the adjacent M2.Largely, the alveolar bone height improved, however sites with deeper mesioangular and horizontal impactions are at greater risk of developing alveolar bone defect postoperatively.

Türkçe özet: *Gömülü mandibular üçüncü molarların çekilmesinden sonra mandibular ikinci moların periodontal durumu- prospektif bir klinik çalışma Amaç: Mandibular üçüncü molar (M3) çekimi yaygın olarak gerçekleştirilen cerrahi işlemlerdir; ancak komplikasyonlardan biri komşu ikinci azı dişlerinde (M2) periodontal hastalık gelişmesidir. Dolayısıyla bu çalışmanın amacı, M3 ekstraksiyonunun M2'nin periodontal durumu üzerindeki etkisini değerlendirmektir. Gereç ve yöntem: Çalışma, gömülü M3'e bitişik mandibular M2'ye sahip 120 alanı içeriyordu. M3'ün cerrahi olarak çıkarılmasından önce ve 9-12 ay sonra plak indeksi (PI), dişeti indeksi (GI), sondalama cep derinlikleri (PD), klinik ataşman seviyeleri (CAL), dişeti çekilmesi (GR) ve alveolar kemik yüksekliği (ABH) belirlendi. değerlendirildi. Hasta algısı, ikili derecelendirme kullanılarak değerlendirildi. Gömüklük derecesi, flep tasarımı, kemik kaldırılması, diş kesiti gibi değişkenlerle birlikte dört tip gömük diş (IMP) çalışmaya dahil edildi. Bulgular: Başlangıçta mezioangular ve yatay IMP daha yüksek PPD ve CAL gösterdi. M3'ün ekstraksiyonundan sonra PPD ve CAL'de önemli bir düşüş oldu. Vakaların %14'ü M2'nin distobukkalinde dişeti çekilmesinde önemli artış gösterdi. Hastaların %10,9'unda M2'nin distalinde alveolar kemik defekti (ABD) olmasına rağmen, ABH'de başlangıca göre önemli bir iyileşme belirlendi. ABD'ler çoğunlukla mezioangular ve yatay IMP ile ilişkili bulundu. Sonuç: Etkilenen M3'ün çıkarılmasının M2'nin periodontal durumu üzerinde faydalı olduğu kanıtlanmıştır. Bununla birlikte, bazen, mezioangular ve yatay IMP'nin M2'nin distalinde ABD geliştirmesi muhtemeldir ve bu nedenle ABD oluşumunu önlemek için rejeneratif prosedürler takip edilebilir. Anahtar kelimeler: alveolar kemik defekti, gömülü diş, mandibular üçüncü molar, mandibular ikinci molar, diş çekimi*

Ethics Committee Approval: This was a prospective clinical trial conducted at Vishnu Dental College, in accordance with Helsinki Declaration and Good Clinical Practice guidelines after obtaining ethical clearance (IEC No: IEC/VDC/MDS15 PERIO 04).

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: SS, SNVSG, CDD participated in designing the study. SS, KSVR, GSP participated in generating the data for the study. SS, VB participated in gathering the data for the study. SS, SNVSG, KSVR participated in the analysis of the data. SS, CDD wrote the majority of the original draft of the paper. SS, SNVSG, GSP, CDD participated in writing the paper. SS, KSVR, GSP, VB have had access to all of the raw data of the study. SS, SNVSG, KSVR, CDD have reviewed the pertinent raw data on which the results and conclusions of this study are based. SS, SNVSG, KSVR, GSP, CDD, VB have approved the final version of this paper. SS, SNVSG, KSVR guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Lima CJ, Silva LC, Melo MR, Santos JA, Santos TS. Evaluation of the agreement by examiners according to classifications of M3. Med Oral Patol Oral Cir Bucal 2012;17:281–316. [CrossRef]
2. Lieblich SE, Dym H, Fenton D. Dentoalveolar Surgery. J Oral Maxillofac Surg 2017;75:50-73. [CrossRef]
3. Santosh P. Impacted Mandibular third molars: Review of Literature and a Proposal of a Combined Clinical and Radiological Classification. Ann Med Health Sci Res 2015;5:229-34. [CrossRef]
4. Zhang Y, Chen X, Zhou Z, Hao Y, Li H, Cheng Y, Ren X, Wang X. Effects of Impacted Lower third molarextraction on Periodontal Tissue of the Adjacent M2. Ther Clin Risk Manag 2021;17:235-247. [CrossRef]
5. Lytle JJ. Etiology and indications for the management of impacted teeth. Northwest Dent 1995;74:23–32.
6. Blakey GH, Marciani RD, Haug RH, Phillips C, Offenbacher S, Pabla T, et al. Periodontal pathology associated with asymptomatic M3. J Oral Maxillofac Surg 2002;60:1227–33. [CrossRef]
7. Petsos H, Korte J, Eickholz P, Hoffmann T, Borchard R. Surgical removal of third molars and periodontal tissues of adjacent second molars. J Clin Periodontol 2016;43:453–60. [CrossRef]
8. Coleman M, McCormick A, Laskin DM. The incidence of periodontal defects distal to the maxillary second molar after impacted third molar extraction. J Oral Maxillofac Surg 2011;69:319–21. [CrossRef]
9. Dodson TB. Management of mandibular third molar extraction sites to prevent periodontal defects. J Oral Maxillofac Surg 2004;62:1213–24. [CrossRef]
10. Sammartino G, Tia M, Bucci T, Wang HL. Prevention of Mandibular third molar Extraction-Associated Periodontal Defects: A Comparative Study. J Periodontol 2009;80:389-96. [CrossRef]
11. Kan KW, Liu JK, Lo E, Corbet EF, Leung WK. Residual periodontal defects distal to the mandibular second molar 6–36 months after impacted third molar extraction. J Clin Periodontol 2002;29:1004-11. [CrossRef]
12. Kugelberg CF, Ahlstro¨m U, Ericson A, Hugoson A, Kvint S. Periodontal healing after impacted lower third molar surgery in adolescents and adults. A prospective study. Int J Oral Maxillofac Surg 1991;20:18–24. [CrossRef]
13. Krausz AA, Machtei EE, Peled M. Effects of lower third molar extraction on attachment level and alveolar bone height of the adjacent second molar. Int J Oral MaxillofacSurg 2005;34:756–60. [CrossRef]
14. Silness J, Loe H. Periodontal disease in pregnancy. Ii. Correlation between oral hygiene and periodontal condition. Acta OdontolScand 1964;22:121–35. [CrossRef]
15. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. Acta OdontolScand 1963;21:533–51. [CrossRef]
16. Montero J, Mazzaglia G. Effect of removing an impacted mandibular third molar on the periodontal status of the mandibular second molar. J Oral MaxillofacSurg 2011;69:2691–97. [CrossRef]
17. White RP, Jr, Fisher EL, Phillips C, Tucker M, Moss KL, Offenbacher S. Visible third molar as risk indicator for increased periodontal probing depth. J Oral MaxillofacSurg 2011;69:92–103. [CrossRef]
18. Stephens RJ, App GR, Foreman DW. Periodontal evaluation of two mucoperiosteal flaps used in removing impacted mandibular third molar. J Oral MaxillofacSurg 1983;41:719–24. [CrossRef]
19. Ash MM. M3 as periodontal problems. Dent Clin North Am 1964;45: 51–61. [CrossRef]
20. Chin Quee TA, Gosselin D, Millar EP, Stamm JW. Surgical removal of the fully impacted mandibular third molar. The influence of flap design and alveolar bone height on the periodontal status of the second molar. J Periodontol 1985;56:625–30. [CrossRef]
21. Archer W. Oral and maxillofacial surgery. Philadelphia: Saunders; 1975.
22. Faria AI, Gallas-Torreira M, Lopez-Raton M. Mandibular second molar periodontal healing after impacted third molar extraction in young adults. J Oral MaxillofacSurg 2012;70:2732–2741. [CrossRef]
23. Ylipaavalniemi P, Turtola L, Rytomaa I, Helminen S, Jauhiainen L. Effect of position of wisdom teeth on the visible plaque index and gingival bleeding index. Proc Finn Dent Soc 1982;78:47–9.
24. Giglio JA, Gunsolley JC, Laskin DM, Short K. Effect of removing third molar on plaque and gingival indices. *J Oral MaxillofacSurg* 1994;52:584–87. [CrossRef]
25. Kruger GO. Oral & Maxillofacial Surgery. St Louis (MO): Mosby; 1984.
26. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. J Periodontol 1996;67:93–102. [CrossRef]
27. Dodson TB. Is there a role for reconstructive techniques to prevent periodontal defects after third molar surgery? J Oral MaxillofacSurg 2005;63:891–96. [CrossRef]
28. Peng KY, Tseng YC, Shen EC, Chiu SC, Fu E, Huang YW. Mandibular second molar periodontal status after third molar extraction. J Periodontol 2001;72:1647-51. [CrossRef]
29. Prósper AA, Mira GB, Morón LC, Diago PM. Distal probing depth and attachment level of lower second molar following surgical extraction of lower third molar: a literature review. Med Oral Patol Oral Cir Bucal 2010;15:755-59. [CrossRef]
30. Faria AI, Gallas-Torreira M, López-Ratón M, Crespo-Vázquez E, Rodríguez-Núñez I, López-Castro G. Radiological infrabony defects after impacted mandibular third molar extractions in young adults. J Oral Maxillofac Surg 2013;71:2020-28. [CrossRef]
31. Kugelberg CF, Ahlstrom U, Ericson S, Hugoson A, Kvint S. Periodontal healing after impacted lower third molar surgery in adolescents and adults. A prospective study. Int J Oral Maxillofac Surg 1991a;20:18–24. [CrossRef]
32. Aniko-Włodarczyk M, Jaroń A, Preuss O, Grzywacz A, Trybek G. Evaluation of the Effect of Surgical Extraction of an Impacted Mandibular third molar on the Periodontal Status of the second molar -Prospective Study. J Clin Med 2021 16;10:2655. [CrossRef]
33. Passarelli, PC, Lajolo, C, Pasquantonio, G, et al. Influence of mandibular third molar surgical extraction on the periodontal status of adjacent second molar. J Periodontol 2019; 90: 847– 855. [CrossRef]

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 117-123

Original research

The effects of resin infiltration on demineralized root surface: An experimental study

Uzay Koc Vural[1], **Ayfer Ezgi Yılmaz**[2], **Zeynep Bagdatli**[1], **Sevil Gurgan**[1]

Purpose
The objective of this experimental invitro study was to investigate the effects of resin infiltration (RI) on surface roughness, microhardness, color and surface characteristics of artificially demineralized root surfaces.

Materials and Methods
Forty-two root specimens prepared from freshly extracted intact human upper incisors were subjected to surface roughness, microhardness, and color tests. Profilometer was used to measure surface roughness and Vicker's Hardness tester was used to measure the changes in microhardness. The color measurements were performed by a spectrophotometer using the CIELAB parameters. Following measurements, specimens were divided into 3 groups (n=14): G1: intact root surfaces, G2: demineralized root surfaces and G3: Resin infiltrated root surfaces (Icon, DMG) following demineralization. Surface roughness, microhardness and color measurements were repeated in G2 and G3 after demineralization and RI. One specimen from each group was examined by SEM. Data were analyzed statistically ($p<0.05$).

Results
Application of RI to artificially demineralized root surfaces significantly decreased the surface roughness ($p<0.001$) and increased the microhardness ($p=0.023$). RI also affected the color of demineralized root surfaces. SEM examinations revealed that the porosities on demineralized root surfaces seemed to be sealed after RI.

Conclusion
RI affected the surface roughness, microhardness, color and surface appearance of artificially demineralized root surfaces.

Keywords: *Resin infiltration, root surface caries, microhardness of root surface, roughness of root surface, color of root surface*

Introduction

Root caries is a global public health issue, causing the breakdown of remaining natural and restored teeth, especially in elderly patients (1, 2). Gingival recession because of periodontal disease, xerostomia as well as traumatic tooth-brushing habits increase the susceptibility of root caries as the thin cementum can be easily removed. In addition, due to reduced salivary flow in elderly patients, biofilm and plaque accumulation increase easily and also act as risk factors for root caries formation (3). Moreover, due to the lower mineral content of cementum, demineralization rapidly occurs on even at higher pH values compared to enamel and dentin (4).

In the management of root caries lesions, the main treatment principle is firstly to prevent the caries formation by reducing the caries risk factors and diagnose the caries lesions in the early phase when formed, thereby, reducing the need for more invasive treatments. In this regard, several approaches have been beneficial such as preventive measures, mainly reha-

ORCID IDs of the authors: U.K.V. 0000-0002-8764-2174; A.E.Y. 0000-0002-6214-8014; Z.B. 0000-0001-5421-4184; S.G. 0000-0002-0408-8949

[1]Department of Restorative Dentistry, Faculty of Dentistry, Hacettepe University, Ankara, Turkiye

[2]Department of Statistics, Hacettepe University, Ankara, Turkiye

Corresponding Author: Uzay Koc Vural

E-mail: uzay.koc@hacettepe.edu.tr

Received: 4 June 2021
Revised: 15 December 2021
Accepted: 22 December 2021

DOI: 10.26650/eor.2022948009

How to cite: *Koc Vural U, Yilmaz AE, Bagdatli Z, Gurgan S. Effects of resin infiltration on demineralized root surface: An experimental study. Eur Oral Res 2022; 56(3): 117-123. DOI: 10.26650/eor.2022948009*

bilitation of oral hygiene, as well as the topical application of remineralizative antimicrobial agents and resin sealers (5, 6). However, in case restorative treatment is required, the least invasive methods should be chosen (7).

Low-viscosity resin infiltration (RI) into the porosities of initial caries lesion is a relatively new treatment modality for the early enamel caries lesions (8, 9). In this technique, resin monomers can penetrate into the initial lesions up to 34–58 µm in depth, after hypermineralized enamel is removed with 15% hydrochloric acid for 2 min. The unique caries-inhibiting effect of RI is based on the occlusion of the spaces within the body of the lesion. RI only requires one visit and mechanically stabilize the fragile lesion structure (10-13).

It has been shown that the coating of root surfaces with a resin-based material, which has the capacity of release and recharge the fluoride ions was effective in the protection of the root surfaces against demineralization (6).

Various experimental and in vivo studies have reported that RI inhibits the progression of early carious lesions of enamel and increasingly recommended it for clinical use (11-14). However, the effect of RI on initial root surface lesions has not been investigated. Therefore, the purpose of this in vitro experimental study was to examine the effects of RI on artificially demineralized root surface lesions in terms of surface roughness, microhardness, and color. The null hypotheses were that; RI application would not change neither of the surface roughness, microhardness nor the color of artificially demineralized root surfaces

Material and Methods

Ethical statement

The study protocol was approved by the non-interventional clinical researches ethics boards of the university.

Sample size determination

The power of the sample size was calculated by a flexible statistical power analysis program for the social, behavioral, and biomedical sciences (G*Power, version 3.1, Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) with a 95% confidence interval, and 80% power, and 0.50 effect size values for n=42 (14 in each group) according to one-way ANOVA-type power analysis (15, 16).

Specimen preparation

Forty-two intact human permanent maxillary incisors extracted due to the periodontal reasons in the last 6 months were used in the study. Teeth having roots without any other defects were included after cleaning from soft tissues using slurry of pumice and stored in 0.1% thymol solution to avoid bacterial growth. Root surfaces of the teeth were examined by a stereomicroscope (American Optical, Buffalo, NY, USA) at ×40 magnification and then the roots were cut 1 mm below from the cemento-enamel junction using a diamond saw at low speed (Isomet 2000, Buehler Ltd., Lake Bluff, IL, USA) under water coolant and embedded in acrylic resin (Vertex, Vertex-Dental B.V, Soesterberg, Netherlands) facing the buccal surfaces upward. The root specimens were ground flattened using 2400-, and 4000- grid silicon carbide papers to obtain standardized and well-polished surfaces. The root surfaces were re-examined under the stereomicroscope to ensure cementum was not removed. After the specimens were ultrasonically cleaned in distilled water for 2 min, they were partly coated with a nail varnish resistant to acidic challenge, leaving a window of 4 × 4 mm on the cementum.

The polished root specimens (n=42) were subjected to surface roughness, microhardness and color tests. Surface roughness was measured by a contact type profilometer (Perthometer M2, Mahr, Gottingen, Germany), microhardness was measured by Vicker's hardness tester (Microhardness Tester, Shimadzu, Kyoto, Japan), and color readings were obtained by a spectrophotometer (VITA Easyshade, Advance, Zahnfabrik, Bad Säckingen, Germany).

Surface Roughness (Ra, mm) measurement

Surface roughness was detected via a contact- type profilometer with a stylus. After placing the specimens on a flat surface, the needle of the device was put on the root specimen surface, and recordings were done. Five Ra measurements were taken from each specimen within the measuring length and an arithmetic mean value was calculated. After each 5 specimens, the device was calibrated to ensure reliable readings.

Surface microhardness (VHN) measurement

Microhardness of each specimen was measured with a microhardness tester using a 980 g load with a 20 s dwell time. VHN was calculated by making five indentations on the center of each specimen and 0.5 mm apart from each other. The arithmetic mean value was calculated from each specimen for the statistical analysis. After measurement of each specimen, the device was calibrated.

Color measurement

Color of each specimen was measured by a dental spectrophotometer against a white background. Shade of each specimen was detected based on L*, a*, and b* values, in which L* is the value of 0 (black) to 100 (white), a* is the amount of red and green, and b* is the amount of yellow and blue. Color change was calculated via the following formula (17):

$$\Delta E=[(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{1/2}$$

Calibration of the device was performed after 5 readings by the ceramic reflectance standard calibration block of the device.

Study groups

After surface roughness, microhardness and color measurements, the specimens were randomly allocated into 3 groups: G1 (n=14) (Negative control): Intact root surfaces were stored in artificial saliva throughout the study which was replaced with fresh artificial saliva every day. Artificial saliva was prepared according to the formula described by

of Gohring *et al.*(18). The pH was arranged 7.4 - 7.8 throughout the experimental period to avoid dehydration. G2 (n = 14) (Positive control with demineralised root surfaces): Demineralization of root surfaces were generated according to the protocol of Ten Cate and Duijsters (19, 20). The entire specimen bodies were immersed in a buffer solution in disposable container containing demineralizing solution for 72 hr at room temperature (23+1 °C). The pH was monitored daily. After 72 hours, the specimens were cleaned in distilled water approximately for 1 min and dried with mild-air for 5 min. The demineralized root surfaces were evaluated under the stereomicroscope. G3 (n = 14): In this group, RI (Icon Resin Infiltration; DMG, Hamburg, Germany) was applied to the root surfaces following demineralization using the same protocol in G2. The manufacturer's instructions were strictly followed to perform RI. First, the dried root surface was etched with Icon-etch (hydrochloric acid) for 120s, and then rinsed for 30 s. After, Icon-dry was used for 30 s for dehydration, Icon-Resin infiltrant was gently applied on the specimen with an applicator tip and left undisturbed for 3 min. Then a gentle air was blown, and light-irradiated for 40 s by LED curing unite (Translux Power Blue, a wavelength of 460–470 nm and a light output of 600–1,550 mW/cm^2, Kulzer GmbH, Hanau, Germany). Icon-Resin infiltrant was applied again for an extra 1 min and light-irradiated for 40 s. Finally, 4000- grit, aluminum oxide impregnated abrasive paper was used for polishing of the specimen surface.

The surface roughness, microhardness and color measurements were repeated for G2 and G3 specimens.

Scanning electronic microscopy (SEM) analysis

One representative specimen from each group was mounted on aluminum stubs, sputter-coated and submitted to SEM analysis (JSM-6400, JEOL, Tokyo, Japan). Images were obtained at ×50, ×100, and ×200 magnifications.

Statistical analysis

Normality was evaluated by Shapiro Wilk test. Test of homogeneity of variances was performed by Levene's test. Intragroup comparisons were performed by one-way ANOVA, followed by Tukey HSD multiple comparisons test. When the assumption of homogeneity of the variance was not met, Welch test as an alternative to one-way ANOVA and Games-Howell test as an alternative to Tukey's HSD test was conducted. One-way repeated-measures ANOVA was used to compare the color changes of the groups followed by Sidak's multiple comparison test. P<0.05 was considered as significant.

Results

Table 1 presents mean, median, SD and min-max Ra of the groups. Shapiro Wilk test revealed that the data was normally distributed and Levene's test indicated non-homogeneity of variances p<0.05). Significant differences were revealed among the groups (p<0.001) by Welch test. The highest Ra was observed in G2, which the specimens were demineralized, while the lowest Ra was observed in G1. Welch test showed that, application of RI significantly decreased the Ra of demineralized root surfaces (p<0.001) but did not reach to the Ra of intact root surfaces (Table 1).

Table 2 presents mean, median, SD and min-max VHN of the groups. Shapiro-Wilk test showed that the data was normally distributed and Levene's test concluded the homogeneity of variances. One-way ANOVA test showed that there were also significant differences among the groups (p<0.001). Highest VHN was observed in G1, while the lowest was observed in G2. RI increased the VHN values but did not reach to the VHN of intact root surface (Table 2).

Shapiro Wilk test showed the data was normally distributed and Mauchly's Test of Sphericity indicated that the assumption of sphericity was met (p>0.05). The highest ΔE was calculated after demineralization of intact root surfaces. According to the one-way repeated measures ANOVA, there were statistically significant differences among the ΔE of the three groups (p=0.029).

The SEM images of intact, demineralized and RI applied root surfaces are demonstrated in Figure 1, Figure 2 and Figure 3. Photomicrographs of representative groups were taken at x50, x100 and x200 magnifications. Figure 1a,1b and 1c illustrate the intact root surfaces. Micrographs seemed to have smooth root surfaces. No morphological changes were detected at different magnifications. Only some scratches were seen on the surfaces. Figure 2a, 2b and 2c illustrate demineralized root surfaces at x50, x100 and x200 magnifications. Demineralized root surfaces with irregular appearances were detected. Figure 3a, 3b and 3c illustrate RI applied root surfaces. At different magnifications, it was seen that RI application to the demineralized root surfaces seemed to seal the root surface porosities resulting the surfaces appeared smoother. Table 3 presents color change (ΔE) of the groups.

Table 1: *Mean, SD, median, and min-max of surface roughness (Ra, µm) of the groups.*

	Mean (SD)	Median	Min - Max	p*
Intact root surface	0.192 (0.049) [a]	0.182	[0.141 – 0.324]	<0.001
Demineralized root surface	0.67 (0.056) [b]	0.674	[0.569 – 0.773]	
Resin infiltrated root surface	0.322 (0.085) [c]	0.320	[0.201 – 0.447]	

* Welch test (p<0.05). Different letters denote statistically significant differences

Table 2: *Mean, SD, median, and min-max of surface microhardness (VHN) of the groups.*

	Mean (SD)	Median	Min - Max	p*
Intact root surface	65.22 (5.25) [a]	65.80	[56.70 – 73.80]	<0.001
Demineralized root surface	37.87 (4.14) [b]	37.74	[28.39 – 43.64]	
Resin infiltrated root surface	54.91 (3.72) [c]	55.15	[49.30 –59.64]	

* One-way ANOVA test (p<0.05). Different letters denote statistically significant differences

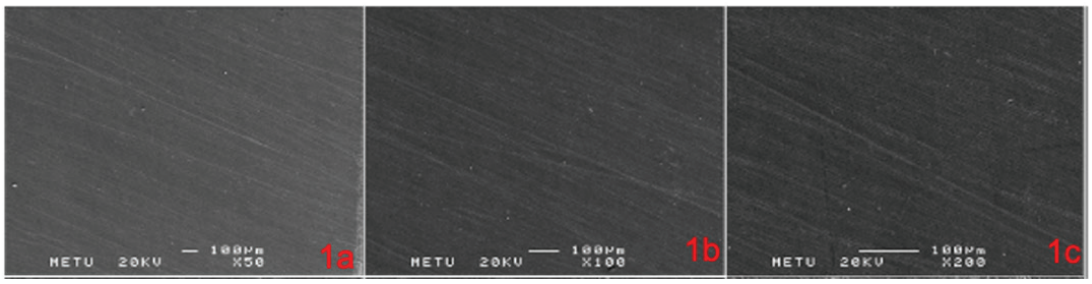

Figure 1. *SEM images of intact root surfaces.*
×50 (1a), ×100 (1b), ×200 (1c) magnifications

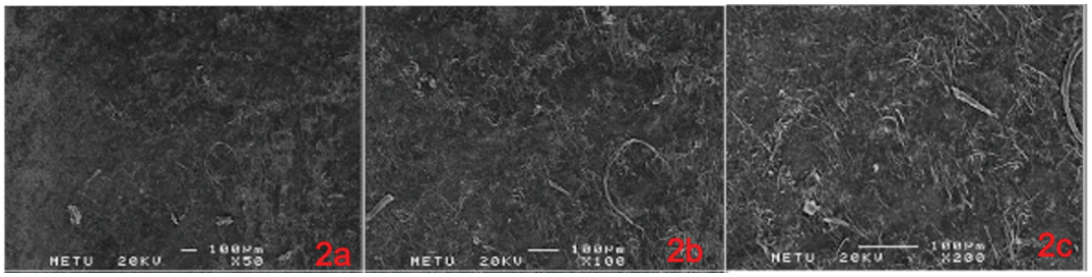

Figure 2. *SEM images of demineralized root surfaces.*
×50 (1a), ×100 (1b), ×200 (1c) magnifications

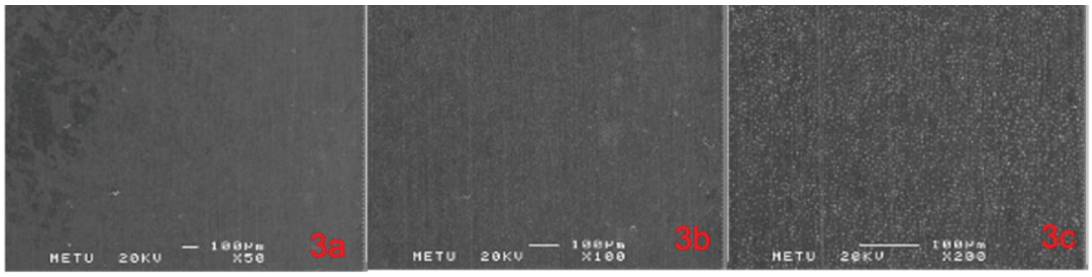

Figure 3. *SEM images of resin infiltrated root surfaces.*
×50 (1a), ×100 (1b), ×200 (1c) magnifications

Table 3: *ΔL, Δa , Δb, and calculated ΔE of the groups.*

Pairs	ΔL Mean (SD)	Δa Mean (SD)	Δb Mean (SD)	ΔE Mean (SD)	p*
Intact root surface - Demineralized root surface	9.46 (7.64)	-1.79 (1.40)	-8.33 (5.55)	14.11 (7.01) [a]	0.029
Demineralized root surface - Resin infiltrated root surface	7.91 (7.82)	0.47 (1.31)	-3.96 (7.38)	12.61 (5.56) [b]	
Intact root surface - Resin infiltrated root surface	-1.55 (7.86)	1.48 (1.35)	4.37 (6.08)	9.58 (5.25) [c]	

*One-way repeated measures ANOVA test ($p<0.05$). Different letters denote statistically significant differences

Discussion

Considering the prolonged lifetime in today's conditions, as the proportion of dentate elderly population is getting higher, the prevalence of root caries has been also increased. So, preventive and arrestive applications on root caries is crucial, especially to sustain the functional occlusion for better quality of life of elderly.

To inhibit lesion progression initiated on root surface, coating of the lesion surface with an adhesive material was recommended in several studies (21-23). Although promising results showing reduced severity of root surface lesions after coating, coating with adhesives was unable to fully resist the demineralization induced by acid attack (6). One reason for this phenomenon may be that the coating thickness of the adhesives was too thin to act as a substantive physical barrier against demineralization (22).

Recently, a resinous coating material with pre-reacted glass-ionomer fillers was investigated for the prevention of root caries. Ma *et al.* (6) examined the ability of this coating for protecting the root surface from further demineralization and reported that this pre-reacted glass-ionomer coating resin could be an effective material for protecting root surface from both chemical and biological challenges.

Resin infiltration (RI) was developed for the management of smooth surface and proximal non-cavitated caries lesions

in which the porosities of enamel lesion are infiltrated with a low viscosity resin, creating a diffusion barrier within the lesion without establishing any material on the enamel surface delaying the time for restoration placement (13, 14, 24, 25). However, to the extent of the authors' knowledge, up to date only one study focused on the use of this technique on initial root surface lesions (26). In this study, Zhou *et al.* (26) evaluated the penetration of RI on root caries induced by Streptococcus mutans biofilms by fluorescent microscope, swept-source optical coherence tomography and confocal laser scanning microscope. They reported that RI had a good penetration ability and preventive effect on root caries. However, an additional risk factor of cervical enamel loss was identified.

In the present experimental in vitro study, the effect of RI on the surface roughness, microhardness and color of artificially demineralized root surfaces were investigated. As there have been no other studies conducted on this topic, the results of the present study were discussed with the effects of RI on early enamel demineralization.

Physicochemical properties of a material and tooth surfaces including surface roughness carries great importance since rough surfaces accommodate retention areas for both in vitro and in situ biofilm formation and so caries development (8).

It has been previously stated that the surface of RI applied enamel lesions may remain irregular even after finishing and polishing procedures (27). Inadequate RI to demineralized surfaces, the polymerization shrinkage and / or the interference of ethanol in the polymerization can play an important role (28, 29). Another factor may be the hydrochloric acid used for etching protocol. It was reported that, etching with 15% hydrochloric acid produced grooves and cracks in enamel (30). Considering the higher organic content and vulnerable structure of root surface to the acidic challenges, it was thought that hydrochloric acid, as a strong acidic agent, increased the surface roughness of root surfaces in the present study compared to intact root surfaces. However, application of RI to demineralized root surfaces resulted in significantly lower surface roughness values. This may probably be due to the resin, infiltrated into the demineralized root surfaces. Therefore, the first null hypothesis was rejected. Under clinical conditions, the surface roughness may show variations after etching compared to the obtained in vitro results considering the dynamic nature of the oral cavity. Thus, this aspect requires further research before making any clinical recommendations on root surface etching procedures.

The microhardness of resin infiltrated surfaces has been reported to be affected by the demineralization level of the surface, RI depth and the chemical composition of infiltrating resin agent (31, 32). The used resin monomers, such as TEGDMA-based resins, could increase the elasticity of the surface (33). For this reason, the results should be cautiously interpreted since, after indentation, elastic deformation may interfere the results, as previously shown in the comparison of micro- and nano- indentation procedures (34). In the present study, RI treated root surface lesions showed significantly higher microhardness values than the deminerized root surfaces. So, the second null hypothesis, regarding RI application would not change the microhardness of root surface lesions was rejected. This shows the penetration ability of the low-viscosity resin with high penetration coefficient for filling the pores within the remained crystal structures of the lesion and rehardening facility of the demineralized tissue. This result was also conformed with the SEM images in the current study. The images showed that, porosities on demineralized root surfaces seemed to be mostly sealed.

RI technique has been shown to mask white spot lesions of enamel (14, 35, 36). In this experimental study, the application of RI to the root surfaces resulted in a significant color change. Therefore, it has also a positive effect in masking the demineralization of root surfaces. This may be due to the fact that micro porosities of resin infiltrated demineralized root surfaces were filled with resin infiltrant instead of water and/or air. So, the third null hypothesis was also rejected.

The results of this study differ from the in vitro studies that have been performed already on enamel. It is important that the pretreatment with 15% hydrochloric acid has the potential of damaging susceptible cervical parts of the vital teeth structures. So, it should not be ignored. However, when this strong acid contacts soft tissues it has been shown to be harmless (37).

According to results of the current study, resin infiltration can be considered as an effective application option for the restoration of artificially demineralized root surfaces owing to its penetration ability, provision of better surface characteristics including microhardness and surface roughness, and recovering of color. Thus, Resin Infiltration is an effective microinvasive technique that seem better suited to treat artificially demineralized root surfaces.

Conclusion

Within the limitations of this experimental in-vitro study, it can be concluded that resin infiltration of the artificially demineralized root surfaces decreased the surface roughness and increased the micro hardness, additionally affected the color stability.

Türkçe öz: *Rezin infiltrasyonunun demineralize kök yüzeyi üzerine etkileri: Deneysel bir çalışma Amaç: Bu deneysel invitro çalışmanın amacı, rezin infiltrasyonunun (RI) yapay olarak demineralize edilmiş kök yüzeylerinin yüzey pürüzlülüğü, mikrosertliği, rengi ve yüzey özellikleri üzerindeki etkilerini araştırmaktır. Gereç ve yöntem: Yeni çekilmiş sağlam insan üst keser dişlerinden hazırlanan kırk iki kök örneği, yüzey pürüzlülüğü, mikrosertlik ve renk testlerine tabi tutuldu. Yüzey pürüzlülüğünü ölçmek için profilometre ve mikrosertlikteki değişiklikleri ölçmek için Vicker's Hardness test cihazı kullanıldı. Renk ölçümleri, CIELAB parametreleri kullanılarak bir spektrofotometre ile gerçekleştirildi. Ölçümlerin ardından örnekler 3 gruba ayrıldı (n=14): G1: sağlam kök yüzeyleri, G2: demineralize kök yüzeyleri ve G3: Rezin infiltre edilmiş kök yüzeyleri (Icon, DMG). Demineralizasyon ve RI sonrası G2 ve G3 örneklerinin yüzey pürüzlülüğü, mikrosertlik ve renk ölçümleri tekrarlandı. Her gruptan birer örneğin yüzeyleri SEM ile incelendi. Veriler istatistiksel olarak analiz edildi ($p<0.05$). Bulgular: Yapay olarak demineralize edilmiş kök yüzeylerine RI uygulaması, yüzey pürüzlülüğünü önemli ölçüde azalttı ($p<0,001$) ve mikrosertliği artırdı ($p=0,023$). RI, demineralize kök yüzeylerinin rengini de etkiledi. SEM incelemelerinde, demineralize kök yüzeylerindeki pörözitelerin RI'den sonra örtülendiği görüldü. Sonuç: RI, yapay olarak demineralize edilmiş kök yüzeylerinin yüzey pürüzlülüğünü, mikrosertliğini, rengini ve yüzey görünümünü etkiledi. Anahtar kelimeler: Rezin infiltrasyon; kök yüzeyi çürükleri; kök yüzeyinin mikrosertliği; kök yüzeyinin pürüzlülüğü; kök yüzeyinin rengi.*

Ethics Committee Approval: The study protocol was approved by the non-interventional clinical researches ethics boards of the university.

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: UKV, AEY, ZB, SG participated in designing the study. UKV, AEY, ZB, SG participated in generating the data for the study. UKV, AEY, ZB, SG participated in gathering the data for the study. UKV, AEY, ZB, SG participated in the analysis of the data. UKV, AEY, ZB, SG wrote the majority of the original draft of the paper. UKV, AEY, ZB, SG participated in writing the paper. UKV, AEY, ZB, SG have had access to all of the raw data of the study. UKV, AEY, ZB, SG have reviewed the pertinent raw data on which the results and conclusions of this study are based. UKV, AEY, ZB, SG have approved the final version of this paper. UKV, AEY, ZB, SG guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict on interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Arthur RA, Martins VB, de Oliveira CL, Leitune VC, Collares FM, Magalhaes AC, et al. Effect of over-the-counter fluoridated products regimens on root caries inhibition. Arch Oral Biol 2015;60:1588-94. [CrossRef]
2. Griffin SO, Griffin PM, Swann JL, Zlobin N. Estimating rates of new root caries in older adults. J Dent Res 2004;83:634-8. [CrossRef]
3. Banting DW, Papas A, Clark DC, Proskin HM, Schultz M, Perry R. The effectiveness of 10% chlorhexidine varnish treatment on dental caries incidence in adults with dry mouth. Gerodontology 2000;17:67-76. [CrossRef]
4. Burgess JO, Gallo JR. Treating root-surface caries. Dent Clin North Am 2002;46:385-404. [CrossRef]
5. Rolland SL, Walls AW, McCabe JF, German MJ. Use of micro-Raman spectroscopy to investigate hybrid layer quality in demineralized root dentine. J Biomed Mater Res B Appl Biomater 2010;95:62-8. [CrossRef]
6. Ma S, Imazato S, Chen JH, Mayanagi G, Takahashi N, Ishimoto T, et al. Effects of a coating resin containing S-PRG filler to prevent demineralization of root surfaces. Dent Mater J 2012;31:909-15. [CrossRef]
7. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries - a review: report of a FDI task group. Int Dent J 2012;62:223-43. [CrossRef]
8. Paris S, Meyer-Lueckel H, Mueller J, Hummel M, Kielbassa AM. Progression of sealed initial bovine enamel lesions under demineralizing conditions in vitro. Caries Res 2006;40:124-9. [CrossRef]
9. Paris S, Meyer-Lueckel H, Kielbassa AM. Resin infiltration of natural caries lesions. J Dent Res 2007;86:662-6. [CrossRef]
10. Meyer-Lueckel H, Paris S, Kielbassa AM. Surface layer erosion of natural caries lesions with phosphoric and hydrochloric acid gels in preparation for resin infiltration. Caries Res 2007;41:223-30. [CrossRef]
11. Altarabulsi MB, Alkilzy M, Splieth CH. Clinical applicability of resin infiltration for proximal caries. Quintessence Int 2013;44:97-104.
12. Paris S, Bitter K, Naumann M, Dorfer CE, Meyer-Lueckel H. Resin infiltration of proximal caries lesions differing in ICDAS codes. Eur J Oral Sci 2011;119(2):182-6. [CrossRef]
13. Paris S, Meyer-Lueckel H. Inhibition of caries progression by resin infiltration in situ. Caries Res 2010;44:47-54. [CrossRef]
14. Gugnani N, Pandit IK, Gupta M, Josan R. Caries infiltration of noncavitated white spot lesions: A novel approach for immediate esthetic improvement. Contemp Clin Dent 2012;3:S199-202. [CrossRef]
15. Rodrigues CS, Nora BD, Mallmann A, May LG, Jacques LB. Repolishing Resin Composites After Bleaching Treatments: Effects on Color Stability and Smoothness. Oper Dent 2019;44:54-64. [CrossRef]
16. Torres C, Zanatta RF, Silva TJ, Borges AB. Effect of Calcium and Fluoride Addition to Hydrogen Peroxide Bleaching Gel On Tooth Diffusion, Color, and Microhardness. Oper Dent 2019;44:424-32. [CrossRef]
17. (CIE) CIdLE. Recommendations on Uniform Colour Spaces, Colour-Difference Equations, Psychometric Colour Terms 1978.
18. Gohring TN, Zehnder M, Sener B, Schmidlin PR. In vitro microleakage of adhesive-sealed dentin with lactic acid and saliva exposure: a radio-isotope analysis. J Dent 2004;32:235-40. [CrossRef]
19. ten Cate JM, Duijsters PP. Influence of fluoride in solution on tooth demineralization. II. Microradiographic data. Caries Res 1983;17:513-9. [CrossRef]
20. ten Cate JM, Duijsters PP. Influence of fluoride in solution on tooth demineralization. I. Chemical data. Caries Res 1983;17:193-9. [CrossRef]
21. Walter R, Duarte WR, Pereira PN, Swift EJ, Jr., Heymann HO, Arnold RR. Effect of resin adhesive systems on root caries formation in vitro. Quintessence Int 2008;39:33-7.
22. Kaneshiro AV, Imazato S, Ebisu S, Tanaka S, Tanaka Y, Sano H. Effects of a self-etching resin coating system to prevent demineralization of root surfaces. Dent Mater 2008;24:1420-7. [CrossRef]
23. Gernhardt CR, Koravu T, Gerlach R, Schaller HG. The influence of dentin adhesives on the demineralization of irradiated and non-irradiated human root dentin. Oper Dent 2004;29:454-61.
24. Kielbassa AM, Ulrich I, Schmidl R, Schuller C, Frank W, Werth VD. Resin infiltration of deproteinised natural occlusal subsurface lesions improves initial quality of fissure sealing. Int J Oral Sci 2017;9:117-24. [CrossRef]
25. Aswani R, Chandrappa V, Uloopi KS, Chandrasekhar R, RojaRamya KS. Resin Infiltration of Artificial Enamel Lesions: Evaluation of Penetration Depth, Surface Roughness and Color Stability. Int J Clin Pediatr Dent 2019;12:520-3. [CrossRef]
26. Zhou Y, Matin K, Shimada Y, Sumi Y, Tagami J. Evaluation of resin infiltration on demineralized root surface: An in vitro study. Dent Mater J 2017;36:195-204. [CrossRef]
27. Mueller J, Yang F, Neumann K, Kielbassa AM. Surface tridimensional topography analysis of materials and finishing procedures after resinous infiltration of subsurface bovine enamel lesions. Quintessence Int 2011;42:135-47.
28. Torres CR, Rosa PC, Ferreira NS, Borges AB. Effect of caries infiltration technique and fluoride therapy on microhardness of enamel carious lesions. Oper Dent 2012;37(4):363-9. [CrossRef]
29. Askar H, Lausch J, Dorfer CE, Meyer-Lueckel H, Paris S. Penetration of micro-filled infiltrant resins into artificial caries lesions. J Dent 2015;43:832-8. [CrossRef]
30. Yim HK, Min JH, Kwon HK, Kim BI. Modification of surface pretreatment of white spot lesions to improve the safety and efficacy of resin infiltration. Korean J Orthod 2014;44:195-202. [CrossRef]
31. Paris S, Schwendicke F, Seddig S, Muller WD, Dorfer C, Meyer-Lueckel H. Micro-hardness and mineral loss of enamel lesions after infiltration with various resins: influence of infiltrant composition and application frequency in vitro. J Dent 2013;41:543-8. [CrossRef]
32. Tostes MA, Santos E, Jr., Camargo SA, Jr. Effect of resin infiltration on the nanomechanical properties of demineralized bovine enamel. Indian J Dent 2014;5:116-22. [CrossRef]
33. Asmussen E, Peutzfeldt A. Influence of UEDMA BisGMA and TEGDMA on selected mechanical properties of experimental resin composites. Dent Mater 1998;14:51-6. [CrossRef]
34. Van Meerbeek B, Willems G, Celis JP, Roos JR, Braem M, Lambrechts P, et al. Assessment by nano-indentation of the hardness and elasticity of the resin-dentin bonding area. J Dent Res 1993;72:1434-42. [CrossRef]

35. Manoharan V, Arun Kumar S, Arumugam SB, Anand V, Krishnamoorthy S, Methippara JJ. Is Resin Infiltration a Microinvasive Approach to White Lesions of Calcified Tooth Structures?: A Systemic Review. Int J Clin Pediatr Dent 2019;12:53-8. [CrossRef]
36. Abbas BA, Marzouk ES, Zaher AR. Treatment of various degrees of white spot lesions using resin infiltration-in vitro study. Prog Orthod 2018;19:27. [CrossRef]
37. Croll TP, Killian CM, Miller AS. Effect of enamel microabrasion compound on human gingiva: report of a case. Quintessence Int 1990;21:959-63.

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 124-129

Original research

Length of hospital stay and complications of mini-facelift versus modified Blair incision for parotid abscess drainage

Purpose
To compare the length of hospital stay (LHS) and complications between mini-facelift (MFL) and modified Blair incisions (MBI) for adult patients undergoing parotid abscess drainage (PAD).

Materials and Methods
A retrospective cohort study design was utilized comprising 2 groups of healthy adult patients (American Society of Anesthesiology [ASA] status I-II) who underwent PAD during a 7-year interval. The primary predictor variable was incision type (MFL vs. MBI). The primary outcomes were LHS and adverse complications resulting from the incision type. Other study variables were grouped into demographic, clinical, microbiological, and therapeutic categories. Difference in the cohort characteristics were analyzed using appropriate descriptive and uni- and bivariate statistics. Multivariate logistic regression was used to measure the effect of the incision type had on the LHS and adverse complication rates.

Results
The sample included 120 subjects (50% females) with a mean age of 41.7±18.3 years. Patients in the MFL group were hospitalized for 8.2±7.7 days, and the other group stayed in the hospital for 10.2±8 days (adjusted odd ratio [OR] 1.19, 95% confidence interval [95% CI] 0.52 to 2.7; p=0.8). In comparison with MBI, MFL did not significantly increase complication risks in term of facial paralysis (adjusted OR 0.93, 95% CI 0.06 to 15.29; p=1.0) and necessity of re-operation (adjusted OR 0.61, 95% CI 0.1 to 3.8; p=0.7).

Conclusion
Given no different LHS and complication risks, MFL can replace MBI for ASA I-II adult patients undergoing PAD.

Keywords: *Parotid abscess, incision, hospital stay, complication, head and neck infection*

Poramate Pitak-Arnnop[1], Nattapong Sirintawat[2], Keskanya Subbalekha[3], Jean-Paul Meningaud[4], Prim Auychai[5], Chatpong Tangmanee[6], Andreas Neff[1]

ORCID IDs of the authors: P.P. 0000-0002-7427-3461; N.S. 0000-0002-6441-5243; K.S. 0000-0002-1570-2289; J.P.M. 0000-0001-9227-9026; P.A. 0000-0002-6505-3424; C.T. 0000-0001-6805-2921; A.N. 0000-0001-5865-0020

[1]Department of Oral and Maxillofacial Surgery, University Hospital of Giessen and Marburg, UKGM GmbH, Campus Marburg, Faculty of Medicine, Philipps-University of Marburg, Marburg, Germany

[2]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Mahidol University, Bangkok, Thailand

[3]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

[4]Department of Plastic, Reconstructive, Aesthetic and Maxillofacial Surgery, Henri Mondor University Hospital, AP-HP, Faculty of Medicine, University Paris-Est Créteil Val de Marne (Paris XII), Créteil, France

[5]Department of Paediatric Dentistry, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

[6]Department of Statistics, Chulalongkorn Business School, Bangkok, Thailand

Corresponding Author: Poramate Pitak-Arnnop

E-mail: poramate.pitakarnnop@gmail.com

Received: 2 September 2021
Revised: 3 December 2021
Accepted: 27 December 2021

DOI: 10.26650/eor.2022989445

Introduction

The *International Classification of Diseases*, 10th Revision, Clinical Modification (ICD-10-CM) separates parotid abscess (PA) (K11.3) from acute suppurative parotitis (APP) (K11.21) despite the fact that the former is generally accepted as a disease spectrum end of the latter *("continuum concept")*. PA emerges from *ca.* one fifth of APP cases and links to ductal stricture or kinks, primary parenchymal involvement, or infection of peri-/intraparotid lymph nodes, especially with poor oral hygiene. Surgical intervention is indicated in patients with (1) no clinical improvement after 24-48 hours of conservative treatment: hydration, gland massage/stimulation and broad-spectrum antibiotics, (2) facial paralysis, (3) deep fascial space infections, (4) intraglandular parenchymal suppuration, or (5) risk of severe infections, e.g. osteomyelitis, necrotizing fasciitis, or sepsis. Superficial parotidectomy is often necessary for recurrent or chronic PA (1-8).

How to cite: *Pitak-Arnnop P, Sirintawat N, Subbalekha K, Meningaud JP, Auychai P, Tangmanee C, Neff A. Length of hospital stay and complications of mini-facelift versus modified Blair incision for parotid abscess drainage. Eur Oral Res 2022; 56(3): 124-129. DOI: 10.26650/eor.2022989445*

With time, surgeries with minimal/short incisions have gained popularity not only for aesthetic but also for oncologic and traumatological purposes. Mini-facelift (MFL) has gradually superseded conventional facelift and modified Blair incisions (MBI) for parotidectomy. Over the past two decades, authors of several standard textbooks have recommended MFL for parotid abscess drainage (PAD), and MBI should be performed only in case of caudally extending/locating PA (1,4,8-10). Minimally invasive surgical techniques result in gratifying outcomes, low complications rates, and rapid return to daily activities (11-14). However, our literature search unveiled a truth that the recommendation on surgical approach to PA relied on Level of Evidence IV and V after the Oxford Centre of Evidence-Based Medicine (CEBM). Existing studies included small sample sizes and non-systematic research designs, making them difficult to ascertain conclusions concerning risks of prolonged hospitalization (> 7 days) and complications.

The purpose of the present study was to analyze length of hospital stay (LHS) and complications resulting from (extended) deep plane MFL *vs.* traditional MBI for relatively healthy adult patients undergoing parotid abscess drainage (PAD). We also sought to determine whether any difference in LHS and complication risks existed between both incisions. The investigators hypothesized that no significant difference would be found in prolonged LHS and adverse risks when using MFL *vs.* MBI. Our specific aims were to perform a retrospective outcome research (CEBM's Level of Evidence 2c), to document type and frequency of surgical incisions for PAD, to calculate the prolonged LHS and complication rates, and to prove the differences in outcomes of each PA incision.

Material and Methods

Study design and samples

We completed a retrospective cohort study recruiting 2 groups of patients undergoing PAD performed by a single surgeon (P.P.) during a 7-year interval. Subjects eligible for study inclusion were female or male, older than18 years of age, who had undergone PAD via any incision types in an inpatient setting with postoperative antibiotics. The diagnosis was established based on clinical presentations, routine blood test, and radiographic confirmation with computed tomography (CT): low attenuated, single cyst-like or multiple loculated lesions with contrast enhancement of the abscess wall (5,7). The surgical technique was together decided by provider and patient factors. In the MFL group, the patients were informed about the chance of intraoperative converting the incision into the conventional MBI, depending on surgical difficulty. All subjects received routine use of general anaesthetics and continuous intraoperative neuromonitoring (cIONM) of the facial nerve, as described by other authors (15-17). Subjects were excluded from the study if they did not satisfy the inclusion criteria, had poor general health (American Society of Anesthesiology [ASA] status III-IV), or if infection became disseminating to other tissues/organs or arose from a tumor ("tumor necrosis"). Treatment outcomes in pediatric/adolescent patients may be difficult to evaluate, and ASA III-IV patients often suffer from poor/delayed healing (3,18). Both of these patient groups were therefore excluded from the study.

Ethical statement

This retrospective cohort study with chart review was approved by the institutional review board, and the ethical guidelines of the World Medical Association's Declaration of Helsinki and the STROCSS criteria were followed throughout the study. Every patient gave consent for participation and prospective consent for their anonymous data in future researches.

Study variables

The primary predictor variable was incision types: MFL *vs.* MBI. The surgical technique was recorded as documented in operative notes. MFL began with the preauricular incision extending into its natural crease superior to the tragus, and then curved posterior to the tragus and inferior to the inferior ear lobule with/without small postauricular extension. The incision included neither temporal hair nor trichophytic incision nor extension beyond the mastoid skin (Figure 1A). In the MBI group, we used the conventional Blair "Lazy-S" incision with extension into the upper neck (Figure 1B). Details of both surgical methods were extensively described by other authors (4,11-14,19,20). The parotid fascia was exposed and incised parallel to the facial nerve. An incision biopsy was also performed to rule out tumor diseases. After microbiological swab, abscess evacuation and aggressive antiseptic lavage (mostly, 7.5% povidone-iodine: Braunol® Haut-, Schleimhaut- und Wundantiseptikum, B. Braun Melsungen AG, Melsungen, Germany), one or two penrose drains (size 8 or 10 or 12 mm; Easy-Flow-Drainage®, Dispomedica GmbH, Hamburg, Germany) for postoperative irrigation were left *in situ* until a day before patient discharge.

The primary outcomes were length of hospital stay (days) and incidence of adverse complications related to the surgical incision. Complications included delayed wound healing/dehiscence/fistula, recurrence of the infection, trismus, facial paralysis, Frey's syndrome, sensory disturbance, and hypertrophic scar/keloid. The patients were discharged when clinical symptoms resolved and blood chemical test results were unremarkable.

The other study variables were categorized into 4 categories: (1) demographic: age, gender, relevant risk factors (metabolic diseases, dehydration, irradiation, Sjögren's syndrome, HIV infection, placement of a Sengstaken-Blakemore tube, previous endoscopic retrograde cholangiopancreatography [ERCP], continuous positive airway pressure therapy, and use of total parenteral nutrition) (8), (2) clinical: limited mouth opening (defined as an inability to vertically align 3 fingers between upper and lower central incisors up to the first distal interphalangeal folds) (21), dysphagia/odynophagia, reduced/poor general condition including severe pyrexia and malaise (defined as Eastern Co-operative Oncology Group [ECOG]/WHO Performance Score Grade 3-5) (22), (3) microbiological: identified pathogen, and (4) therapeutic: used antibiotic.

Statistical analysis

Statistical analyses were performed using SPSS V27 (Statistical Package for Social Sciences, IBM Corporation, NY, USA) for all analyses. For all categorical comparisons, we used the χ^2 test or Fisher's Exact Test, as appropriate. For comparisons

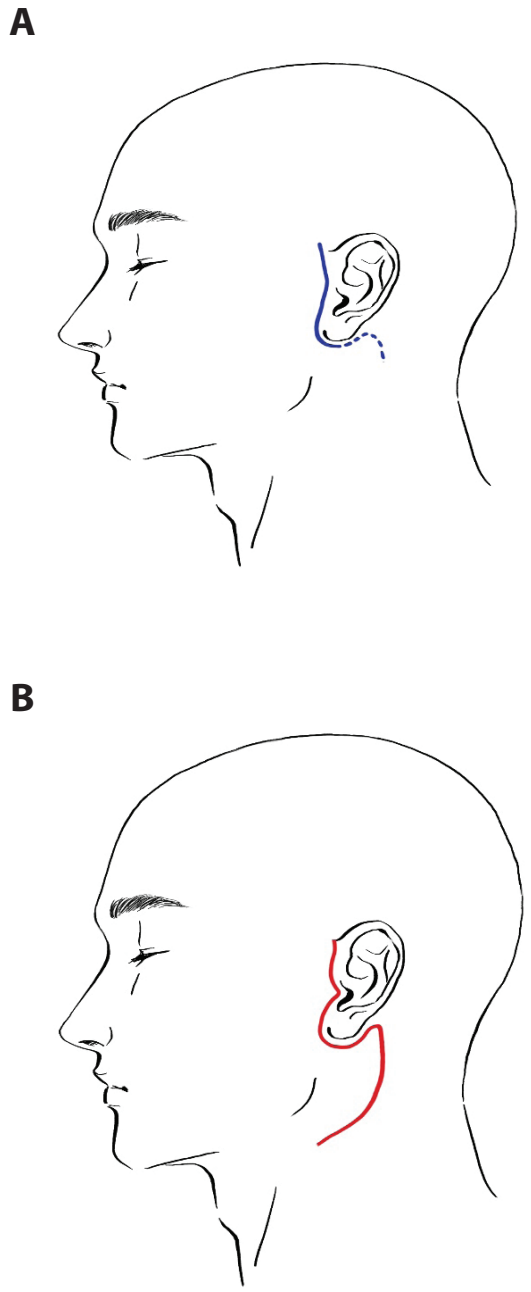

Figure 1. *Drawings showing (A) mini-facelift incision and (B) modified Blair incision.*

of continuous variables, we used independent samples *t* test. Multivariable logistic regression analysis was then applied to measure the effect of the incision technique on prolonged LHS and adverse complication rates. The multivariate model was adjusted into binary before calculation. We reported 95% confidence intervals (CIs) and calculated *P* values. All statistical tests were 2-sided using a standard alpha of 0.05.

Results

A total of 120 PA patients treated by the first author (P.P.) were identified during the 7-year study period. Patient demographics, outcomes, and data analyses are summarized in *Table 1*. The only risk factor in this cohort was found, i.e. metabolic diseases in 11 (or 9.2%) patients. Advanced age and usual symptoms of odontogenic infections (i.e. limited mouth opening, swallow difficulty, reduced general condition) were not common. However, gram-positive oral bacteria were the main pathogen of the infection, and intravenous ampicillin/sulbactam remained the gold standard of empiric antibiotic therapy. Only 10 (or 8.3%) patients had a Staphylococcal infection.

Neither incision conversion (MFL to MBI) nor surgical airways nor secondary parotidectomy was warranted. All patients were successfully intubated via the orotracheal route with/without a flexible fiberoptic bronchoscope. There were no postoperative complications other than 2 (or 1.7%) transient facial paralyses (House-Brackmann scoring Grade II and III) and 5 (or 4.2%) re-operations. Of those, 4 re-operated patients were Asian/Eurasian immigrants and had an infection of *Burkholderia pseudomallei*, making the association between this pathogen and re-operation events statistically significant ($P = 0.0001$).

On multivariate logistic regression analysis, there was no significantly increased risk of LHS > 7 days (adjusted odd ratio [OR] 1.19, 95% confidence interval [95% CI] 0.52 to 2.7; $P = 0.8$) and adverse complication (facial paralysis: adjusted OR 0.93, 95% CI 0.06 to 15.29, $P = 1.0$; necessity of re-operation (adjusted OR 0.61, 95% CI 0.1 to 3.8, $P = 0.7$).

Discussion

Given a proliferation of facial plastic surgical techniques, there exists a need to assess the efficacy between different surgical approaches to determine which offers the optimal results. To address this deficit, we compared two surgical techniques for PAD. Our findings point to specific factors that could support a decision regarding the incision for PAD in ASA I-II patients. MBI provides a wide surgical approach to visualize the facial nerve, abscess, hematoma and necrotic tissue, but it causes aesthetic concerns and probably fistulation. In this regard, MFL seems to be more advantageous because the MBI's disadvantages are overcome (23,24).

For aesthetic purposes, MBI and MFL yield comparable short-time outcomes. MBI offers a superior long-term result in the neck only (12). However, correction of cervical laxity and/or bulky neck is not the main aim of PAD. In this study, the investigators could not demonstrate the significant difference of LHS and complication rates between both sample groups. These results correspond with those recently reported by other investigators (23,24). MBI should therefore be used in case of caudally extending/locating PA – an alternative for this situation is extending the short retroauricular incision to allow a better vision with a completely hidden scar behind the ear lobe instead of a visible occipital prehairline scar (11). One huge drawback of the MFL incision is that the direction of the drainage is often not parallel to the gravity. However, the effect of this unfavorable vector is unlikely to hinder treatment outcomes in this series.

Staphylococcus aureus and *Streptococcus viridians* are common pathogenic causes of PA. Gram-negative bacilli and strict anaerobes, e.g. *Klebsiella spp, Bacteroides spp, Fusobacterium nucleatum,* and *Peptostreptococcus anaerobius* have been identified in patients with poor oral hygiene. Rare PA arises from methicillin-resistant *S. aureus, Mycobacterium spp, Salmonella spp, Neisseria meningitides, Treponema pall-*

Table 1: *Cohort characteristics grouped by incision type. Continuous data are listed as mean ± SD. Categorical data are presented as number (percentage). Statistically significant P-values are indicated in bold typeface.*

Characteristics	Overall	Mini-Facelift	Modified Blair incision	*P* value (adjusted odd ratio; 95% confidence interval)
Demographic				
Sample size	120	62	58	N/A
Age at diagnosis	41.7 ± 18.3	43.1 ±17.3	40.1 ± 19.4	0.4
Age at diagnose > 60 years	29 (24.2)	14 (48.3)	15 (51.7)	0.8 (0.84; 0.36-1.93)
Female gender	60 (50)	29 (48.3)	31 (51.7)	0.6 (0.77; 0.37-1.57)
Metabolic diseases	11 (9.2)	7 (63.6)	4 (36.4)	0.5 (1.72; 0.48-6.21)
Clinical				
Limited mouth opening	23 (19.2)	9 (39.1)	14 (60.9)	0.2 (0.53; 0.21-1.35)
Dysphagia/odynophagia	5 (4.2)	3 (60)	2 (40)	1.0 (1.42; 0.23-8.84)
Reduced/poor general condition	4 (3.3)	2 (50)	2 (50)	1.0 (0.93; 0.13-6.85)
Microbiological				
Gram-positive cocci	68 (56.7)	33 (48.5)	35 (51.5)	0.5 (0.75; 0.36-1.54)
Gram-negative cocci	9 (7.5)	5 (55.6)	4 (44.4)	1.0 (1.18; 0.3-4.64)
Anaerobes	11 (9.2)	5 (45.5)	6 (54.5)	0.8 (0.76; 0.22-2.64)
Burkholderia pseudomallei	4 (3.3)	2 (50)	2 (50)	1.0 (0.9; 0.13-6.85)
Candida albicans	5 (4.2)	2 (40)	3 (60)	0.7 (0.61; 0.1-3.8)
Therapeutic				
Ampicillin/sulbactam	95 (79.2)	50 (52.6)	45 (47.4)	0.8 (1.2; 0.5-2.91)
Clindamycin	12 (10)	5 (41.7)	7 (58.3)	0.6 (0.64; 0.19-2.14)
Others after antibiogram	13 (10.8)	7 (53.8)	6 (46.2)	1.0 (1.1; 0.35-3.5)
Length of hospital stay	9.2 ± 7.9	8.2 ± 7.7	10.2 ± 8	0.2
Length of hospital stay > 7 days	31 (25.8)	17 (27.4)	14 (25.5)	0.8 (1.19; 0.52-2.7)
Postoperative				
Facial paralysis	2 (1.7)	1 (50)	1 (50)	1.0 (0.93; 0.06-15.29)
Re-operation	5 (4.2)	2 (40)	3 (60)	0.7 (0.61; 0.1-3.8)
Complications with evidence of *Burkholderia pseudomallei*	4 (3.3)	2 (50)	2 (50)	1.0 (0.9; 0.13-6.85)

idum, Bartonella henselae, Eikenella corrodens, Fusobacterium necrophorum (Lemierre's disease) and *B. pseudomallei* (melioidosis) (6,8,25). Retrograde infection of the parotid secretory system results from ductal erosion with subsequent bacterial penetration, exudate formation within the parenchyma, and glandular destruction (3,23). Notwithstanding our findings that oral bacteria were commonly found, oral health indices, such as caries prevalence DMFT/DMFS, Community Periodontal Index (CPI), in PA patients are beyond this study's scope.

Similar to results of other studies, diabetes mellitus (DM) was an important risk factors in PA patients (3,7,24,25). It appears clear that DM increases susceptibility to infection and worsens outcomes of infectious diseases. For example, DM patients have a 12-fold increased risk of melioidosis, and over half of the melioidosis cases have diabetes. Main mechanisms are impairment of phagocyte function and adaptive T-cell immunity, chronic hyperactivation of the innate immune response (i.e. polyclonal B-cell stimulation and enhanced antibody production to stimuli), altered skin flora (including increased colonization of *S. aureus*), and antimicrobial resistance (18). It has been believed that prolonged usage of broad-spectrum antibiotics in DM patient precipitates selective colonization of the upper respiratory tract with Gram-negative bacteria, e.g. *Klebsiella, Pseuromonas*, because the commensals are shed out (3). On the other hand, acute infection leads to hyperglycemia as a consequence of the stress-response activation of the hypothalamic-pituitary-adrenal axis to increase secretion of cortisol and other hormones, which promote peripheral insulin resistance and alter insulin-receptor signaling by pro-inflammatory cytokines (18). Altogether, appropriate blood sugar management is an essential part of successful treatments for PA patients with DM.

Melioidosis has often been reported in farmers, transporters, machine workers and recreation activists in Southeast Asia and Northern Australia, and presents as pneumonia (*ca.* 15%) and/or multiple soft-tissue abscesses (*ca.* 20%), especially in DM patients. Bacteremia and septic shock (*ca.* 20%) are the strong predictors of death with the mortality rates of 33%-65%. Radiological appearances of the melioidosis abscesses vary from large abscesses with the "honeycomb" or "Swiss cheese" appearance to dispersing microabscesses (26.) All of our melioidosis patients were apt to re-operations.

This finding may indicate high virulence of *B. Pseudomallei*, as also described by other authors (23,24,26.) PA arising from this bacterium should therefore be treated cautiously.

If the patient's general health does not suit an invasive treatment, ultrasound-guided emergency needle aspiration of the pus may be able to prevent dissemination of the infection (23,27). Our cohort enrolled only ASA I-II patients; thereby, needle aspiration was not attempted. In another German series (n = 31), all but 4 healed uneventfully after PAD with cIONM. The other four patients underwent superficial parotidectomy because of multiple recurrences of PA (2). To the best of our knowledge, ultrasound-guide PAD appears to be relatively unpopular in this country.

Facial paralysis in PA patients has been sporadically reported in the literature and may occur due to the severity of infection, perineuritis, or nerve compression (6,7). A Taiwanese series demonstrated one of 14 (or 7.1%) patients with temporary facial paralysis (5), and 13% (2/15) in another Malaysian series (3). We found no facial paralysis before the surgery. A possible explanation is that all patients presented to us within a few days after the infection began and the PA sizes were less than 5 cm in preoperative CT. Contrast to postoperative/iatrogenic facial paralysis, facial paralysis due to PA *per se* often resolves spontaneously within a few months after the disease cure. Facial paralysis resistant to therapy is very highly suggestive of parotid malignancy and mandates further workups (6,10).

Dissection, transaction, laceration, clamp compression, retraction, electrocautery, ligature entrapment, suction trauma, or even compressive ischemia can cause iatrogenic facial nerve injury (17). cIONM during parotid surgery allows early nerve identification, forewarns surgeons of unexpected facial nerve stimulation, maps the nerve course, reduces mechanical nerve damage, and helps to evaluate and prognosticate the nerve function at the end of the procedure (15,16.) This real-time monitoring of the facial nerve undoubtedly decreases operation time and increases patient satisfaction (17). Although an elevated nerve response (0.5 mA) could predict postoperative facial nerve paresis at the end of procedure, an absence of an electrically evoked response does not exclude the facial nerve injury (15, 17). The incidence of temporary postoperative facial weakness in our cohort is much lower than that in the recent meta-analysis (1.7% *vs.* 23.4%, adjusted OR 0.06, 95% CI 0.01 to 0.23, $P = 0.0001$) (16). Possible explanations are that most data in that meta-analysis were based on studies with 2-channel systems during parotidectomy, while we used passive 4 channel-monitoring (electrode placement in the frontal, orbicularis oculi and oris, and mentalis muscles). Our patients with postoperative facial paralysis were conservatively treated with physiotherapy and returned to normal nerve functions within a year.

In Taiwanese, Thai and Malaysian series, trismus was found in 43% (or 6/14), 50% (or 31/62) und 60% (or 9/15) of PA patients, respectively (3,5,25). However, limited mouth opening, swallowing problem and reduced general condition (ECOG/WHO Performance Score Grade 3 or more) in our patients were uncommon. The most likely cause of the discrepancies is that the patients in the abovementioned Asian series came to the treatment later than ours (6.3 ± 6.3 [Taiwan] *vs.* 1.8 ± 0.6 [Germany] days; 95% CI 3.28 to 5.61, $P = 0.0001$; Malaysian means: 15.2 days), and had more percentages of patients with underlying metabolic diseases (40% [Malaysia] *vs.* 42.9% (Taiwan) *vs.* 9.2% [Germany]; adjusted OR 0.13, 95% CI 0.04 to 0.46, $P = 0.0028$), probably because we included ASA I-II patients only. This could explain why our patients tended to have shorter hospitalization (14 ± 39.3 [Taiwan] *vs.* 9.2 ± 7.9 [Germany] days; 95% CI -3.26 to 12.86, $P = 0.24$; Malaysian means: 14.2 days), albeit not statistically significant. Moreover, our patients did not require advanced airways management. In other words, the German healthcare system seems to support a quick referral of problematic patients to specialists.

Our study was limited in several ways, most notably by the retrospective observational study design. Inaccurate charting and missing data cannot be excluded as a possibility in some reviewed cases. Besides, chart reviewing was not blinded. Despite no surgeon variation, we did not analyze the whole patient population in the catchment areas of the studied facilities. The demographic data may be unrepresentative, e.g. how many APP patients developed PA remains unknown, and our results might not be generalized to other patient groups, e.g. those with ASA III-IV and/or advanced infections. Patient satisfaction after PAD is our next research project.

Conclusion

The results of our study allow us to give strong recommendations in favor of the use of MFL in ASA I-II adult patients undergoing PAD. Both MFL and MBI techniques are low-risk with regard to LHS and postoperative complications. However, it should be borne in mind that the faster the treatment begins, the less chance the patients have of getting complications. DM and melioidosis seem to be important risk factors and require particular attention. Postoperative facial nerve dysfunction after PAD is temporary and diminished after conservative physiotherapy.

Türkçe özet: *Parotis apsesi drenajı için mini yüz germe tekniği ya da modifiye Blair insizyonu kullanılan hastalarda meydana gelen komplikasyonların ve hastanede kalış süresinin değerlendirilmesi.Amaç: Parotis apse drenajı (PAD) uygulanan yetişkin hastalarda mini yüz germe (MFL) ve modifiye Blair insizyonları (MBI) arasındaki hastanede kalış süresini (LHS) ve komplikasyonları karşılaştırmaktır.Gereç ve yöntem:7 yıllık bir aralıkta PAH uygulanan 2 sağlıklı yetişkin hasta grubunu (Amerikan Anesteziyoloji Derneği [ASA] durum I-II) içeren retrospektif bir kohort çalışma tasarımı kullanıldı. Birincil öngörücü değişken, insizyon tipiydi (MFL'ye karşı MBI). Birincil sonuçlar, LHS ve insizyon tipinden kaynaklanan olumsuz komplikasyonlardı. Diğer çalışma değişkenleri demografik, klinik, mikrobiyolojik ve terapötik kategorilere ayrılmıştır. Kohort özelliklerindeki fark, uygun tanımlayıcı tek ve iki değişkenli istatistikler kullanılarak analiz edildi. İnsizyon tipinin LHS üzerindeki etkisini ve olumsuz komplikasyon oranlarını ölçmek için çok değişkenli lojistik regresyon kullanıldı.Bulgular: Örneklem, ortalama yaşı 41.7 ± 18.3 olan 120 deneği (%50 kadın) içermiştir. MFL grubundaki hastalar 8,2 ± 7,7 gün hastanede yatırıldı ve diğer grup 10.2 ± 8 gün hastanede kaldı (düzeltilmiş olasılık oranı [OR] 1.19, %95 güven aralığı [%95 GA] 0.52 ila 2.7; P = 0.8). MBI ile karşılaştırıldığında MFL, fasiyal paralizi (düzeltilmiş OR 0.93, %95 GA 0.06 ila 15.29; P = 1.0) ve yeniden ameliyat gerekliliği (düzeltilmiş OR 0.61, %95 CI 0.1 ila 3.8) açısından komplikasyon risklerini önemli ölçüde artırmadı. ; P = 0.7). Sonuç: Hastanede kalış süresi ve komplikasyon riski göz önüne alındığında, MFL, PAH uygulanan ASA I-II yetişkin hastalarda MBI'ın yerini alabilir.Anahtar kelimeler: parotis apsesi; kesi; hastanede kalış; komplikasyon; baş ve boyun enfeksiyonu*

Ethics Committee Approval: This retrospective cohort study with chart review was approved by the institutional review board, and

the ethical guidelines of the World Medical Association's Declaration of Helsinki and the STROCSS criteria were followed throughout the study.

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: PPA, NS, KS, JPM, PA, CT, AN participated in designing the study. PPA, NS, KS, JPM, CT, AN participated in generating the data for the study. PPA, NS, KS, PA, CT, AN participated in gathering the data for the study. PPA, NS, KS, JPM, PA, CT, AN participated in the analysis of the data. PPA, AN wrote the majority of the original draft of the paper. PPA, NS, KS, JPM, PA, CT, AN participated in writing the paper. PPA, NS, KS, JPM, PA, CT, AN have had access to all of the raw data of the study. PPA, NS, KS, JPM, PA, CT, AN have reviewed the pertinent raw data on which the results and conclusions of this study are based. PPA, NS, KS, JPM, PA, CT, AN have approved the final version of this paper. PPA, NS, KS, JPM, PA, CT, AN guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Ord RA. Acute suppurative parotitis. In: Fonseca RJ, Williams TP, Stewart J-CB, editors. Oral and Maxillofacial Surgery. Volume 5: Surgical Pathology. 1st Ed. Philadelphia: WB Saunders Co., 2000, p. 275-6.
2. Thiede O, Stoll W, Schmäl F. Klinische Aspekte der abszedierenden Parotitis. *HNO* 2002;50:332-8. v
3. Tan VE, Goh BS. Parotid abscess: A five-year review—clinical presentation, diagnosis and management. J Laryngol Otol 2007;121:872-9. [CrossRef]
4. Sajjadian A, Magge KT. Salivary gland disorders. In: Guyuron B, Eriksson E, Persing J, Chung KC, Disa JJ, Gosain AK, et al, editors. Plastic Surgery. Indications and Practice. 1st Ed. Philadelphia: Saunders, 2009, p. 778-86. [CrossRef]
5. Chi TH, Yuan CH, Chen HS. Parotid abscess: A retrospective study of 14 cases at a regional hospital in Taiwan. *B-ENT* 2014;10:315-8. Available at http://www.b-ent.be/en/parotid-abscess-a-retrospective-study-of-14-cases-at-a-regional-hospital-in-taiwan-16315 (accessed 14 October 2021).
6. Alam M, Hasan SA, Hashmi SF, Singh PK. Facial palsy due to parotid abscess: An unusual complication. Turk Arch Otorhinolaryngol 2016;54:168-71. doi: 10.5152/tao.2016.1671. [CrossRef]
7. Kim YY, Lee DH, Yoon TM, Lee JK, Lim SC. Parotid abscess at a single institute in Korea. Medicine (Baltimore) 2018;97:e11700. [CrossRef]
8. Porter SR, Fedele S, Mercadante V. Acute suppurative sialadenitis (suppurative parotitis; bacterial sialadenitis; bacterial parotitis). In: Watkinson JC, Clarke EW, Jones TM, Paleri VP, White N, Woolford T, editors. Scott-Brown's Otorhinolaryngology, Head and Neck Surgery. Volume 3: *Head and Neck Surgery, Plastic Surgery*. 8th Ed. London: CRC Press, 2019, p. 712-4.
9. Theissing J. Eingriffe beim Parotisabszess. In: Theissing J, Rettinger G, Werner JA, editors. HNO-Operationslehre. 4th Ed. Stuttgart: Georg Thieme Verlage, 2006, p. 309. [CrossRef]
10. Mydlarz WK, Ha PK, Eisele DW. Bacterial sialadenitis. In: Sataloff RT, Gullane PJ, Goldstein DP, editors. Sataloff's Comprehensive Textbook of Otolaryngology, Head and Neck Surgery, Vol. 5: Head and Neck Surgery. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd, 2016, p. 395-6.
11. Atiyeh BS, Dibo S, Papazian N, Zgheib E. Overcoming limitations of short scar minimal access cranial suspension facelift for enhanced rejuvenation. J Craniofac Surg 2015;26:800-6. [CrossRef]
12. Antell DE, May JM, Bonnano MJ, Lee NY. A comparison of the full and short-scar face-lift incision techniques in multiple sets of identical twins. Plast Reconstr Surg 2016;137:1707-14. [CrossRef]
13. Borges J, Loureiro F. Minilifting technique for treatments of the lower third of the face and anterior cervical neck with tumescent anesthesia. J Cosmet Dermatol 2020;19:1208-10. [CrossRef]
14. Van Pham T, Truong KHTN. Short or minimum incision deep plane/extended deep plane facelift/rhytidectomy. Facial Plast Surg 2020;36:376-85. [CrossRef]
15. Guntinas-Lichius O, Eisele DW. Facial Nerve Monitoring. Adv Otorhinolaryngol 2016;78:46-52. [CrossRef]
16. Stankovic P, Wittlinger J, Georgiew R, Dominas N, Hoch S, Wilhelm T. Kontinuierliches intraoperatives Neuromonitoring (cIONM) in der Kopf-Hals-Chirurgie – eine Übersicht. HNO 2020;68:801-9. [CrossRef]
17. Chiesa-Estomba CM, Larruscain-Sarasola E, Lechien JR, et al. Facial nerve monitoring during parotid gland surgery: A systematic review and meta-analysis, Eur Arch Otorhinolaryngol 2021;278:933-43. [CrossRef]
18. Dunachie S, Chamnan P. The double burden of diabetes and global infection in low and middle-income countries. Trans R Soc Trop Med Hyg 2019;113:56-64. [CrossRef]
19. Wormald R, Donnelly M, Timon C. "Minor" morbidity after parotid surgery via the modified Blair incision. J Plast Reconstr Aesthet Surg 2009;62:1008-11. [CrossRef]
20. Riyadh S, Abdulrazaq SS. Assessment of the extracapsular dissection of the benign parotid tumors, extending the literature. J Oral Maxillofac Surg Med Pathol 2018;30:86-90. [CrossRef]
21. Agrawal J, Shenai PK, Chatra L, Kumar PY. Evaluation of normal range of mouth opening using three finger index: South India perspective study. Indian J Dent Res 2015;26:361-5. [CrossRef]
22. Sok M, Zavrl M, Greif B, Srpčič M. Objective assessment of WHO/ECOG performance status. Support Care Cancer 2019;27:3793-8. [CrossRef]
23. Ganesh R, Leese T. Parotid abscess in Singapore. Singapore Med J 2005;46:553-6. Available at https://www.sma.org.sg/smj/4610/4610a5.pdf (accessed on 14 October 2021).
24. Buaberg S. Comparative study of incision and drainage parotid abscess using long incision and short incision in Yasothon Hospital. Thai J Otolaryngol Head Neck Surg 2019;20:46-56. Available at http://www.rcot.org/2016/assets/pdf/journal-rcot-20-1-2562.pdf (accessed on 14 October 2021).
25. Wadwongtham W, Cutchavaree A. Parotid abscesses: A ten-year review in King Chulalongkorn Memorial Hospital. Chula Med J 1988;42:1069-77. Available at http://www.clmjournal.org/_fileupload/journal/300-2-2.pdf (accessed on 14 October 2021).
26. Kingsley PV, Leader M, Nagodawithana NS, Tipre M, Sathiakumar N. Melioidosis in Malaysia: A review of case reports. PLoS Negl Trop Dis 2016;10:e0005182. [CrossRef]
27. Scattergood S, Moore S, Prior A, Yusuf GT, Sidhu PS. Percutaneous drainage of a parotid gland abscess under contrast-enhanced ultrasound guidance: A case report. Ultrasound 2018;26:182-6. [CrossRef]

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 130-135

Original research

The relationship between frontal sinus dimensions and skeletal malocclusion

Murat Tunca[1], **Volkan Kaplan**[2], **Yeşim Kaya**[3], **Yasemin Tunca**[1]

Purpose
The aim of this retrospective research is to compare frontal sinus dimensions in skeletal Class I, skeletal Class II, and skeletal Class III individuals and to evaluate the relationship of these dimensions with anterior skull base length and some cephalometric values.

Materials and Methods
In this research, we used lateral cephalometric radiographs of 60 people aged 17 to 25. In individuals with skeletal Class I malocclusion, skeletal Class II malocclusion due to mandibular insufficiency, and skeletal Class III malocclusion due to mandibular excess, measurements of frontal sinus length and height as well as S-N, Co-A and Co-Gn lengths, ANB^0, FMA^0, SN-GoGn^0 angles values were performed. The length between the highest point and the lowest point of the frontal sinus was calculated as the height of the frontal sinus, and the length between the most anterior and the most posterior points of the frontal sinus was calculated as the length of the frontal sinus.

Results
The frontal sinus length and height were found to be higher in skeletal Class III individuals than in skeletal Class I and skeletal Class II individuals, however, there was no significant difference between skeletal Class I and Class II individuals.

Conclusion
The increase in frontal sinus height and length correlated positively with the decrease in the ANB angle and the increase in the SN and Co-Gn lengths. The dimensions of the frontal sinus may be an indicator for the remaining mandibular growth potential.

Keywords: *Frontal sinus, cephalometry, mandible, skeletal malocclusion, growth*

Introduction

Growth modification is frequently used in the treatment of skeletal Class II and Class III malocclusion during growth and development (1–3). In this treatment method, where functional appliances can be used, the growth and development of the nasomaxillary complex as well as the growth potential of the lower jaw in the sagittal direction are important for the treatment to be applied to the individual. The close relationship of the growth and development, spurt periods of the mandible with the general growth and development of the individual directly affects the stability and success of the treatment (4,5).

Various methods are used to accurately predict the growth and development periods of individuals. These methods include chronological age, tooth age, height and weight gain, menarche, and bone age (1). In the bone age method, one of the most reliable methods, hand-wrist radiographs are frequently used (6). These radiographs have advantages such as the spread of the calcification of many bones in the hand-wrist area

ORCID IDs of the authors: M.T. 0000-0002-9157-9390; V.K. 0000-0002-7605-1125; Y.K. 0000-0002-5795-7327; Y.T. 0000-0003-4933-1380

[1]*Department of Orthodontics, Faculty of Dentistry, Van Yuzuncu Yil University, Van, Turkiye*

[2]*Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Tekirdag Namık Kemal University, Tekirdag, Turkiye*

[3]*Department of Orthodontics, Faculty of Dentistry, Ankara Yıldırım Beyazıt University, Ankara, Turkiye*

Corresponding Author: Murat Tunca

E-mail: murattunca@yyu.edu.tr

Received: 18 May 2021
Revised: 17 January 2022
Accepted: 29 January 2022

DOI: 10.26650/eor.2022938080

How to cite: *Tunca M, Kaplan, Kaya Y, Tunca Y. The relationship between frontal sinus dimensions and skeletal malocclusion. Eur Oral Res 2022; 56(3): 130-135. DOI: 10.26650/eor.2022938080*

over a wide range, different union times of the epiphysis and diaphysis, obtaining images close to the actual size, and low superposition. However, it has been noted that it has disadvantages such as exposure to radiation second time, loss of time, cost, being in a region far from the nasomaxillary complex, and being not ideal in representation due to being a small component of the skeletal system (7–9).

Ruf and Pancherz (10) have stated that the frontal sinuses, one of the paranasal sinuses, could be an indicator of the growth pattern of the nasomaxillary complex. Also, there are studies in the literature regarding the use of frontal sinuses in areas such as age, gender, and forensic medicine (11,12). It has been reported that the frontal sinus bud, which was located in the ethmoid region after birth, cannot be observed on radiography until the age of eight, and that most of its development is completed until the age of $13_{3/4}$ in females and $15_{1/2}$ in males. This growth in the frontal sinuses has been stated to coincide with the growth and spurt period observed 1.4 years on average after the maximum height increase (12,13).

Considering that mandibular growth can continue until the age of 18 in females and 20 in males, the prediction of mandibular growth and development in individuals with skeletal Class II malocclusion with mandibular insufficiency and skeletal Class III malocclusion with mandibular excess is important in terms of the success of orthodontic treatment (14). At this point, it has been reported that there might be a correlation between the frontal sinus, which completes its development at an earlier age, and skeletal malocclusion in the sagittal direction. Also, it has been stated that it could give an idea about the malocclusion that may occur and about the prediction of the possibility of orthognathic surgery (15).

In the light of this information, this study aims to compare frontal sinus dimensions in skeletal Class I, skeletal Class II, and skeletal Class III individuals and to evaluate the relationship of these dimensions with S-N, Co-A and Co-Gn lengths and ANB^0, FMA^0, $SN\text{-}GoGn^0$ angles values. The main null hypothesis tested in this research is that the frontal sinus dimensions are not related either with S-N, Co-A or Co-Gn lengths or ANB^0, FMA^0, $SN\text{-}GoGn^0$ angles values.

Material and Methods

Ethical statement

The ethics committee approval was obtained from Van Yuzuncu Yil University Faculty of Medicine Research Ethics Committee (2019/15-02). Informed consent was obtained for the use of cephalometric radiographs taken for diagnostic purposes.

Study design

This retrospective research was carried out using lateral cephalometric radiographs, found in the archives of Van Yuzuncu Yil University, Faculty of Dentistry, Department of Orthodontics, of 60 individuals (35 females, 25 males) between the ages of 17-25 who were admitted for orthodontic treatment between 2014-2018.

The study group included cephalometric radiographs of individuals who had not previously received orthodontic treatment, had no cleft lip-palate and systemic syndrome, no frontal sinus pathology, and had skeletal Class I, skeletal Class II malocclusion due to mandibular deficiency, and skeletal Class III malocclusion due to mandibular excess. Lateral cephalometric radiographs with poor image quality for measurement and in which the frontal sinus dimensions could not be observed were excluded from the study.

Imaging protocols

All lateral cephalometric radiographs were taken with the Sirona Orthophos XG (Bensheim, Germany) imaging system. Lateral cephalometric radiographs were imported into the NemoCeph NX 2005 software package (Nemotec, Madrid, Spain). To minimize magnification, it was calibrated with a ruler of known length on the forehead bar before measuring length values on cephalometric radiographs. Lateral cephalometric radiographs were drawn by a single investigator (YT) (Figure 1).

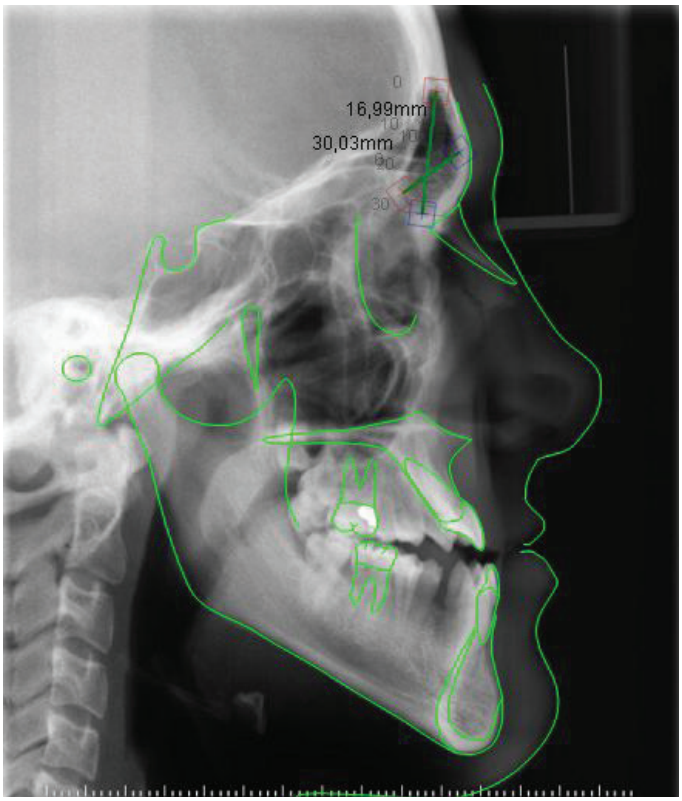

Figure 1. *Determining cephalometric points and evaluating values.*

Sample size determination

According to previous studies; the standard deviations (Σ) for frontal sinus width varies between 3 and 4 (16). Therefore, standard deviation was considered as 3.5. For the 95% of confidence coefficient and approximetaly 80% power value the effect size (d) was assumed as 1.5, and Z value 1.96 was used for the 0.05 type I error rate. The sample size was found to be approximately 20 by using the equation for sample size calculation ($n = Z^2\,\Sigma^2\,/d^2$)

Image analysis

Thirteen points are marked, and three angles and five length values are calculated (Table 1). According to the angle ANB,

Table 1: *Definition of points, angles and lengths used in the research.*

A-point (A)	The deepest point on the maxillary alveolar process's outer contour.
B-point (B)	The deepest point on the mandibular alveolar process's outer contour.
Sella (S)	Midpoint of sella
Nasion (N)	The most anterior point of the frontonasal suture
Gonion (Go)	Intersection of the lines tangent to the ramus's posterior border and the mandible's lower border
Gnathion (Gn)	The point on the bony chin that is the most anterior and inferior.
Porion (Po)	Uppermost point of the external auditory meatus
Orbitale (Or)	Lowermost point of the bony orbita
Condylion (Co)	The most posterosuperior point on the curvature of the average of the right and left outlines of the condylar head
SN-GoGn^0	The angle between the anterior cranial base (SN) and the mandibular plane (GoGn)
ANB^0	The angle between the N-A and N-B lines
FMA^0	The angle between the Go-Gn and Frankfurt Horizontal (Po-Or lines
S-N	The distance between S point and N point
Co-A	The distance between Co point and A point
Co-Gn	The distance between Co point and Gn point
SH	The highest point of frontal sinus
SL	The lowest point of frontal sinus
SA	The most anterior point of the frontal sinus
SP	The most posterior point of the frontal sinus
FSH	The length between the highest point (SH) and the lowest point (SL)
FSL	The length between the most anterior (SA) and the most posterior (SP) points

which is the angle between the Nasion, A, and B points, three equal groups were created consisting of skeletal Class I (20 individuals, $0^0 \leq ANB \leq 4^0$), skeletal Class II due to mandibular deficiency (20 individuals, $4^0<ANB$) and skeletal Class III due to mandibular excess (20 individuals, $ANB <0^0$). Moreover, the part located between the sella (S) and nasion (N) points was calculated as the anterior skull base length, the part between the condilion (Co) and A points was calculated as the effective maxillary length, and the part between the condilion (Co) and gnathion (Gn) points was calculated as the effective mandibular length Furthermore, the Sella-Nasion-Gonion-Gnathion plane angle (SN-GoGn) and the Frankfort-mandibular plane angle (FMA), two commonly used angles, were analyzed in terms of the groups' vertical values (17,18).

In order to evaluate the dimensions of the frontal sinus, four points were determined on the inner surface of the cortical bone that limit the frontal sinus. These are defined as the highest point of the frontal sinus (SH), the lowest point of the frontal sinus (SL), the most anterior point of the frontal sinus (SA), and the most posterior point of the frontal sinus (SP). The length between the highest point and the lowest point of the frontal sinus was calculated as the height of the frontal sinus (FSH), and the length between the most anterior and the most posterior points of the frontal sinus was calculated as the length of the frontal sinus (FSL) (19). The points of the frontal sinus were determined by another researcher (VK) (Figure 2).

Inter-observer error rate was evaluated using the intraclass correlation coefficient. Ten randomly selected cephalometric radiographs were drawn again three weeks after the first measurements by the same researchers. It was determined that the intraclass correlation coefficient for all repeated measurements was 0.815.

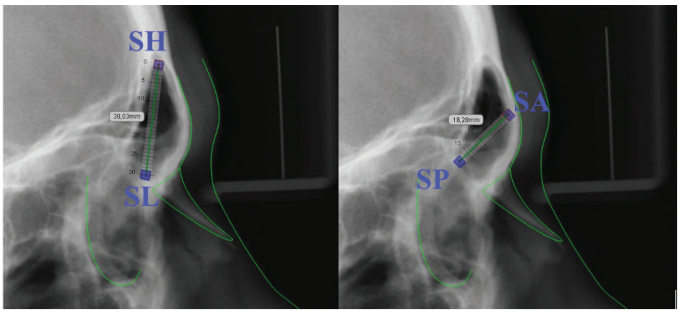

Figure 2. *Points used to calculate the height and length of the frontal sinus.*

Statistical analysis

Statistical analysis was performed using SPSS for Windows version 21.0 (IBM SPSS Armonk, NY, USA) statistical software package. Pearson's Chi-Square test, and One-way Analysis of Variance (ANOVA) was performed to compare the means of groups in terms of continuous variables. Following the analysis of variance, the Duncan multiple comparison test was used to determine the different groups. Pearson's correlation coefficient was calculated separately for each group to determine the correlation between these variables. The confidence interval was set to 95% and p values less than 0.05 were considered as statistically significant

Results

The demographic data of the individuals included in the study are shown in Table 2. There was no significant difference

Table 2: *Demographic variables of the study.*

		Skeletal Class I	Skeletal Class II	Skeletal Class III	p[1]
n (%)	Female	13 (65%)	13 (65%)	11 (55%)	0.754
	Male	7 (35%)	7 (35%)	9 (45%)	
	Total	20 (100%)	20 (100%)	20 (100%)	
Age (year) Mean±SD		19.74±2.5	19.85±2.3	20.24±2.3	

SD: Standard deviation [1]Pearson chi-square test (p<0.05).

Table 3: *Comparison of ANB angles S-N, Co-A and Co-Gn lengths among groups.*

	Groups	Mean±SD	Minimum	Maximum	p[2]
ANB (⁰)	Skeletal Class I	2.26±1.00[a]	1.0	3.7	0.001
	Skeletal Class II	6.10±1.07[b]	5.0	9.0	
	Skeletal Class III	-2.34±1.35[c]	-6.0	-8.0	
S-N (mm)	Skeletal Class I	67.56±3.57	62.2	75.8	0.570
	Skeletal Class II	66.76±2.85	62.0	73.4	
	Skeletal Class III	66.59±2.71	62.3	71.6	
Co-A (mm)	Skeletal Class I	82.46±5.03	68.4	93.2	0.089
	Skeletal Class II	83.52±4.86	75.7	92.2	
	Skeletal Class III	79.87±5.92	68.9	90.0	
Co-Gn (mm)	Skeletal Class I	110.83±5.99[a]	98.2	121.3	0.007
	Skeletal Class II	106.95±7.19[ab]	95.4	119.6	
	Skeletal Class III	114.28±7.93[ac]	102.5	128.3	

SD: Standard deviation [2]Oneway ANOVA test; (p<0.05) [a, b, c]: shows the difference between groups in the same row.

between the groups in terms of female-male ratio and mean age. No significant difference was found between the skeletal Class I, Class II and Class III groups in terms of SN and Co-A lengths, while the Co-Gn length was longer in skeletal Class III individuals than in skeletal Class II individuals (Table 3).

The frontal sinus length and height were found to be higher in skeletal Class III individuals than in skeletal Class I and skeletal Class II individuals, however, no significant difference was found between skeletal Class I and Class II individuals (Table 4).

When measured vertically, the SN-GoGn angle ranged between 31.2±6.0 and 33.2±4.3 degrees; the FMA angle was between 22.8±3.7 and 23.7±4.1 degrees. Furthermore, no significant differences in SN-GoGn and FMA values were found between the groups (Table 5).

As a result of the correlation analysis, it was determined that there was a negative correlation between the frontal sinus height and length, and the ANB angle, and a positive correlation between the S-N and Co-Gn lengths (Table 6).

Discussion

The results of the present study, in which frontal sinus dimensions were compared in individuals with skeletal Class I, Class II and Class III malocclusion,and the relationship between these dimensions and the anterior skull base length and some cephalometric values were evaluated, showed that the Co-Gn length was longer in skeletal Class III individuals than in class II individuals and the frontal sinus length

Table 5: *Comparison of FMA and SN-GoGn between groups.*

	Groups	Mean±SD	Minimum	Maximum	p[2]
FMA (⁰)	Skeletal Class I	23.1±3.7	17.0	27.9	0.740
	Skeletal Class II	23.7±4.1	17.0	31.3	
	Skeletal Class III	22.8±3.7	16.2	29.2	
SN-GoGn (⁰)	Skeletal Class I	31.8±4.6	22.4	38.3	0.429
	Skeletal Class II	33.2±4.3	22.9	41.0	
	Skeletal Class III	31.2±6.0	17.6	38.9	

SD: Standard deviation; [2]Oneway ANOVA test; (p<0.05) FMA: SN-GoGn:

Table 4: *Comparison of frontal sinus height and length between groups.*

	Groups	Mean±SD	Minimum	Maximum	p[2]
FSH (mm)	Skeletal Class I	24.44±4.20[a]	16.05	31.33	0.001
	Skeletal Class II	24.00±4.22[a]	16.14	31.50	
	Skeletal Class III	29.87±3.91[b]	24.75	36.73	
FSL (mm)	Skeletal Class I	14.03±2.93[a]	9.04	19.74	0.001
	Skeletal Class II	13.81±2.57[a]	9.55	18.77	
	Skeletal Class III	17.23±3.68[b]	11.54	25.16	

SD: Standard deviation; [2]Oneway ANOVA test; (p<0.05) FSH: Height of the frontal sinus; FSL: Length of the frontal sinus a, b, c: shows the difference between groups in the same row

Table 6: *Correlation analysis of the height and length of the frontal sinus between the ANB angle and length of ANB S-N, Co-A, and Co-Gn.*

	ANB (°)	S-N (mm)	Co-A (mm)	Co-Gn (mm)
Height of the frontal sinus	-0.539**	0.322*	0.100	0.443**
Length of the frontal sinus	-0.452**	0.301*	0.141	0.384**

*: p<0.05; **: p<0.01

and height was higher in skeletal class III individuals than in Class I and Class II individuals. Besides, it was determined that there was a negative correlation between the frontal sinus height and length, and the ANB angle, and a positive correlation between the S-N and Co-Gn lengths.

It has been stated that the frontal sinus, which is thought to play a role in the development of respiratory functions and the architecture of the skull, is also effective in nasomaxillary complex and mandible taking its final shape (13,20). Although it has been stated that the frontal sinus continues to grow until the age of 18-20, it expands greatly at the age of 12 in parallel with the pubertal and growth and spurt period, and then reaches its maximum width and length until the age of 14-16 (20). Besides, it has been reported that each individual has a unique frontal sinus shape as in fingerprints, and its volume is affected by factors such as race, environmental factors, the individual's growth and development pattern, and gender. In studies comparing frontal sinus volumes between genders, it was observed that males have a larger volume than females (11,13). For this reason, individuals in the age range of 17-25 with equal ratios of males and females were included in our study in order to prevent the frontal sinus from being affected by age and gender-related changes.

The two-dimensional lateral cephalometric films have been frequently used in studies in which the frontal sinus dimensions were evaluated in cases such as skeletal malocclusion, gender, pubertal spurt, and forensic medicine (12,16). Lateral cephalometric films, which are routinely taken as one of the orthodontic diagnostic materials, have disadvantages such as being two-dimensional and superimposition of hard tissues. However, the use of lateral cephalometric films was preferred in the calculation of frontal sinus dimensions in our study due to the additional radiation and costs of three-dimensional imaging techniques.

There are studies in the literature comparing frontal sinus dimensions and area with lateral cephalometric radiographs in individuals with skeletal Class I, Class II and Class III malocclusion. In one of these studies, Yassaei *et al*. (16) have reported that frontal sinus size and volume are larger in individuals with skeletal Class III malocclusion than in individuals with skeletal Class I and Class II malocclusions. Similarly, in a study by Prashar *et al*., (21) in which only the frontal sinus area was evaluated, it was reported that it was larger in individuals with skeletal Class III malocclusion than in individuals with Class I and Class II malocclusions. In another study comparing individuals with skeletal Class I and Class II malocclusions, no significant difference was observed between the two groups in terms of frontal sinus dimensions (22). In our study, consistent with the results of current studies, it was found that frontal sinus height and length were higher in individuals with skeletal Class III malocclusion than in skeletal Class I and Class II individuals, and no significant difference was observed between skeletal Class I and Class II individuals.

Again, as a result of the correlation analysis, it was observed that there was a negative correlation between the frontal sinus height and length, and the ANB angle, and a positive correlation between the S-N and Co-Gn lengths. In a study by Tehranch *et al*., (17) in which no skeletal classification was made in the sagittal direction, frontal sinus dimensions were evaluated from lateral and posteroanterior cephalometric radiographs in 144 individuals. As a result of the study evaluating cephalometric values such as SN-FH, Mand-SN, Occ-SN, total of posterior angles, face angle, Jarabak index, ANB, SNA, SNB, Wits, and Y-axis angle, consistent with our findings, it was stated that there was a negative correlation between the frontal sinus dimensions and ANB angle, and that the location of the nasion point might change due to the frontal sinus dimensions and accordingly the dimensions of the anterior skull base were affected. In another study in which skeletal Class I and Class III individuals were compared and cephalometric values such as maxillary length, mandibular length, condylar length, symphysis width, FMA angle, and ANB angle were evaluated, a negative correlation was reported between frontal sinus area and ANB, and a positive correlation between that and mandibular length (22).

The treatment of skeletal class III individuals with excessive mandibles through both growth and development and adulthood is difficult. The goal of this research was to examine if there was a relationship between the height and length of the fronral sinus, which completed most of the mandible's growth according to the growth spurt period. At this point, the observation that individuals with large frontal sinus height and length are more likely to be in skeletal class III individuals than skeletal class I and skeletal class II individuals suggests that we should consider the possibility of mandible breakthrough in individuals in the growth and development period in the future.

Two-dimensional measurements made from lateral cephalometric radiographs and small sample size are among the major limitations of this study. Hence, further research in which frontal sinus dimensions are evaluated with three-dimensional methods in larger sample sizes should be performed.

Conclusion

Within the limitations of our study, it was determined that the increase in frontal sinus height and length correlated positively with the decrease in ANB angle and the increase in SN and Co-Gn lengths. Therefore, the dimensions of the frontal sinus may be an indicator of individuals skeletal Class III malocclusion with mandibular excess.

Türkçe Özet: *Frontal Sinüs Boyutları ile İskelet Maloklüzyon Arasındaki İlişki. Amaç: Bu retrospektif araştırmanın amacı frontal sinüs boyutlarının iskeletsel Sınıf I, iskeletsel Sınıf II ve iskeletsel Sınıf III bireylerde ve bu boyutların ön kafa kaidesi uzunluğu ve bazı sefalometrik değerlerle*

ilişkisinin karşılaştırılmasıdır. Gereç ve Yöntem: Bu araştırmada yaşları 17 ile 25 arasında değişen 60 kişinin lateral sefalometrik radyografileri kullanıldı. İskeletsel Sınıf I maloklüzyon, mandibular yetmezliğe bağlı iskeletsel Sınıf II maloklüzyon ve mandibular fazlalığa bağlı iskeletsel Sınıf III maloklüzyona sahip bireylerde frontal sinüs uzunluğu ve yüksekliği ile SN, Co-A, Co-Gn uzunlukları ve ANB^0, FMA^0, SN-GoGn^0 açı değerleri değerlendirildi. Frontal sinüsün en yüksek noktası ile en alt noktası arasındaki uzunluk frontal sinüsün yüksekliği, frontal sinüsün en ön ve en arka noktaları arasındaki uzunluk ise frontal sinüsün uzunluğu olarak hesaplandı. Bulgular: Frontal sinüs uzunluğu ve yüksekliği, iskeletsel Sınıf III bireylerde, iskeletsel Sınıf I ve iskeletsel Sınıf II bireylere göre daha yüksek bulundu, ancak iskeletsel Sınıf I ve Sınıf II bireyler arasında anlamlı bir farklılık yoktur. Sonuç: Frontal sinüs yüksekliği ve uzunluğundaki artışın ANB açısındaki azalma ve SN ve Co-Gn uzunluklarındaki artış ile pozitif ilişkili olduğu belirlendi. Frontal sinüsün boyutlarının da kalan mandibular büyüme potansiyeli için bir gösterge olabileceği düşünülmektedir. Anahtar Kelimeler: Frontal Sinus, sefalometri, mandibula, iskeletsel maloklüzyon, büyüme.

Ethics Committee Approval: The ethics committee approval was obtained from Van Yuzuncu Yil University Faculty of Medicine Research Ethics Committee (2019/15-02).

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: MT participated in designing the study. VK, YT participated in generating the data for the study. VK, YT participated in gathering the data for the study. YK participated in the analysis of the data. MT wrote the majority of the original draft of the paper. MT, YK participated in writing the paper. YT has had access to all of the raw data of the study. MT has reviewed the pertinent raw data on which the results and conclusions of this study are based. MT, VK, YK, YT have approved the final version of this paper. MT guarantees that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Flores-Mir C, Orth C, Nebbe B, W. Major P. Use of skeletal maturation based on hand-wrist radiographic analysis as a predictor of facial growth: a systematic review. Angle Orthod 2004;74:118-24.
2. Björk A, Helm S. Prediction of the age of maximum puberal growth in body height. Angle Orthod 1967;37:134-43.
3. Baccetti T, Franchi L, McNamara JA. The Cervical Vertebral Maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. Semin Orthod 2005;11:119-29. [CrossRef]
4. Bacetti T, Reyes BC, McNamara JA. Gender differences in Class III malocclusion. Angle Orthod 2005;75:510-21.
5. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofac Orthop 1995;107:58-66. [CrossRef]
6. Perinetti G, Westphalen GH, Biasotto M, Salgarello S, Contardo L. The diagnostic performance of dental maturity for identification of the circumpubertal growth phases: A meta-analysis. Prog Orthod 2013;14:8. [CrossRef]
7. Durka-Zajac M, Marcinkowska A, Mituś-Kenig M. Bone age assessment using cephalometric photographs. Polish J Radiol 2013;78:19-25. [CrossRef]
8. Patcas R, Signorelli L, Peltomäki T, Schätzle M. Is the use of the cervical vertebrae maturation method justified to determine skeletal age? A comparison of radiation dose of two strategies for skeletal age estimation. Eur J Orthod 2013;35:604-9. [CrossRef]
9. Soegiharto BM, Cunningham SJ, Moles DR. Skeletal maturation in Indonesian and white children assessed with hand-wrist and cervical vertebrae methods. Am J Orthod Dentofac Orthop 2008;134:217-26. [CrossRef]
10. Ruf S, Pancherz H. Development of the frontal sinus in relation to somatic and skeletal maturity. A cephalometric roentgenographic study at puberty. Eur J Orthod 1996;18:491-7. [CrossRef]
11. Enlow DH, Hans MG. Essentials of facial growth. Philadelphia: Saunders, 1996.
12. Buyuk SK, Karaman A, Yasa Y. Association between frontal sinus morphology and craniofacial parameters: A forensic view. J. Forensic Leg Med 2017;49:20-3. [CrossRef]
13. Mahmood HT, Shaikh A, Fida M. Association between frontal sinus morphology and cervical vertebral maturation for the assessment of skeletal maturity. Am J Orthod Dentofac Orthop 2016;150:637-42. [CrossRef]
14. Lambrechts AH, Harris AM, Rossouw PE, Stander I. Dimensional differences in the craniofacial morphologies of groups with deep and shallow mandibular antegonial notching. Angle Orthod 1996;66:265-72.
15. Salehi P, Heidari S, Khajeh F. Relationship between frontal sinus surface area and mandibular size on lateral cephalograms of adults. J Isfahan Dent Sch 2012;8:244-50.
16. Yassaei S, Emami A, Mirbeigi S. Cephalometric association of mandibular size/length to the surface area and dimensions of the frontal and maxillary sinuses. Eur J Dent 2018; 12:253-61. [CrossRef]
17. Tehranchi A, Motamedian SR, Saedi S, Kabiri S, Shidfar S. Correlation between frontal sinus dimensions and cephalometric indices: A cross-sectional study. Eur J Dent 2017; 11:64-70. [CrossRef]
18. Metin-Gürsoy G, Akay G, Baloş Tuncer B. Frontal sinus: is it a predictor for vertical malocclusions? Anat Sci Int 2021;96:62-9. [CrossRef]
19. Ertürk N. Fernröntgenuntersuchungen über die Entwicklung der Stirnhöhle. Fortschr Kieferorthop 1968;29:245-8. [CrossRef]
20. Guevara Y, Watanabe N, Yamaki M, Saito I. The frontal sinus enlargement as an indicator of growth maturity in class III patients- A pilot study. Int. J. Med. Sci. Public Heal 2013;2:430-4. [CrossRef]
21. Prashar A, Sharma VP, Singh G, Sharma N, Singh H. A cephalometric study of frontal sinus and its relation with craniofacial patterns. Indian J Dent Sci 2012;4:4-8.
22. Gökalp H, Şenol A, Karaca N. Sınıf II Maloklüzyonda Frontal Sinus ve Maksiller Büyüme Tahmini: Sefalometrik Çalışma. Ankara Üniv Diş Hek Fak Dergi 2015;42:159-64.

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 136-142

Original research

Professional motivations and perceptions of senior dental students in the distance education period during the first year of the Covid-19 pandemic

Cansu Ozsin Ozler[1],
Cansu Atalay[2],
Ece Meral[2],
Meryem Uzamis Tekcicek[1],
Bahar Guciz Dogan[3],
Esra Ergin[2]

Purpose
Dental students are particularly prone to be affected by the global emergency of Coronavirus-19 (Covid-19) pandemic. The aim of this study was to evaluate the professional motivations and perceptions of senior dental students during the distance education period due to pandemic.

Materials and Methods
The data was collected via an online questionnaire, including questions related to students' professional motivation and perceptions, and views about preventive dentistry. For identifying the distress levels, Turkish version of Depression Anxiety Stress Scale (DASS)-21 was used. Descriptive statistics and marginal homogeneity test were used for statistical analysis.

Results
A total of 114 (83 female, 31 male) students, with the mean age of 23.7±1.03 participated the study. Statistically significant changes were observed on the students' career plans ($p<0.001$); fear about getting and transmitting infectious diseases ($p<0.001$); and satisfaction about their profession ($p<0.001$) during the Covid-19 pandemic. Motivation loss was determined on the participants.

Conclusion
There is an urgent need for revision on dental education in order to ensure the students be competent to provide oral health service that can meet the latest needs and achieve professional self-confidence without deterioration on their professional motivation and perceptions. Crisis-oriented psychological support programs should be provided for students. Some improvements should be structured in terms of preventive dentistry issues, both for dental education and dental health service aspects.

Keywords: *Covid-19, dental students, distance education, motivation, preventive dentistry*

Introduction

Since the end of 2019, world has spanning a pandemic occurred by a virus which the disease setting named Coronavirus disease (Covid-19) (1). The global emergency of Covid-19 has been extraordinary disruptive for several industries and sectors, including education (2, 3). Worldwide prevention methods like quarantine, social distancing in education and possible working areas, cancellation of flights, postponement of art and sports activities were implemented for an unknown time period. The closure of educational institutions was a necessity for reducing the spread of infection within the community (4). Since mid-March of 2020, face-to-face education in the universities has shifted to distance education in Turkey as in most of the countries in the world (5). In Turkey, the undergraduate education period of dental faculties is 5 years and during the 4th and

ORCID IDs of the authors: C.O.O. 0000-0002-9366-3991; C.A. 0000-0002-5128-1741; E.M. 0000-0002-7087-8084; M.U.T. 0000-0003-1179-7708; B.G.D. 0000-0002-9658-2513; E.E. 0000-0002-7667-7494

[1]Department of Pediatric Dentistry, Faculty of Dentistry, Hacettepe University, Ankara, Turkiye

[2]Department of Restorative Dentistry, Faculty of Dentistry, Hacettepe University, Ankara, Turkiye

[3]Department of Public Health, Faculty of Medicine, Hacettepe University, Ankara, Turkiye

Corresponding Author: Cansu Ozsin Ozler

E-mail: cansu.ozsin@hacettepe.edu.tr

Received: 21 May 2021
Revised: 17 January 2022
Accepted: 1 February 2022

DOI: 10.26650/eor.2022940520

How to cite: *Ozler Ozsin C, Atalay C, Meral E, Tekcicek Uzamış M, Dogan Guciz B, Ergin E. Professional motivations and perceptions of senior dental students in the distance education period during the first year of the Covid-19 pandemic. Eur Oral Res 2022; 56(3): 136-142. DOI: 10.26650/eor.2022940520*

5th years, students receive clinical and theoretical education (6). After 5-years of university education, for dental profession, graduates can work as private dentists, can service in public dental hospitals or may choose to specialize and take the central specialty exam organized by the government. Candidates who want to attend a specialty education are allocated to certain Dental Faculties with this exam (7). The specialty education continues 3 or 4 years according to the preferred program. Students should present a dissertation thesis and take an oral scientific exam to complete the selected program (8).

The consequences of such outbreaks might ruin physical and mental health and affect the professional motivation and career plans as well (9). Being on the list of high-risk professions due to the great infection risk besides bearing the work overload, dentists are much expected to develop severe anxiety related to the current pandemic (10). Sharing these common concerns as graduate candidates, 5th year dental students had also faced with additional challenges with the unexpected university closures and shift to distance education, which may also affect their mental and psychological health (4). From this point, senior dental students about to step practicing their profession are a special group which might be particularly confused about their professional life.

Undoubtedly, it is vital to revise the dental education and dental practice related to current conditions and requirements. Therefore, it is very important to investigate the influence of Covid-19 pandemic on dental students' professional motivations and perceptions for being able to make the necessary revisions on dental education and to eliminate the existing nullified issues. The current study aimed to examine these issues, by evaluating the professional motivations and perceptions of senior dental students during the Covid-19 pandemic.

Material and Methods

Participants

This descriptive cross-sectional study was conducted at Hacettepe University, Faculty of Dentistry, located at the capital city of Turkey. The universe of the study consisted of 150 senior students, enrolled in the faculty during the 2019-2020 academic year.

Ethical statement and data collection

In the Covid-19 pandemic period, education transferred to distance learning beginning from 16th March 2020 until the end of the academic year, for this reason the data were gathered online. Non-interventional Clinical Researches Ethics Board of Hacettepe University approved the study protocol (GO 20/538). Besides, the mandatory formal permission was also obtained from Turkish Republic Ministry of Health (2020-05-21T15_38_18). A questionnaire was developed that reflected the possible impact of Covid-19 on the professional career plans and views of 5th year dental students. The questionnaire was pre-tested with a group of 10 randomly selected 5th year students from other dental faculties. Following the justification of the protocol, the questionnaire link was posted on the entrance page of the "Hacettepe University Faculty of Dentistry Student Portal" as an announcement and volunteers were asked to participate. Participation was entirely voluntary. In order to encourage students' participation, they were informed that all related data would be kept confidential.

The study questionnaire

The questionnaire was opened by clicking on a link created on an online survey system ("Surveey.com") and the students were informed about the dates when the link would be active as data collection period (June 24 – July 1, 2020). An informed consent form was placed at the first page of the questionnaire. The questionnaire form consisted of 27 questions: 3 of them regarding sociodemographic characteristics, 4 health conditions and stress status, 7 career plans before the pandemic and in the distance education period, 4 fear from getting an infectious disease or infecting patients, 5 profession satisfaction levels before and after the pandemic, 4 inclusion of "concepts and principles of preventive dentistry" into the curricula of the dentistry faculty. In addition, students were also asked to fill the Turkish version of Depression Anxiety Stress Scale (DASS)-21, which was previously reported to be a useful tool to measure distress levels by means of a self-reported questionnaire (11, 12, 13, 14).

Statistical analysis

The data was analyzed by using Statistical Package for the Social Sciences Version 20.0 (SPSS Inc., Chicago, IL, USA). Frequency and percentages for the qualitative data, and distribution statistics for the quantitative data were used as descriptive statistics. Besides, marginal homogeneity test was used to determine the differences between the responses of the group before and during the pandemic. Statistical significance level was considered as $p < 0.05$.

Results

In this study, 114 of 150 fifth year students participated the online survey. The characteristics of the participants are presented in Table 1. Among the participants, 83 (72.8%) were female. The mean age of the students was 23.7±1.03 ranging between 22 and 28. Among all participants, 9 international students out of 10, 7 Turkish students out of 59 could not go back to their home and they had to stay in Ankara, Turkey; while other 45 were in Ankara at family home during the distance education period. Twenty students (17.5%) reported to have a chronic/systemic disease. Of all students, 31.6%, 18.4% and 13.2% were out of the normal ranges for depression, anxiety and stress, respectively.

Distribution of students' views about their professional motivation and perceptions before Covid-19 pandemic and in the distance education period during the first year of the pandemic are shown in Table 2. The participants reported that their career plans were 44.8% being an academician, 33.3% working in a private practice, 6.1% working in a public dental hospital and 15.8% were undecided before pandemic. Significant changes were observed on students' career plans during the Covid-19 pandemic ($p<0.001$) (Table 2). According to the

Table 1: *Some characteristics of the participants (Ankara-Turkiye, 2020).*

Characteristics (n=114)	n	%
Sex		
Female	83	72.8
Male	31	27.2
Age		
X±SD=23.7±1.03; Median: 23.5; 1. Quartile: 23; 3. Quartile: 24; Min.: 22, Max.: 28		
Accommodation in this period		
Foreign student, home country	1	0.9
Foreign student, stated in Ankara	9	7.9
Turkish student, at family home in Ankara	45	39.5
Turkish student, at family home out of Ankara	52	45.6
Turkish student, stated in Ankara	7	6.1
Having a chronic/systemic disease		
No	94	82.5
Yes	20	17.5
Depression status according to DASS 21†		
Normal (<9)	78	68.4
More than normal range	36	31.6
Anxiety status according to DASS 21†		
Normal (<7)	93	81.6
More than normal range	21	18.4
Stress status according to DASS 21†		
Normal (<14)	99	86.8
More than normal range	15	13.2

† Severity ranking scores according to DASS-42 (14). DASS-21 mean scores are doubled to calculate severity ranking: Depression: normal = 0-9. Anxiety: normal = 0-7. Stress: normal = 0-14.

participants' reports, 91.2% was planning to take the central dental specialty exam before the Covid-19 pandemic; no significant changes were observed on students' plans during the distance education period (p=0.108) (Table 2). No significant change was observed on students' (n=96) first choice for planned dental specialty during the Covid-19 pandemic, which is seen in Table 2 (p=0.094). A small number of students who planned to choose invasive clinical practices before the pandemic changed their mind to prefer "oral diagnosis and maxillofacial radiology" and "orthodontics".

The participants reported the fear of getting an infectious disease before the pandemic as "not/a little scared" 54.4% and "terrified" 1.8%, and fear of transmitting an infectious disease as 80.7% and 1.8%, respectively. Significant changes were observed on students' fear about picking up and transmitting an infectious disease during the pandemic (p<0.001) (Table 2). The students who were "little scared" off picking up an infectious disease before the pandemic, changed their mind to "scared" (70.2%) or "terrified" (15.8%). The students who were "little scared" off transmitting an infectious disease before the pandemic, changed their mind to "scared" (61.4%) or "terrified" (6.8%). Furthermore, the students who were "scared" for picking up or transmitting an infectious disease before the Covid-19 pandemic, changed their mind to "terrified" in percentages 46.0% and 25.0%; respectively.

Of all students, 12.3% (n=14) stated that they didn't have chosen dentistry by her/himself willingly; 1.8% stated that they were "not satisfied" at all, 3.5% "not glad", 18.4%, "undecided", 46.5% "glad", 29.8% "very glad" to be a dentist before the Covid-19 pandemic. Significant changes were observed on students' satisfaction levels about their profession during the first year of the Covid-19 pandemic (p<0.001) (Table 2). Twenty-eight of 53 "glad" students and 3 of 34 "very glad" students turned to be undecided in this period related to their profession. Seven out of 9 "undecided" students before the pandemic, decided "not to work as a dentist" during the distance education period with a statistically unsignificant change (p=0.330, Table 2).

The responses of the students showed that 107 of the participants (93.9 %) projected some changes in dental profession due to Covid-19 pandemic. Among the students, 60.5% thought that the "preventive dentistry" issues were adequately covered in the dental curriculum before Covid-19 pandemic and 28 (24.6%) were not. Also, 58.8% of the students recommended that the intensity of "preventive dentistry" issues included in the dental curriculum during and after the Covid-19 outbreak should be increased. Among the students who recommended an increase, 40.3% previously used to believe that the "preventive dentistry" issues have been adequately covered. Already, it was found that 39.1% among the students previously believed that the "preventive dentistry" issues were adequately covered in the dental curriculum changed their mind into need for increase. In the same vein, 99 participants (86.8%) thought that the place and importance of "preventive dentistry" would gain even more prominence in dental profession due to Covid-19 pandemic (Table 3).

Discussion

During the first year of the Covid-19 pandemic period, there were several factors such as the social restrictions, prohibitions, quarantine processes, lockdowns, and disruption of face-to-face education etc. that may influence the professional views and psychological states of the students. When countries first entered lockdown phase, universities were at the beginning of the spring semester, in Turkey. In dental schools, students both in their pre-clinical and clinical years had transitioned to online courses and examinations. Fourth- and fifth-year students could not continue the clinical trainings and faced with further concerns about their career. Especially, for fifth year senior students, the unclarity related to graduation, interrupted face-to-face activities, un-

Table 2: *Distribution of students' views about their professional motivation and perceptions before and in the distance education period during pandemic (Ankara-Turkiye, 2020).*

Views	In the distance education period during pandemic (n, %†)			
	Before Covid-19 pandemic (n, %‡)	**Persistent on previous idea**	**Changed previous idea**	**p***
Career plans	n=114 (100.0)	n=78 (68.4)	n=38 (31.6)	**<0.001**
Being an academician	51 (44.7)	33 (64.7)	18 (35.3)	
Working in a private practice	38 (33.3)	29 (76.4)	9 (23.6)	
Working in a public dental hospital	7 (6.1)	4 (57.1)	3 (62.9)	
Undecided	18 (15.8)	12 (66.7)	6 (33.3)	
Plans for taking central dental specialty exam	n=114 (100.0)	n=101 (88.6)	n=13 (13.4)	0.108
No	3 (2.6)	2 (66.7)	1 (33.3)	
Yes	104 (91.2)	96 (92.3)	8 (7.7)	
Undecided	7 (6.1)	3 (42.9)	4 (57.1)	
Planned first choice dental specialty	n=96¶ (100.0)	n=84 (73.7)	n=12 (26.3)	0.094
Oral and maxillofacial surgery	23 (24.0)	20 (87.0)	3 (13.0)	
Oral diagnosis and maxillofacial radiology	2 (2.1)	2 (100.0)	0 (0.0)	
Endodontics	2 (2.1)	2 (100.0)	0 (0.0)	
Orthodontics	10 (10.4)	9 (90.0)	1 (10.0)	
Pediatric Dentistry	18 (18.8)	15 (83.3)	3 (16.7)	
Periodontics	13 (13.5)	9 (69.2)	4 (30.8)	
Prosthodontics	12 (12.5)	11 (91.7)	1 (8.3)	
Restorative Dentistry	9 (9.4)	9 (100.0)	0 (0.0)	
Undecided	7 (7.2)	7 (100.0)	0 (0.0)	
Fear from getting an infectious disease	n=114 (100.0)	n=36 (31.6)	n=78 (68.4)	**<0.001**
Not scared	5 (4.4)	1 (20.0)	4 (80.0)	
A little scared	57 (50.0)	8 (14.0)	49 (86.0)	
Scared	50 (43.9)	26 (52.0)	24 (48.0)	
Terrified	2 (1.8)	1 (50.0)	1 (50.0)	
Fear of transmitting the infectious disease	n=114 (100.0)	n=38 (33.3)	n=76 (66.7)	**<0.001**
Not scared	48 (42.1)	8 (16.7)	40 (83.3)	
A little scared	44 (38.6)	14 (31.8)	30 (68.2)	
Scared	20 (17.5)	14 (70.0)	6 (30.0)	
Terrified	2 (1.8)	2 (100.0)	0 (0.0)	
Satisfaction about being a dentist	n=114 (100.0)	n=60 (52.6)	n=54 (47.4)	**<0.001**
Not satisfied at all	2 (1.8)	2 (100.0)	0 (0.0)	
Not glad	4 (3.5)	2 (50.0)	2 (50.0)	
Undecided	21 (18.4)	12 (57.1)	9 (42.9)	
Glad	53 (46.5)	28 (52.8)	25 (47.2)	
Very glad	34 (29.8)	16 (47.1)	18 (52.9)	
Thinking not practicing the dentistry after graduation	n=114 (100.0)	n=82 (71.9)	n=32 (28.1)	0.330
No	95 (83.3)	81 (85.3)	14 (14.7)	
Yes	10 (8.8)	1 (10.0)	9 (90.0)	
Not sure	9 (7.9)	0 (0.0)	9 (100.0)	

†Row percentage ‡ Column percentage ¶Before the Covid-19, 104 students were planning to take the exam, while 99 were planning after the pandemic; 96 is the number of students who were planning in both periods. *Marginal Homogeneity-test

Table 3: *The distribution of the students' views about the place and importance of "preventive dentistry" in dental education and profession (Ankara-Turkiye, 2020).*

Views (n=114)	n	%
Thinking any change occurrence in dental profession due to Covid-19 pandemic		
No	4	3.5
Yes	107	93.9
Undecided	3	2.6
Thinking the "preventive dentistry" issues were adequately covered in the dental curriculum before Covid-19 pandemic		
No	28	24.6
Yes	69	60.5
Undecided	17	14.9
The intensity of "preventive dentistry" issues included in the dental curriculum during and after the Covid-19 pandemic		
Should be increased	67	58.8
Should be the same	35	30.7
Should be decreased	6	5.3
No idea	6	5.3
Thinking the place and importance of "preventive dentistry" would gain even more prominence in dental profession due to Covid-19 pandemic		
No	11	9.6
Yes	99	86.8
Undecided	4	3.5

fulfilled clinical courses and infection concerns were all expected to influence their professional views and psychological health (15). Based on these facts, this study was carried out to evaluate the professional motivations and perceptions of the senior dental students in the online education period during the first year of Covid-19 pandemic. It was revealed that the pandemic has influenced the students' views about their profession and career plans to some extend and it is crucial to make some provisions/revisions in dental education for being able to meet the current requirements both for students and dental public health aspects.

Distress is defined as "a set of painful mental and physical symptoms that are associated with normal fluctuations of mood in most people. In some cases, however, it is assessed by as putative self-report measures of depression and anxiety" (16). In this study, the depression, anxiety and stress status of the students were evaluated with DASS-21. The study was carried out, almost at the end of spring semester, 3 months after the detection of first Covid-19 case in the country. This certain period was chosen for revealing the status in a more stabilized online education and moderately normalized-controlled social life period rather than an acute condition. According to the findings of DASS-21, the distress levels of the students might be affected negatively due to the pandemic. However, it's impossible to know the influence of pandemic on the participants' psychological status for certain, since their previous distress levels were something of a puzzle. The results of our study are in line with previous findings. Ozdede et al. (17) reported that the pre-clinical and clinical dental students in Pamukkale University/Turkey were anxious about Covid-19 evaluated with State-Trait-Anxiety-Inventory (STAI) scales. Hakami et al. (18) from Saudi Arabia reported elevated depression, anxiety and stress among first-to-fifth-year dental students by using DASS-21. Consolo et al. (19) reported an anxiety rate of 10.3% among the dentists in Northern Italy using Generalized Anxiety Disorder-7 (GAD-7) scale. Generali et al. (20) evaluated the psychological impact of Covid-19 on dental students in Emilia-Romagna, the fifth most affected region of Italy by the pandemic, and found that 6.5% of dental students showed symptoms related to high levels of anxiety. Chakraborty et al. (21) conducted a study to screen the depression levels of the dental students and practitioners during the Covid-19 lockdown. They reported a high level of depression among a significant number of dental students and practitioners and highlighted the importance of addressing the mental health needs of these groups during and after the pandemic. The findings of our study are consistent with those reported by the mentioned studies.

The pandemic may have a serious influence on the professional views and career plans of students at the pre-graduation stage. They might have changed their plans due to the lack of their motivation and felt a fear of challenges caused by the Covid-19 crisis they would have to face unpreparedly. Garcia et al. (22) reported that 11.5% of dental and dental hygiene students have changed their career plans regarding the limited employment opportunities, long-term stability of the dental profession, and the interruptions to clinical education and licensure examinations since the Covid-19 outbreak. Consolo et al. (19) stated that the majority of dentists (89.6%) reported concerns about their professional future and the hope for economic measures to help dental practitioners. Agius et al. (23) stated the dental students greatly felt fear of losing their manual dexterity skills and experienced anxiety related to its consequences on their long-term plans. In the present study, the results showed that 66.7% of the students continued to be "undecided" for their career plans after the graduation, while students who previously planned to be an academician, to work in a private practice, to work in a public dental hospital changed their minds as "undecided" in different proportions (21.6%, 15.8% and 42.9%; respectively) due to pandemics. Besides, it is noteworthy that students who were planning to attend pediatric dentistry and periodontology specialty programs before pandemic, changed their ideas towards oral diagnosis and maxillofacial radiology or orthodontics programs, which might be categorized as minimal invasive/non-invasive branches. The loss of motivation, the demand in less invasive and physical contact clinical applications, infection fear and uncertainty about the post-pandemic clinical regulations on profession might be speculated as the reasons for these findings.

Among healthcare professionals, dentists have a great risk of getting infected due to close contact with patients. For infection prevention in dental settings, there is a need to improve understanding of dental healthcare personnel about the basic principles and the use of checklists, policies, and practices about prevention (10, 24). Adeel Ahmed et al. (10) reported that 87.0% of the dental care professionals were afraid of getting infected from a patient/co-worker and

90.0% were anxious while providing a treatment. This is parallel with our results that showed 89.4% of the students were scared or terrified of getting infection. The percentages of "not scared/a little scared" were more than the half (54.4%) before the pandemic. This result might be caused with the thought of performing procedures under approved, safe and adequate protection measures. On the other hand, these former views might be arisen from the thought of "nothing happens to me", which supports the need for revision of dental students' knowledge related to infection control. Furthermore, the percentages of "scared/terrified" for the fear of transmitting an infectious disease to the patients were 19.3% before the pandemic, and increased to 62.3% with the pandemic. The significant increase in these groups might be caused by the negative influence of Covid-19 disease on students. The unexpected Covid-19 disease may have prompted an awakening of the participants about the risks associated with the dental profession. In addition, while 57.1% of "undecided" students about their satisfaction with being a dentist before the pandemic remained their indecisiveness, 39.6% of "glad" and 8.8% of "very glad" students being a dentist changed their mind as "undecided" due to pandemic. This inconstancy about job satisfaction might brought along a loss of motivation. Furthermore, 14.7% of the students who intend to pursue the dentistry profession after graduation decided not to work as dentist during Covid-19 pandemic.

Preventive dentistry prioritizes protection and it is important to handle infectious diseases in terms of oral health. In this study, it was found that 39.1% among the students previously believed that the "preventive dentistry" issues were adequately covered in the dental curriculum changed their mind in "to be increased". This finding make think that some of the students who previously believed that the "preventive dentistry" issues were adequately covered in the dental curriculum, found some deficiencies and changed their mind during the Covid-19 pandemic. The increasing interest, the thought of "preventive dentistry will gain importance after the Covid-19 outbreak", in preventive branches could prevent tooth loss and reduce the need for many aggressive treatments that create a source of infection with aerosol media. Furthermore, 93.9% (n=107) of the students reported that some changes would take place in dental professional practice after the pandemic as an obvious result due to increased awareness.

In order to make it clear, it is very important to pay attention to the limitations of the study. Firstly, the possibility of the negative influence on students' motivation and physiological status was evaluated via an online questionnaire and scale, but their status before the pandemic is not known, which is a critical point to interpret the relation about the pandemic. Also, it should not be forgotten that, the current findings just reflect the feelings and thoughts of the students in the early stage of the Covid 19 pandemic; and the results might have changed nowadays. Additionally, due to the nature of the study plan, the presented results were gathered from only one faculty which limits the generalizability of the findings for all senior dentistry students, who continued their education under different conditions.

As a consequence, the motivation loss and distress signs were observed in senior dental students. The ravages of pandemic on young dentist candidates who are at the beginning of their careers, is concerning. This negative influence might continue and increase due to the prolonged time of pandemic and exhaustion caused by this period. In any case, universities and education leaders should regularly update their students on what the future can bring in terms of courses or programs without forgetting the importance of social support (25). The necessary efforts should be made by universities to help students stay in good mental and physical health (26). On the other hand, even after the Covid 19 pandemic ends, similar pandemics could be likely experienced in the future. Therefore, by taking lessons from the current trouble, academic members and administrators should take on responsibility to revise dental education and dental health service concepts to meet the current requirements and to be prepared for future crises.

Conclusion

The distress levels of the included students highlight the need for crisis-oriented psychological support programs for dentistry students during Covid-19 pandemic involving institutional counseling services. Dentistry faculties need to revise their education and infection protocols for senior students; so that they can assemble their education completely, achieve professional self-confidence as well as competence to manage oral health services that can meet the latest needs hereupon the Covid-19 pandemic without deterioration on their motivation and perceptions. In terms of "Preventive Dentistry" issues, some improvements are expected to be driven from the actual emergency situation, both for dental education and dental health service aspects.

Türkçe Özet: *Kovid-19 pandemisinin birinci yılında uzaktan eğitim döneminde diş hekimliği öğrencilerinin mesleki motivasyonları ve algıları. Amaç: Diş hekimliği öğrencileri, Koronavirus-19 (Kovid-19) pandemisinin erken döneminde küresel ölçekte yaşanan durumlardan etkilenmeye özellikle daha meyillidir. Bu çalışmanın amacı, son sınıf diş hekimliği öğrencilerinin pandemiye bağlı uzaktan eğitim döneminde mesleki motivasyonlarını ve algılarını değerlendirmektir. Gereç ve Yöntem: Veriler, öğrencilerin mesleki motivasyonları ve algıları ile koruyucu diş hekimliği hakkındaki görüşleri ile ilgili soruları içeren çevrimiçi bir anket aracılığıyla toplanmıştır. Sıkıntı düzeylerini belirlemek için Depresyon Anksiyete Stres Ölçeği (DASÖ)-21'in Türkçe versiyonu kullanılmıştır. İstatistiksel analiz olarak tanımlayıcı istatistikler ve marjinal homojenlik testi kullanılmıştır. Bulgular: Araştırmaya yaş ortalaması 23,7±1,03 olan toplam 114 (83 kadın, 31 erkek) öğrenci katılmıştır. Öğrencilerin Kovid-19 pandemisi sırasında kariyer planlarında ($p<0,001$); bulaşıcı hastalıklara yakalanma ve bulaşıcı hastalıkları bulaştırma korkularında ($p<0,001$); ve mesleklerinden memnuniyetlerinde ($p<0,001$) istatistiksel olarak anlamlı değişiklikler gözlenmiştir. Katılımcılarda motivasyon kaybı tespit edilmiştir. Sonuç: Öğrencilerin, mesleki motivasyon ve algılarında bozulma olmadan, güncel ihtiyaçları karşılayabilecek ağız sağlığı hizmeti verebilecek yeterlilikte olmaları ve mesleki özgüvenlerini kazanmaları için diş hekimliği eğitiminde acilen revizyona ihtiyaç vardır. Öğrencilere kriz odaklı psikolojik destek programları sunulmalıdır. Hem diş hekimliği eğitimi, hem de ağız ve diş sağlığı hizmetleri açısından koruyucu diş hekimliği konularında bazı iyileştirmeler yapılandırılmalıdır. Anahtar Kelimeler: Kovid-19, diş hekimliği öğrencileri, uzaktan eğitim, motivasyon, koruyucu diş hekimliği.*

Ethics Committee Approval: Non-interventional Clinical Researches Ethics Board of Hacettepe University approved the study protocol (GO 20/538).

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: COO, BGD, EE participated in designing the study. COO, CA participated in generating the data for the study. COO, CA, EM participated in gathering the data for the study. COO, BGD, EE participated in the analysis of the data. COO, BGD, EE wrote the majority of the original draft of the paper. COO, CA, EM, MUT, BGD, EE participated in writing the paper. COO, CA, EM, MUT, BGD, EE have had access to all of the raw data of the study. COO, BGD, EE have reviewed the pertinent raw data on which the results and conclusions of this study are based. COO, CA, EM, MUT, BGD, EE have approved the final version of this paper. COO, CA, EM, MUT, BGD, EE guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 2020 [accessed 02.02.2022].
2. Remtulla R. The Present and Future Applications of Technology in Adapting Medical Education Amidst the COVID-19 Pandemic. JMIR Med Educ 2020; 6: e20190. [CrossRef]
3. Gralinski L E, Menachery V D. Return of the Coronavirus: 2019-nCoV. Viruses 2020; 12. [CrossRef]
4. Sahu P. Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. Cureus 2020; 12: e7541. [CrossRef]
5. Koronavirüs: Adım adım Türkiye'nin Covid-19'la mücadelesi 2020 [accessed 02.02.2022] .
6. Hacettepe University Course Catalog. Dentistry Programme Course List. [accessed 02.02.2022].
7. Presidency of Measurement, Selection and Placement Center of the Republic of Turkey. Dental Specialization Exam.
8. Legal Information System of the Republic of Turkey. Regulation on Specialty Education in Medicine and Dentistry.
9. Khan S, Siddique R, Li H, Ali A, Shereen M A, Bashir N, et al. Impact of coronavirus outbreak on psychological health. J Glob Health 2020; 10: 010331. [CrossRef]
10. Ahmed M A, Jouhar R, Ahmed N, Adnan S, Aftab M, Zafar M S, et al. Fear and Practice Modifications among Dentists to Combat Novel Coronavirus Disease (COVID-19) Outbreak. Int J Environ Res Public Health 2020; 17. [CrossRef]
11. Antony M M, Bieling J P, Cox J B, Enns W M, Swins P R. Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. Psychological Assessment 1998; 10: 176-81. [CrossRef]
12. Yılmaz O, Boz H, Arslan A. Depresyon Anksiyete Stres Ölçeğinin (DASS 21) Türkçe Kısa Formunun Geçerlilik-Güvenilirlik Çalışması. Finans Ekonomi ve Sosyal Araştırmalar Dergisi 2017; 2: 78-91.
13. Lovibond S, Lovibond P. The Structure Of Negative Emotional States: Comparison Of The Depression Anxiety Stress Scales (Dass) With The Beck Depression And Anxiety Inventories. Behav Res Ther 1995; 33: 335-43. [CrossRef]
14. Lovibond S H, Lovibond P F. Manual for the Depression Anxiety Stress Scales. 2nd ed. Sydney, Australia: Psychology Foundation of Australia; 1995. [CrossRef]
15. Koronavirüs - Okullar 16 Mart'tan itibaren 1 hafta tatil, spor karşılaşmaları Nisan sonuna dek seyircisiz 2020 [accessed 02.02.2022].
16. APA. American Psychological Association Dictionary of Psychology. Psychological distress [accessed 02.02.2022].
17. Özdede M, Cinel Sahin S. Views And Anxiety Levels Of Turkish Dental Students During The Covid-19 Pandemic J Stoma 2020; 73: 123-8. [CrossRef]
18. Hakami Z, Khanagar S B, Vishwanathaiah S, Hakami A, Bokhari A M, Jabali A H, et al. Psychological impact of the coronavirus disease 2019 (COVID-19) pandemic on dental students: A nationwide study. J Dent Educ 2020. [CrossRef]
19. Consolo U, Bellini P, Bencivenni D, Iani C, Checchi V. Epidemiological Aspects and Psychological Reactions to COVID-19 of Dental Practitioners in the Northern Italy Districts of Modena and Reggio Emilia. Int J Environ Res Public Health 2020; 17. [CrossRef]
20. Generali L, Iani C, Macaluso G M, Montebugnoli L, Siciliani G, Consolo U. The perceived impact of the COVID-19 pandemic on dental undergraduate students in the Italian region of Emilia-Romagna. Eur J Dent Educ 2020. [CrossRef]
21. Chakraborty T, Subbiah G K, Damade Y. Psychological Distress during COVID-19 Lockdown among Dental Students and Practitioners in India: A Cross-Sectional Survey. Eur J Dent 2020; 14: S70-S8. [CrossRef]
22. Garcia D T, Akinkugbe A A, Mosavel M, Smith C S, Brickhouse T H. COVID-19 and Dental and Dental Hygiene Students' Career Plans. JDR Clin Trans Res 2021: 2380084420984772. [CrossRef]
23. Agius A M, Gatt G, Vento Zahra E, Busuttil A, Gainza-Cirauqui M L, Cortes A R G, et al. Self-reported dental student stressors and experiences during the COVID-19 pandemic. J Dent Educ 2020. [CrossRef]
24. Cleveland J L, Gray S K, Harte J A, Robison V A, Moorman A C, Gooch B F. Transmission of blood-borne pathogens in US dental health care settings: 2016 update. J Am Dent Assoc 2016; 147: 729-38. [CrossRef]
25. Ullah R, Amin S. The psychological impact of COVID-19 on medical students [Letter]. Psychiatry Res 2020; 288: 113020. [CrossRef]
26. Zhai Y, Du X. Addressing collegiate mental health amid COVID-19 pandemic. Psychiatry Research 2020; 288. [CrossRef]

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 143-148

Original research

Cone beam computed tomography evaluation of sphenoid sinus in different sagittal skeletal pattern

Selin Yesiltepe[1], Elif Kurtuldu[2], Ibrahim Sevki Bayrakdar[3], Ahmet Berhan Yılmaz[4]

Purpose

The purpose of this study is to explore sphenoid sinus variations in individuals with various sagittal skeletal anomalies using cone-beam computed tomography (CBCT).

Materials and Methods

We retrospectively analyzed sphenoid sinus pneumatization on CBCT images of 126 patients aged 18–86 years. The anteroposterior skeletal relationships of the maxilla and mandible were classified as skeletal class I, II or III using the A point–nasion–B point (ANB) angle measured in the sagittal plane. The extensions of the sphenoid sinus were evaluated on three planes including axial, sagittal and coronal sections.

Results

The study population consisted of 84 females (66.7%) and 42 males (33.3%), including 52 (41.3%) class I, 38 (30.1%) class II, and 36 (28.6%) class III cases. The conchal type of sphenoid sinus was not encountered. Presellar sinuses were detected in only 3 (5.8%) class I cases. Incomplete sinuses were detected in 16 (30.8%) class I, 7 (18.4%) class II, and 15 (41.7%) class III cases. Complete sinuses were detected in 33 (63.4%) class I, 31 (81.6%) class II, and 21 (58.3%) class III cases. Lateral extensions were found in 103 (40.9%) of the 252 sinus walls: 33 (31.7%) in class I, 45 (59.2%) in class II, and 25 (34.7%) in class III sinuses.

Conclusion

Regional sphenoid sinus anatomy can be carefully examined via CBCT. The sphenoid sinus pneumatization did not differ significantly in patients exhibiting different types of sagittal skeletal closure, with the exception of the lesser wing type.

Keywords: *Sphenoid sinus, cone beam computed tomography, anatomy, anomalies, malocclusions*

Introduction

The sphenoid sinus is the most inaccessible and variable paranasal sinus and is in the middle of the cranial base. Several important anatomical structures include the optic nerve in the superolateral region, the internal carotid artery in the lateral wall, and the vidian nerve at the base surround the sinus (1). Pneumatization of the sinus enlarges the natural space accessible to large cranial base areas. Pneumatization commences in the ostia at 6 months, and the posterior, inferior, and lateral progress, and the sinus reaches its final size after 14 years (2, 3). The cavernous sinuses surrounding sphenoid sinus laterally, ethmoid air cells anteriorly, the choana inferiorly, the clivus posteriorly, planum sphenoidale, and the pituitary fossa superiorly. The sinus might exhibit various extents of pneumatization, and the size, shape, and pneumatization type vary individually; as has been well documented (4, 5-7). Sometimes, pneumatization extends into the vomer, occipital, ethmoid, and palatine bones; the anterior and

ORCID IDs of the authors: S.Y. 0000-0002-6857-1411; E.K. 0000-0003-4844-4906; I.Ş.B. 0000-0001-5036-9867; A.B.Y. 0000-0001-5494-0290

[1]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Adnan Menderes University, Aydın, Turkiye

[2]Dentomaxillofacial Specialist, Sakarya Oral and Dental Health Center, Ministry of Health, Sakarya, Turkiye

[3]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Eskisehir Osmangazi University, Eskişehir, Turkiye

[4]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Ataturk University, Erzurum, Turkiye

Corresponding Author: Selin Yeşiltepe

E-mail: dt_selin@yahoo.com

Received: 24 September 2021
Revised: 12 January 2022
Accepted: 20 February 2022

DOI: 10.26650/eor.20221000193

How to cite: *Yesiltepe S, Kurtuldu E, Bayrakdar İS, Yılmaz AB. Cone beam computed tomography evaluation of sphenoid sinus in different sagittal skeletal pattern. Eur Oral Res 2022; 56(3): 143-148. DOI: 10.26650/eor.20221000193*

posterior clinoid processes; the lesser and greater wings; the clivus; and the pterygoid process and plates (2, 8). Bone which covers the vidian, and maxillary nerves and the carotid arteries may be thin or even absent. In these cases, these structures are under iatrogenic damage depending on the pneumatization extent (9).

The extent and direction of sphenoid sinus pneumatization is important when planning surgery. The sinus anatomy and its variations must be well understood. As far as we know, no study has yet explored sphenoid sinus variations in individuals with various sagittal skeletal anomalies. Here, we used cone-beam computed tomography (CBCT) to explore this topic in individuals of skeletal classes I, II, and III. The null hypothesis tested in the present study is that the frequencies of sphenoid sinus variations do no differ among individuals having different sagittal skeletal patterns.

Material and Methods

Ethical statement

The Clinical Research Ethical Committee of Atatürk University approved the research protocol on 03/01/2019, with protocol number 2019/21 and the work adhered to all relevant principles of the Declaration of Helsinki and amendments and revisions thereof.

Study population

We retrospectively analyzed sphenoid sinus pneumatization on CBCT images of 126 patients aged 18–86 years. Only high-quality scans revealing the entire sinus were included.

Imaging protocol

All images were obtained using a NewTom 3G CBCT platform (Quantitative Radiology, Verona, Italy) with scan parameters: 94 kVp, 14 mA, and 27 s. In all three planes, images were examined (axial, sagittal, and coronal) by a single investigator (S.Y.) with the aid of Romexis dental software (Planmeca, Helsinki, Finland).

Classification of the skeletal pattern and sphenoid sinus

The anteroposterior skeletal relationships of the maxilla and mandible were categorized as skeletal class I, II or III using the A point (the maxillary bone anterior limit)– nasion (nasofrontal suture anterior limit)– B point (the mandibular bone anterior limit) (ANB) angle [ANB angle 0–4° (class I), ANB angle >4° (class II), and ANB angle <0° (class III)] measured in the sagittal plane. First, the sagittal sections were evaluated and divided into conchal, presellar, and sellar (complete and incomplete) types according to the relationships with the anterior and posterior walls of the sellae turcica. In the conchal type, pneumatization extended for >10 mm beyond the anterior walls of the sellae turcica. In the presellar type, pneumatization did not advance above a vertical line commencing at the anterior pituitary fossa wall. In the sellar type, pneumatization extended over that line. In the incomplete sellar type, pneumatization continued beneath the anterior, but not the posterior, wall of the pituitary fossa; in the complete sellar type, pneumatization proceeded past both walls (Figure 1). There are four types of pneumatization extension into the clivus: occipital, dorsal, subdorsal, and combined occipital-dorsal. In the subdorsal type, pneumatization did not extend below the vidian canal level or above the sellae's inferior margins. Pneumatization in the dorsal type extended above a line drawn from the sellae's floors to the dorsa sellae. Pneumatization in the occipital type extended below the horizontal plane level between the paired vidian canals' upper edges. The combined occipital–dorsal type indicates pneumatization extending from the dorsum top to below a horizontal plane along the vidian canals' the upper edges (Figure 2).

Next, the lateral sphenoid sinus extensions were evaluated on coronal sections. The sinuses were divided into two types, those with lateral and those with lesser wings. The lateral type was evaluated by reference to the vidian canal–foramen rotundum (VR) line. The lateral type, in which pneumatization extended beyond the VR line, comprised three subtypes: greater wing, pterygoid, and fully lateral. The greater wing pneumatization extended past the VR line; pterygoid pneumatization extended to the pterygoid process, and full lateral pneumatization involved both the greater wing and pterygoid process. Pneumatization of the lesser wing type extended toward the optic arrow and anterior clinoid process (Figure 3).

When sphenoid sinus pneumatization was evaluated on axial sections, the anterior sinus type exhibited an anterolateral

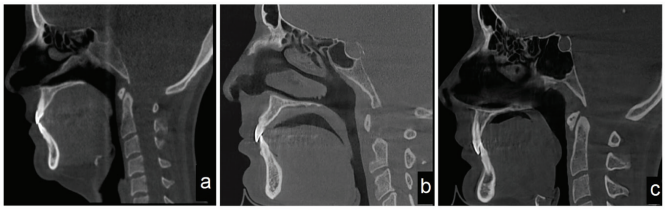

Figure 1. a. *Presellar type,* ***b.*** *Incomplete Sellar type,* ***c.*** *Complete sellar type.*

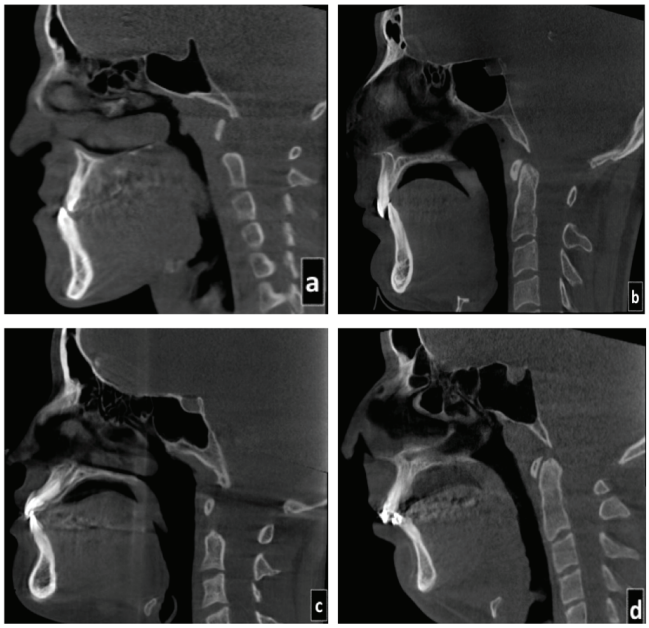

Figure 2. a. *Dorsal type,* ***b.*** *Subdorsal type,* ***c.*** *Occipital type,* ***d.*** *Combined type..*

protrusion extending past a transverse line drawn through the sphenoid crest at the sphenoid sinus side (Figure 4). All sphenoid sinuses were evaluated as described above.

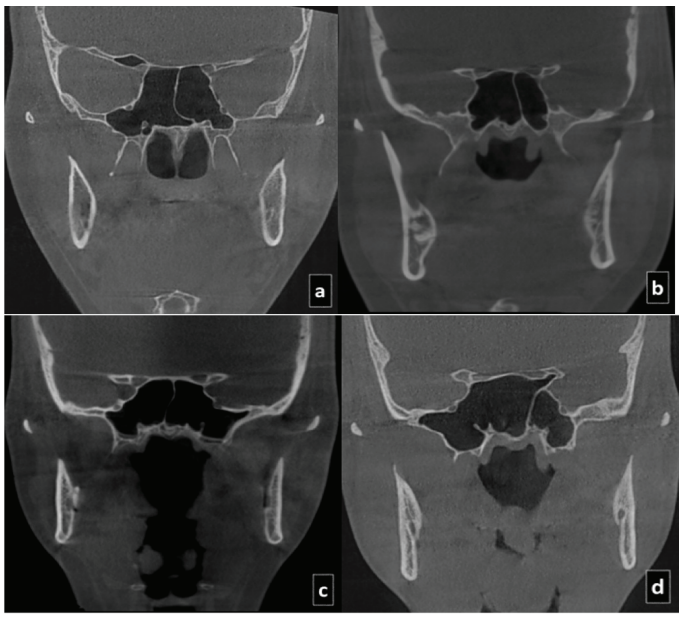

Figure 3. *a. Right full lateral+lesser wing, left greater wing type, b. Bilateral pterygoid type, c. Bilateral full lateral type, d. Right full lateral, left pterygoid +lesser wing type.*

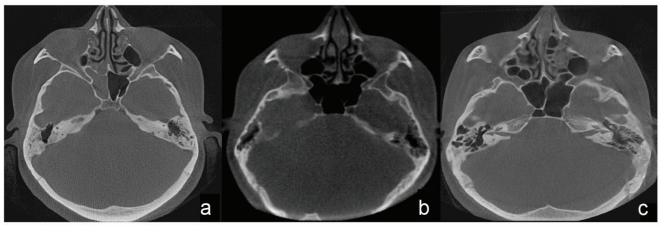

Figure 4. a, b. *Bilateral anterior type,* ***c.*** *Left anterior type.*

Statistical analysis

SPSS (version 20.0) software for Windows (IBM SPSS, Armonk, NY, USA) was used for all statistical analyses. The chi-squared test was used to assess between-group differences. P values less than 0.05 were considered statistically significant.

Results

We retrospectively analyzed CBCT images of 126 patients aged 18–86 years (mean 28.71 ± 13.11 years) in terms of sphenoid sinus pneumatization. The study population included 84 females (66.7%) and 42 males (33.3%), including 52 (41.3%) class I, 38 (30.1%) class II, and 36 (28.6%) class III cases. The conchal type of sphenoid sinus was not encountered. Presellar sinuses were detected in only 3 (5.8%) class I cases. Incomplete sinuses were detected in 16 (30.8%) class I, 7 (18.4%) class II, and 15 (41.7%) class III cases. Complete sinuses were detected in 33 (63.4%) class I, 31 (81.6%) class II, and 21 (58.3%) class III cases (Table 1); 67.4% exhibited clival extensions, most commonly the occipital type [23 (69.7%) class I, 21 (67.8%) class II, and 15 (71.4%) class III]. Lateral extensions were found in 103 (40.9%) of the 252 sinus walls: 33 (31.7%) in class I, 45 (59.2%) in class II, and 25 (34.7%) in class III sinuses. Full lateral extensions were most common, evident in 16 (48.5%) class I, 28 (62.2%) class II, and 17 (68%) class III cases (Table 2). The lesser wing type of pneumatization was in 22 (21.2%) class I, 27 (35.5%) class II, and 10 (13.9%) class III cases. Significant differences among the three sagittal skeletal groups were evident ($p \leq 0.05$) in lesser wing pneumatization. Fifty sinuses (19.8%) were of the anterior type, most commonly in class I cases [24 (23.1%)] (Table 3). The distribution of the combined type sphenoid sinus based on the sagittal skeletal pattern is shown in Table 4.

Table 1: *Distribution of pneumatization types based on the relation to anterior and posterior walls of sellae turcica by sagittal skeletal pattern.*

Pneumatization type		Sagittal Skeletal Pattern		
		Class I	Class II	Class III
Conchal		-	-	-
Presellar		3 (5.8%)	0	0
Sellar	Incomplete sellar	16 (30.8%)	7 (18.4%)	15 (41.7%)
	Complete sellar	33 (63.4%)	31 (81.6%)	21 (58.3%)
Total		52 (100%)	38 (100%)	36 (100%)

Table 2: *Distribution of clival extension in 85 patients and distrubition of lateral extension in 103 sinuses by sagittal skeletal pattern.*

Clival extension type	Sagittal Skeletal Pattern		
	Class I	Class II	Class III
Subdorsal	6 (18.2%)	5 (16.1%)	4 (19%)
Dorsal	2 (6.05%)	0	1 (4.8%)
Occipital	23 (69.7%)	21 (67.8%)	15 (71.4%)
Combined	2 (6.05%)	5 (16.1%)	1 (4.8%)
Total	33 (100%)	31 (100%)	21 (100%)
Lateral extension type	**Class I**	**Class II**	**Class III**
Pterygoid	11 (33.3%)	12 (26.7%)	4 (16%)
Greater wing	6 (18.2%)	5 (11,1%)	4 (16%)
Full lateral	16 (48.5%)	28 (62.2%)	17 (68%)
Total	33 (100%)	45 (100%)	25 (100%)

Table 3: *Distrubition of lesser wing and anterior type by sagittal skeletal pattern.*

	Sagittal Skeletal Pattern		
	Class I	Class II	Class III
Lesser wing type	22 (21.2%)	27 (35.5%)	10 (13.9%)
Anterior type	24 (23.1%)	14 (18.4%)	12 (16.7%)
Total	104 (100%)	76 (100%)	72 (100%)

Table 4: *Distrubition of combined type by sagittal skeletal pattern.*

Combined type	Sagittal Skeletal Pattern		
	Class I	Class II	Class III
Lesser wing+anterior	0	1	0
Lateral+anterior	2	0	2
Lateral+lesser wing	0	0	1
Clival+anterior	4	2	4
Clival+lesser wing	6	4	2
Clival+lesser wing+anterior	2	3	0
Clival+lateral	10	17	10
Clival+lateral+anterior	8	6	3
Clival+lateral+lesser wing	9	17	4
Clival+lateral+lesser wing+anterior	2	1	0

Discussion

The sphenoid sinus is the most changeable space in our body and is difficult to approach. Modern imaging techniques have improved our understanding of both normal and unusual anatomy, rendering surgery safer (10). Sellar access is markedly affected by sinus pneumatization, which ranges from absent to extensive; bone covering the carotid arteries and the optic and vidian nerves may be thin or even missing (11, 12). The first transsphenoidal surgery, initially performed in 1907, is now standard treatment for the sphenoid sinuses and intracranial lesions. Thus, the surgical anatomy of the sinus and adjacent regions must be understood (13). Sinus pneumatization has been explored by many authors. According to the extent of pneumatization around the sellae turcica, Hammer and Radberg (14) classified the sinus into sellar, presellar, and conchal types; this classification remains widely used. In recent years, transsphenoidal surgery has expanded to regions that bounded sphenoid sinus, such as the suprasellar region, middle cranial fossa, planum sphenoidale, clivus, cavernous sinus, and suprasellar region (15-20). Wang *et al.* (4) developed a new classification based on sinus extensions. They divided the sellar type of sphenoid sinus into six types including sphenoid body, lateral, clival, anterior, lesser wing, and combined type. Presellar sinuses were found in 2% of subjects; the conchal type was not encountered. The lowest prevalence observed from the sellar sinuses (98%) was lesser wing type, and the highest prevalence was combined type (59.2%). Hiremath *et al.* (21) classified the sphenoid sinus into conchal, presellar, and sellar (complete and incomplete) types based on the relationships of the sinus to the anterior and posterior walls of the sellae turcica, and classified clivus pneumatization as subdorsal, dorsal, occipital, or combined based on the relationships with the posterior wall, the sellae floors, and the vidian canal. The sellar (incomplete and complete), conchal and presellar types were found in 98.8% (22.2, and 76.6), 0, 1.2 of patients.

El-Kammash *et al.* (22) radiologically examined 182 cases; 3 (1.6%) evidenced conchal, 23 (12.6%) presellar, and 156 (85.7%) sellar pneumatization. On sagittal sections, we found that the sellar type was the most common (97.6%), in line with previous studies (1, 21-25). We did not encounter the conchal type, whose prevalence has been reported as 1–2% in previous studies of Caucasian and East Asian populations (4, 23, 24, 26, 27). We found presellar type sinuses in only 3 (5.8%) class I patients. Incomplete sinuses were detected in 16 (30.8%) class I, 7 (18.4%) class II, and 15 (41.7%) class III patients. Complete sinuses were detected in 33 (63.4%) class I, 31 (81.6%) class II, and 21 (58.3%) class III patients; these differences were not significant.

Wang *et al.* (4) classified posterior sinus pneumatization into dorsum, subdorsum, occipital, and dorsum–occipital types; the respective frequencies were 23.5, 63.2, 1.5, and 11.8%; the figures reported by Lu *et al.* (24) were 12.4, 71.9, 14.6, and 1.1%, and those by El-Kammash *et al.* (22) 7, 4, 3.5, and 5.7%. Hiremath *et al.* (21) reported that the subdorsal type was the most common (65%), followed by the dorsal (4%), combined (3.8%), and occipital types (3.8%). We found clival extensions in 65.7% of sinuses; the most common form was occipital [59 (46.8%) cases: 23 (69.7%) class I, 21 (67.8%) class II, and 15 (71.4%) class III] in contrast to previous studies. The differences were not significant.

Wang *et al*. (4) found lateral extensions in 92 (46%) of 200 sinus walls, including full lateral type in 71 (77%), the greater wing type in 11 (12%), and the pterygoid type in 10 (11%).

We found lateral extensions in 103 (40.9%) of 252 sinus walls: 33 (31.7%) in class I, 45 (59.2%) in class II, and 25 (34.7%) in class III cases. The full lateral extension was the most observed type in this study, as in that by Wang *et al.* (4). The prevalence of pneumatization of the greater wings or the pterygoid process ranged from 0 to 20% in the works of Idowu et al. (28), Hewaidi and Omami (29), and from 30 to 40% in the reports by Hewaidi and Omami (29), Sirikci *et al.* (30), and Kazkayasi *et al.* (31). El-Kammash *et al.* (22) found lateral extensions in 29.5% of all cases: greater wing type in 5.1%, full lateral type in 6.4%, and pterygoid type in 18%. Hiremath *et al.* (21) found the lesser wing type of pneumatization in 20.4% of all sinuses examined; the figure reported by El-Kammash *et al.* (22) was 7%. We detected the lesser wing type of pneumatization in 22 (21.2%) class I, 27 (35.5%) class II, and 10 (13.9%) class III cases; these frequencies differed significantly ($p<0.05$).

Most of the sphenoid sinus front wall is located behind the nasal turbinate, the ethmoidal air cells, and the sphenoid crest, the foremost part of the sinus. The anterior type of sinus features an anterolateral protrusion that advances above a transverse line drawn through the sphenoid crest on the side of the sinus (4). We found that 50 (19.8%) sinuses were of the anterior type, most commonly in class I cases (24; 23.1%). No significant among-group differences were evident. Wang *et al.* (4) found anterior type sinuses in 24 (12%) of 200 sides examined on 100 CT images. El-Kammash *et al.* (22) found such sinuses in 10 of 156 cases (6.4%) of sellar pneumatization.

Conclusion

A highly pneumatized sphenoid sinus may disrupt the normal anatomical configuration. Anatomical sinus varia-

tions may render symptoms complex and cause potentially serious complications, such as injury to adjacent structures or cerebrospinal fluid leakage. Therefore, regional sphenoid sinus anatomy can be carefully examined via CBCT. We found that sphenoid sinus pneumatization did not differ significantly in patients exhibiting different types of sagittal skeletal closure, with the exception of the lesser wing type.

Türkçe özet: *Farklı sagital iskeletsel paternlerde sfenoid sinüsün konik ışınlı bilgisayarlı tomografi ile değerlendirilmesi. Amaç: Bu çalışmanın amacı, çeşitli sagital iskelet anomalileri olan bireylerde sfenoid sinüs varyasyonlarını konik ışınlı bilgisayarlı tomografi (KIBT) kullanarak araştırmaktır. Gereç ve Yöntem: Yaşları 18-86 arasında değişen 126 hastanın KIBT görüntülerinde sfenoid sinüs pnömatizasyonunu geriye dönük olarak analiz ettik. Maksilla ve mandibulanın ön-arka iskelet ilişkileri, sagital düzlemde ölçülen A noktası-nasion-B noktası (ANB) açısı kullanılarak iskeletsel sınıf I, II veya III olarak sınıflandırıldı. Sfenoid sinüsün uzantıları aksiyel, sagital ve koronal olmak üzere üç düzlemde değerlendirildi. Bulgular: Çalışma popülasyonu 52 (%41,3) sınıf I, 38 (%30,1) sınıf II ve 36 (%28,6) sınıf III olmak üzere 84 kadın (%66,7) ve 42 erkek (%33,3) oluşturmuştur. Sfenoid sinüsün konkal tipine rastlanmadı. Sadece 3 (%5,8) sınıf I olguda presellar sinüs saptandı. 16 (%30,8) sınıf I, 7 (%18,4) sınıf II ve 15 (%41,7) sınıf III olguda eksik sinüs saptandı. 33 (%63,4) sınıf I, 31 (%81,6) sınıf II ve 21 (%58,3) sınıf III olguda tam sinüs saptandı. 252 sinüs duvarının 103'ünde (%40,9) lateral uzantı saptandı. Bunların oranı Sınıf I›de 33 (%31,7), sınıf II›de 45 (%59,2) ve sınıf III sinüslerde 25 (%34,7) olarak belirlendi. Sonuç: Bölgesel sfenoid sinüs anatomisi KIBT ile incelenebilir. Sfenoid sinüs pnömatizasyonu, küçük kanat tipi hariç, farklı tipte sagital iskelet kapanması sergileyen hastalarda önemli ölçüde farklılık göstermedi. Anahtar kelimeler: sfenoid sinüs, konik ışınlı bilgisayarlı tomografi, anatomi, anomaliler, maloklüzyonlar*

Ethics Committee Approval: The Clinical Research Ethical Committee of Atatürk University approved the research protocol on 03/01/2019, number 2019/21 and the work adhered to all relevant principles of the Declaration of Helsinki and amendments and revisions thereof.

Informed Consent: Additional informed consent was obtained from all individual participants included in the study.

Peer-review: Externally peer-reviewed.

Author contributions: SY, ISB, ABY participated in designing the study. EK,, ISB participated in generating the data for the study. EK participated in gathering the data for the study. EK participated in the analysis of the data. SY wrote the majority of the original draft of the paper. SY participated in writing the paper. SY has had access to all of the raw data of the study. SY has reviewed the pertinent raw data on which the results and conclusions of this study are based. SY, EK, ISB, ABY have approved the final version of this paper. SY, EK, ISB, ABY guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Štoković N, Trkulja V, Dumić-Čule I et al. Sphenoid sinus types, dimensions and relationship with surrounding structures. Ann Anat-Anatomischer Anzeiger. 2016;203:69-76. [CrossRef]
2. Fujioka M, Young LW. The sphenoidal sinuses: radiographic patterns of normal development and abnormal findings in infants and children. Radiology 1978;129(1):133-6. [CrossRef]
3. Tan HK, Ong Y, Teo MS, Fook-Chong S. The development of sphenoid sinus in Asian children. Int J Pediatr Otorhinolaryngol 2003;67(12):1295-302. [CrossRef]
4. Wang J, Bidari S, Inoue K, Yang H, Rhoton Jr A. Extensions of the sphenoid sinus: a new classification. Neurosurgery 2010;66(4):797-816. [CrossRef]
5. Cheung D, Attia E, Kirkpatrick D, Marcarian B, Wright B. An anatomic and CT scan study of the lateral wall of the sphenoid sinus as related to the transnasal transethmoid endoscopic approach. J Otolaryngol 1993;22(2):63-8.
6. Mafee MF, Chow JM, Meyers R. Functional endoscopic sinus surgery: anatomy, CT screening, indications, and complications. AJR Am J Roentgenol 1993;160(4):735-44. [CrossRef]
7. DeLano MC, Fun F, Zinreich SJ. Relationship of the optic nerve to the posterior paranasal sinuses: a CT anatomic study. Am J Neuroradiol 1996;17:669-75. [CrossRef]
8. Yune HY, Holden RW, Smith JA. Normal variations and lesions of the sphenoid sinus. Am J Roentgenol Radium Ther Nucl Med 1975;124(1):129-38. [CrossRef]
9. Liu S, Wang Z, Zhou B, Yang B, Fan E, Li Y. Related structures of the lateral sphenoid wall anatomy studies in CT and MRI. Lin chuang er bi yan hou ke za zhi= J Clin Otorhinolaryngol 2002;16(8):407-9.
10. Simonetti G, Meloni F, Teatini G et al. Computed tomography of the ethmoid labyrinth and adjacent structures. Ann Otol Rhinol Laryngol 1987;96(3):239-50. [CrossRef]
11. Kinnman J. Surgical aspects of the anatomy of the sphenoidal sinuses and the sella turcica. J Anat 1977;124(Pt 3):541.
12. Hamid O, El Fiky L, Hassan O, Kotb A, El Fiky S. Anatomic variations of the sphenoid sinus and their impact on trans-sphenoid pituitary surgery. Skull base 2008;18(01):009-15. [CrossRef]
13. Perondi GE, Isolan GR, de Aguiar PHP, Stefani MA, Falcetta EF. Endoscopic anatomy of sellar region. Pituitary 2013;16(2):251-9. [CrossRef]
14. Hammer G, Rådberg C. The sphenoidal sinus: an anatomical and roentgenologic study with reference to transsphenoid hypophysectomy. Acta Radiol 1961(6):401-22. [CrossRef]
15. Cappabianca P, Cavallo LM, de Divitiis E. Endoscopic endonasal transsphenoidal surgery. Neurosurgery 2004;55(4):933-41. [CrossRef]
16. Cappabianca P, Cavallo L, Esposito F, De Divitiis O, Messina A, De Divitiis E. Extended endoscopic endonasal approach to the midline skull base: the evolving role of transsphenoidal surgery. Adv Tech Stand Neurosurg Springer; 2008. p. 151-99. [CrossRef]
17. Cavallo L, Cappabianca P, Messina A et al. The extended endoscopic endonasal approach to the clivus and craniovertebral junction: anatomical study. Child's Nerv Syst 2007;23(6):665-71. [CrossRef]
18. Cavallo LM, de Divitiis O, Aydin S et al. Extended endoscopic endonasal transsphenoidal approach to the suprasellar area: anatomic considerations—part 1. Operative Neurosurgery 2007;61(suppl_3):ONS-24-ONS-34. [CrossRef]
19. de Divitiis E, Cavallo LM, Cappabianca P, Esposito F. Extended endoscopic endonasal transsphenoidal approach for the removal of suprasellar tumors: Part 2. Neurosurgery 2007;60(1):46-59. [CrossRef]
20. Kassam AB, Vescan AD, Carrau RL et al. Expanded endonasal approach: vidian canal as a landmark to the petrous internal carotid artery. J Neurosurg 2008;108(1):177-83. [CrossRef]
21. Hiremath SB, Gautam AA, Sheeja K, Benjamin G. Assessment of variations in sphenoid sinus pneumatization in Indian population: A multidetector computed tomography study. Indian J Radiol Imaging 2018;28(3):273. [CrossRef]
22. ELKammash TH, Enaba MM, Awadalla AM. Variability in sphenoid sinus pneumatization and its impact upon reduction of complications following sellar region surgeries. Egypt J Radiol Nuclear Med 2014;45(3):705-14. [CrossRef]
23. Anusha B, Baharudin A, Philip R, Harvinder S, Shaffie BM, Ramiza R. Anatomical variants of surgically important landmarks in the sphenoid sinus: a radiologic study in Southeast Asian patients. Surg Radiol Anat 2015;37(10):1183-90. [CrossRef]

24. Lu Y, Pan J, Qi S, Shi J, Zhang Xa, Wu K. Pneumatization of the sphenoid sinus in Chinese: the differences from Caucasian and its application in the extended transsphenoidal approach. J Anat 2011;219(2):132-42. [CrossRef]
25. Kajoak SA, Ayad CE, Balla EAA, Najmeldeen M, Yousif M, Musa A. Characterization of sphenoid sinuses for Sudanese population using computed tomography. Glob J Health Sci 2014;6(1):135. [CrossRef]
26. Sevinc O, Is M, Barut C, Erdogan A. Anatomic variations of sphenoid sinus pneumatization in a sample of Turkish population: MRI study. Int J Morphol 2014;32:1140-3. [CrossRef]
27. Vaezi A, Cardenas E, Pinheiro-Neto C et al. Classification of sphenoid sinus pneumatization: relevance for endoscopic skull base surgery. Laryngoscope 2015;125(3):577-81. [CrossRef]
28. Idowu O, Balogun B, Okoli C. Dimensions, septation, and pattern of pneumatization of the sphenoidal sinus. Folia Morphol 2009;68(4):228-32.
29. Hewaidi G, Omami G. Anatomic variation of sphenoid sinus and related structures in Libyan population: CT scan study. Libyan J Med 2008;3(3):1-9. [CrossRef]
30. Şirikci A, Bayazıt Y, Bayram M, Mumbuc S, Güngör K, Kanlıkama M. Variations of sphenoid and related structures. Eur Radiol 2000;10(5):844-8. [CrossRef]
31. Kazkayasi M, Karadeniz Y, Arikan OK. Anatomic variations of the sphenoid sinus on computed tomography. Rhinology 2005;43(2):109-14.

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 149-157

Original research

Prevalence and awareness levels of color blindness among students of faculty of dentistry and dental prosthesis technology program

Ayşe Seda Ataol[1], Gulfem Ergun[2]

Purpose
The aim of this study was to evaluate the prevalence and awareness levels of color blindness among students in a faculty of dentistry and dental prosthesis technology program in two different universities.

Materials and Methods
A survey of awareness of color blindness among 710 students (males: n=271; females: n=439) in the faculty of dentistry and dental prosthesis technology program of Gazi University and Ankara Medipol University in 2019–2021 was conducted. The color vision status of 442 of the students (males; n=155; females: n=287) was assessed using an online Ishihara color blindness test. The data obtained were subjected to statistical analysis using SPSS.

Results
There was no statistically significant difference in the color blindness scores in terms of sex (males: 0.75±0.84; females: 0.64±0.75) (p=0.226). The color blindness scores of the dental prosthesis technology students were statistically higher than those of the faculty of dentistry students (p=0.028). Education year was significantly associated with a compromised ability to identify colors properly (p=0.040). There was no statistically significant difference in terms of awareness levels of color blindness according to the number of years of education (p>0.005).

Conclusion
In terms of the prevalence of color blindness, 2.2% of faculty of dentistry and dental prosthesis technology students had a moderate-to-high level of color blindness. Students' awareness of their own color vision status was very low. The educational content of faculty of dentistry and dental prosthesis technology programs on color blindness should be enriched.

Keywords: *Color vision defects, ishihara test, dentistry, dental prosthesis technology, awareness*

Introduction

Esthetics play a critical role in achieving patient satisfaction in prosthetic rehabilitation. Expected esthetic results can be achieved with appropriate morphology and color application in the restoration. One of the most important goals of prosthetic treatment is for the restoration to be compatible with the natural tooth color, especially in fixed and partial teeth or implant- supported prostheses.

Color blindness (color vision defects) can affect color perception and therefore the ability to achieve color matching (1,2). Color blindness is a common color vision anomaly in the population (1,3). Congenital color blindness is the result of genetic mutations, which affect cone pigment expression in the retina. A color vision anomaly may also be an early sign

ORCID IDs of the authors: A.S.A. 0000-0003-3990-179X; G.E. 0000-0001-9981-5522

[1]*Private Practice, Ankara, Turkiye*

[2]*Department of Prosthodontics, Faculty of Dentistry, Gazi University, Ankara, Turkiye*

Corresponding Author: Ayse Seda Ataol

E-mail: sedaataol@gmail.com

Received: 13 September 2021
Revised: 10 February 2022
Accepted: 11 March 2022

DOI: 10.26650/eor.2022994849

How to cite: *Ataol AS, Ergun G. Prevalence and awareness levels of color blindness among students of faculty of dentistry and dental prosthesis technology program. Eur Oral Res 2022; 56(3): 149-157. DOI: 10.26650/eor.2022994849*

of eye damage. For example, color vision anomalies may be linked to optic nerve abnormalities in the retina or disorders in the brain. Diseases, such as cone cell dystrophy and achromatopsia, can also cause color blindness (4).

Vision is a psycho-physical phenomenon based on the sensitivity of retinal cones to wavelengths of about 400–700 nm in the electromagnetic spectrum (5). Three types of cones (red, blue and green) are responsible for spectral sensitivity required for color perception in the eye. The absence of any one of these three color-receiving cones makes it impossible to distinguish colors, and color blindness occurs. Protanopia refers to red cone loss and affects the ability to detect long-wavelength light. Deuteranopia refers to color blindness due to the absence of green cones. The visual spectrum in individuals with deuteranopia is almost normal due to the presence of red cones, which detect the color red at long wavelengths. Red-green color blindness is a genetic disorder that occurs almost exclusively in males. Blue-yellow color blindness is called tritanopia, which is extremely rare (1,5,6).

The Ishihara test is the most commonly used conventional method for detecting color blindness. It provides a rapid and accurate assessment of congenital color vision deficiency. This test consists of colored cards, which are usually used to diagnose red-green color deficiency. It is very important to know whether a person is color blind, to identify and inform dental workers (dentists and dental technicians) about color blindness, to obtain the necessary support for the person's profession, and to pursue a successful career (7).

The aim of this study was to evaluate the prevalence and awareness of color blindness among faculty of dentistry and dental prosthesis technology students attending a private and public university, respectively. The null hypothesis of the present study is that faculty of dentistry and dental prosthesis technology students will demonstrate low level of knowledge about color blindness.

Material and Methods

Ethical statement

This study was approved by the noninterventional clinical research ethics board of Ankara Medipol University (74791132-109/311). Written informed consent was obtained from each participant. All the participants included were informed about the goals of the study.

Study questionnaire

A survey of awareness of color blindness was created using Google Forms. Students in the faculty of dentistry and dental prosthesis technology program were then invited to participate in the survey via a referral link:

(https://www.color-blindness.com/ishihara_cvd_test/ishihara_cvd_test.html?iframe=true&width=500&height=428).

Study participants

All voluntarily students in the faculty of dentistry of Gazi University, Ankara, Turkey and students in faculty of dentistry and dental prosthesis technology program in Ankara Medipol University were included as the source populations of the study. Presence of known color blindness or any systemic disease in the past were not used as an exclusion criterion. In total, 710 students (males: n = 271; females: n = 439) in the faculty of dentistry of Gazi University, Ankara, Turkey (n=544) and students in faculty of dentistry and dental prosthesis technology program in Ankara Medipol University (n=166), Ankara, Turkey in 2019–2021 completed the survey. The survey was completed online to provide a subjective evaluation and to eliminate the directives of the practitioner during survey.

Color blindess test

The color vision status of 442 of the students (males: n = 155; females: n = 287) was evaluated using an online Ishihara color blindness test. In the test, 38 plates were shown to each of the 442 participants, and the participants were asked to detect the numbers and lines on the color plates. They were asked to email screenshots of their test results to the lead author (A.S.A.). The results of the color blindness test were scored on a scale of 0–4, as follows: 0 = none, 1 = weak, 2 = mild, 3 = moderate, and 4 = high.

Statistical analysis

The data obtained were stratified according to sex, type of institution (private or public university), and education year (first, second, third, fourth, and fifth). The compliance of continuous variables with a normal distribution was tested using the Shapiro–Wilk test. Descriptive statistics were used to define continuous variables (mean, standard deviation (SD), minimum, median, and maximum. For comparisons of two independent variables that were not compatible with a normal distribution, the Mann–Whitney U test was used. For comparisons of more than two independent variables that were not compatible with a normal distribution, the Kruskal–Wallis test was applied. A chi-square or Fisher's exact test, where appropriate was used to examine the relationship between categorical variables. The statistical significance level was set at 0.05. All analyses were performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA).

Results

There were 643 (90.6%) faculty of dentistry students and 67 (9.4%) dental prosthesis technology program students in different education years. Among the participants, 544 (76.6%) students were attending Gazi University, and 166 (23.4%) students were attending Ankara Medipol University. According to the survey, 659 (92.8%) students had no systemic diseases, 24 (3.4%) students reported having a systemic disease, and 27 (3.8%) students said they had no knowledge of whether they had a systemic disease.

Among the participants, 0.2%, 2%, 12.4%, and 36.2% had a high, moderate, mild, or weak degree of color blindness, with 1% of females having a moderate-to-high level of color blindness (Table 1). No color blindness was detected in 49.1% of the study population (Table 2). According to the results, 13.3% of the participants who stated they were not color blind had a mild or moderate degree of color blindness (Table 3).

Table 1: *Color blindness score according to gender.*

Color Blindness	Male		Female	
	n	%	n	%
0	71	45.8	146	50.9
1	58	37.4	102	35.5
2	19	12.3	36	12.5
3	7	4.5	2	0.7
4	0	0.0	1	0.3

Table 2: *Average of color blindness score and general questions about the color blindness.*

		mean+SD	Med. (Min.-Max.)
Color Blindness Score		0.68+0.78	1 (0-4)
		n	**%**
Color Blindness Score	**0**	217	49.1
	1	160	36.2
	2	55	12.4
	3	9	2.0
	4	1	0.2
Q10. Are You Colorblind?	**have no information**	19	2.7
	yes	9	1.3
	no	682	96.1
Q11. How did you learn if you are colorblind?	**unanswered**	682	96.0
	my family noticed	3	0.4
	during my education life	7	1.0
	in traffic		
	other (did not learn)	1	0.1
	other (during color blindness test)	1	0.1
	other (can not separate close colors)	1	0.1
	other (absent)	15	2.1
Q12. Have you had a color blindness test?	**yes**	283	39.9
	do not remember	96	13.5
	no	331	46.6
Q16. If you have information about the cause of your color blindness, please write the reason	**unanswered**	692	97.5
	have no information	2	0.3
	genetic	4	0.5
	wonder	1	0.1
	not color blind	4	0.6
	color pigment deficiency	1	0.1
	absent	6	0.8

Table 2: *Continue.*

		n	%
Q18. Is there a colorblind in your family?	**unanswered**	272	38.3
	have no information	40	5.6
	yes	28	3.9
	no	370	52.1
Q19. If there is a colorblind in your family, what is the proximity degree?	**unanswered**	673	94.8
	1st degree relative	1	0.1
	3rd degree relative	3	0.4
	mother	2	0.3
	grandmother	1	0.1
	father	10	1.4
	grandfather	3	0.4
	brother	5	0.7
	cousin	4	0.6
	absent	8	1.1

Table 3: *Correlation between color blind awareness vs color blind score.*

		Mean±SD	Med. (Min.-Max.)
Q10. Are You Colorblind?	**have no information**	1+1.4	0 (0-4)
	yes	2.8+0.45	3 (2-3)
	no	0.65+0.7	1 (0-3)

Color Blindness	have no information		yes		no	
	n	%	n	%	n	%
0	6	54.5	0	0.0	211	49.5
1	2	18.2	0	0.0	158	37.1
2	1	9.1	1	11.1	53	12.4
3	1	9.1	4	44.4	4	0.9
4	1	9.1	0	0.0	0	0.0

There were statistically significant differences in terms of the distribution of color blindness according to the educational institution and education year ($p = 0.02$ and $p = 0.040$ respectively). The average score for color blindness among the students in the dental prosthesis technology program was statistically significantly higher than that of the students in the faculty of dentistry ($p = 0.028$).

The color blindness scores among education years were statistically significant only between second and fifth years ($p = 0.003$). A post-hoc multiple comparison of the color blindness scores of other education years revealed no statistically significant difference in those of first-, third-, and fourth-year students. In addition, there was no statistically significant association between color blindness scores and sex or institution type (i.e., private vs. public) (Table 4).

There was no statistically significant difference in the level of knowledge of about the causes of color blindness

Table 4: *Correlation between Color Blind Score vs gender, the year of education and institution type. Mann-Whitney U test[1], Kruskal Wallis test[2]*

		Color Blindness Score		
		Mean±SD	**Med. (Min.-Max.)**	***p***
Gender	**Male**	0.75±0.84	1(0-3)	0.226[1]
	Female	0.64±0.75	0(0-4)	
Q5. In which higher education do you study?	**Faculty**	0.66±0.78	0(0-4)	**0.028**[1]
	Collage	0.89±0.79	1(0-2)	
Q6. What year of your education are you in?	**1**	0.7±0.82	0.5(0-4)	**0.040**[2]
	2	0.48±0.65	0(0-3)	
	3	0.77±0.71	1(0-2)	
	4	0.69±0.8	1(0-3)	
	5	0.9±0.85	1(0-3)	
Institution	**Ankara Medipol University**	0.73±0.76	1(0-2)	0.354[1]
	Gazi University	0.67±0.79	0.5(0-4)	

Post-Hoc two way analyses (p[1])

Education year	**Color Blindness Score**
1 vs. 2	0.041
1 vs. 3	0.401
1 vs. 4	0.941
1 vs. 5	0.125
2 vs. 3	0.019
2 vs. 4	0.151
2 vs. 5	**0.003**
3 vs. 4	0.425
3 vs. 5	0.571
4 vs. 5	0.185

between the faculty of density students and dental prosthesis technology program students and no statistically significant difference in the level of knowledge according to education year. 56.5% of the students in faculty of dentistry and 43.3% of the students of collage selected genetic causes and acquired eye diseases as the reasons for color blindness. Both male and female students considered their level of knowledge of color blindness to be "medium" (Table 5).

A statistically significantly higher number of faculty of dentistry students than students in the dental prosthesis technology program considered that color blindness was permanent ($p = 0.022$). More students in the faculty of dentistry than in the dental prosthesis technology program responded positively to the statement "If I had learned that I was color blind before choosing dentistry, it would have affected my choice of profession" ($p = 0.001$) (Table 5). The vast majority of students, especially third-year students, thought that color blindness had important implications for professional practice as dentists and dental prosthesis technicians, (Table 6).

The majority of the students were undecided about whether increased use of digital technology in dentistry would have a positive or negative impact on professional skills among practitioners with color vision defects (Table 6).

Discussion

The null hypothesis of the present study was accepted that faculty of dentistry and dental prosthesis technology students demonstrated low level of knowledge about color blindness. Color blindness among dental practitioners in clinical or laboratory settings has implications for job performance. Previous studies showed that individuals who were color blind made significantly more errors in terms of hue and chroma selection in X test than those with normal vision (5,8). Knowledge about the underlying causes and consequences of color blindness can aid career decision making. For example, an individual who is color blind and wishes to pursue a career in dentistry can select to work as part of a team in a clinical or laboratory setting where aesthetic prostheses are expected. In addition, the availability of electronic shade matching devices, such as like colorimeters, spectrophotometers, and digital color analyzers, may make it feasible for color blind individuals to practice dentistry (5).

There are many tests for color blindness. Different color blindness test eg. Pseudoisochromatic plates like Ishihara test and Dvorine, Bostrom, AO HRR, Farnsworth-Munsell 100 Hue Test can be used. However, these tests are not common because of its expense and need for performing by a by a specialist (5). So, in our study, the Ishihara test were used to screen for color blindness. Both the survey and Ishihara color

Table 5: *Questions about knowledge level of color blindness.*

		Faculty		College		
		n	%	n	%	p
Q9. Do you have any information about what is color blindness?	**have no information**	17	2.6	2	3.0	0.224
	yes	607	94.4	60	89.6	
	no	19	3.0	5	7.5	
Q12. Have you had a color blindness test?	**yes**	255	39.7	28	41.8	0.309
	do not remember	91	14.2	5	7.5	
	no	297	46.2	34	50.7	
Q13. Indicate your level of knowledge about the reasons of color blindness	**very low**	38	5.9	3	4.5	0.765
	very high	8	1.2	0	0.0	
	low	119	18.5	15	22.4	
	medium	378	58.8	37	55.2	
	absent	23	3.6	4	6.0	
	high	77	12.0	8	11.9	
Q14. What are the causes of color blindness?	**brain injuries**	5	0.8	0	0.0	0.055
	have no information	2	0.3	0	0.0	
	have no information maybe genetic	1	0.2	0	0.0	
	genetic	467	72.6	37	55.2	
	know it's related to the receptors in the eye	1	0.2	0	0.0	
	all of them	1	0.2	0	0.0	
	acquired eye diseases	162	25.2	29	43.3	
	color blindness can occur due to the lack of pigment in photoreceptor cells and the failure of these cells to function properly	1	0.2	0	0.0	
	there is no reason	0	0.0	1	1.5	
	age	3	0.5	0	0.0	
Q15. If you know you are color blind do you have any information about the cause of color blindness of you?	**unanswered**	239	37.2	33	49.3	0.151
	have information	52	8.1	4	6.0	
	have no information	352	54.7	30	44.8	
Q17. Is color blindness genetic?	**unanswered**	239	37.2	33	49.3	0.192
	yes	288	44.8	19	28.4	
	no	4	0.6	1	1.5	
	indecisive	36	5.6	4	6.0	
	definitely yes	75	11.7	10	14.9	
	definitely no	1	0.2	0	0.0	
Q20. Is color blindness permanent or temporary?	**unanswered**	239	37.2	33	49.3	**0.022**
	it is temporary	1	0.2	1	1.5	
	it is permanent	288	44.8	18	26.9	
	indecisive	57	8.9	8	11.9	
	it is absolutely permanent	58	9.0	7	10.4	
Q21. Do you think color blindness has professional importance for dentists / dental prosthetic technicians?	**unanswered**	239	37.2	33	49.3	0.464
	yes	199	30.9	17	25.4	
	no	24	3.7	2	3.0	
	indecisive	71	11.0	4	6.0	
	definitely yes	109	17.0	11	16.4	
	definitely no	1	0.2	0	0.0	

Table 5: *Continue.*

		Faculty		College		
		n	%	n	%	p
Q22. If you are color blind do you think it will affect your professional success?	**unanswered**	239	37.2	33	49.3	0.213
	yes	189	29.4	16	23.9	
	no	50	7.8	3	4.5	
	indecisive	105	16.3	6	9.0	
	definitely yes	55	8.6	8	11.9	
	definitely no	5	0.8	1	1.5	
Q23. Do you think the increasing use of digital dentistry will increase the effect of color blindness on professional skills in a negative way?	**unanswered**	239	37.2	33	49.3	0.117
	yes	147	22.9	11	16.4	
	no	68	10.6	3	4.5	
	indecisive	154	24.0	13	19.4	
	definitely yes	30	4.7	6	9.0	
	definitely no	5	0.8	1	1.5	
Q24. If you had learned that you are colorblind before choosing your profession, would it affect your choice of profession?	**unanswered**	239	37.2	33	49.3	**<0.001**
	yes	113	17.6	11	16.4	
	no	114	17.7	6	9.0	
	indecisive	132	20.5	6	9.0	
	definitely yes	26	4.0	10	14.9	
	definitely no	19	3.0	1	1.5	

Tablo 6: *Questions about the effect of color blindness on profession.*

		1st class		2nd class		3rd class		4th class		5th class		p
		n	%	n	%	n	%	n	%	n	%	
Q9. Do you have any information about what is color blindness?	**have no information**	9	2.9	5	3.8	2	2.5	2	1.7	1	1.3	0.554
	yes	290	94.8	122	91.7	74	93.7	107	92.2	74	97.4	
	no	7	2.3	6	4.5	3	3.8	7	6.0	1	1.3	
Q12. Have you had a color blindness test?	**yes**	117	38.2	51	38.3	35	44.3	46	39.7	34	44.7	0.878
	do not remember	47	15.4	15	11.3	11	13.9	14	12.1	9	11.8	
	no	142	46.4	67	50.4	33	41.8	56	48.3	33	43.4	
Q13. Indicate your level of knowledge about the reasons of color blindness	**very low**	16	5.2	7	5.3	2	2.5	8	6.9	8	10.5	0.466
	very high	4	1.3	0	0.0	1	1.3	2	1.7	1	1.3	
	low	53	17.3	25	18.8	22	27.8	23	19.8	11	14.5	
	medium	180	58.8	78	58.6	41	51.9	68	58.6	48	63.2	
	absent	14	4.6	3	2.3	4	5.1	2	1.7	4	5.3	
	high	39	12.7	20	15.0	9	11.4	13	11.2	4	5.3	
Q14. What are the causes of color blindness?	**brain injuries**	5	1.6	0	0.0	0	0.0	0	0.0	0	0.0	0.417
	have no information	1	0.3	0	0.0	1	1.3	0	0.0	0	0.0	
	have no information maybe genetic	0	0.0	0	0.0	0	0.0	0	0.0	1	1.3	
	genetic	217	70.9	103	77.4	53	67.1	77	66.4	54	71.1	
	know it's related to the receptors in the eye	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	
	all of them	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	
	acquired eye diseases	80	26.1	29	21.8	25	31.6	36	31.0	21	27.6	

Tablo 6: *Continue.*

		1st class		2nd class		3rd class		4th class		5th class		p
		n	%	n	%	n	%	n	%	n	%	
Q14. What are the causes of color blindness?	**color blindness can occur due to the lack of pigment in photoreceptor cells and the failure of these cells to function properly**	0	0.0	0	0.0	0	0.0	1	0.9	0	0.0	0.417
	there is no reason	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	
	age	1	0.3	1	0.8	0	0.0	1	0.9	0	0.0	
Q15. If you know you are color blind do you have any information about the cause of color blindness of you?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	0.258
	have information	22	7.2	11	8.3	5	6.3	14	12.1	4	5.3	
	have no information	175	57.2	77	57.9	40	50.6	52	44.8	38	50.0	
Q17. Is color blindness genetic?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	0.811
	yes	135	44.1	66	49.6	33	41,8	45	38,8	28	36,8	
	no	2	0.7	0	0.0	0	0.0	2	1.7	1	1.3	
	indecisive	17	5.6	5	3.8	5	6.3	8	6.9	5	6.6	
	definitely yes	42	13.7	17	12.8	7	8.9	11	9.5	8	10.5	
	definitely no	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	
Q20. Is color blindness permanent or temporary?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	0.799
	it is temporary	2	0.7	0	0.0	0	0.0	0	0.0	0	0.0	
	it is permanent	133	43.5	63	47.4	32	40.5	50	43.1	28	36.8	
	indecisive	34	11.1	12	9.0	7	8.9	6	5.2	6	7.9	
	it is absolutely permanent	28	9.2	13	9.8	6	7.6	10	8.6	8	10.5	
Q21. Do you think color blindness has professional importance for dentists / dental prosthetic technicians?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44,7	**0.013**
	yes	101	33.0	34	25.6	28	35.4	35	30.2	18	23.7	
	no	7	2.3	5	3.8	2	2.5	7	6.0	5	6.6	
	indecisive	46	15.0	13	9.8	4	5.1	8	6.9	4	5.3	
	definitely yes	42	13.7	36	27.1	11	13.9	16	13.8	15	19.7	
	definitely no	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	
Q22. If you are color blind do you think ıt will affect your professional success?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	0.181
	yes	93	30.4	35	26.3	23	29.1	31	26.7	23	30.3	
	no	20	6.5	8	6.0	5	6.3	14	12.1	6	7.9	
	indecisive	58	19.0	22	16.5	12	15.2	12	10.3	7	9.2	
	definitely yes	23	7.5	21	15.8	5	6.3	8	6.9	6	7.9	
	definitely no	3	1.0	2	1.5	0	0.0	1	0.9	0	0.0	
Q23. Do you think the increasing use of digital dentistry will increase the effect of color blindness on professional skills in a negative way?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	**0.002**
	yes	91	29.7	22	16.5	13	16.5	24	20.7	8	10.5	
	no	21	6.9	13	9.8	11	13.9	13	11.2	13	17.1	
	indecisive	69	22.5	41	30.8	15	19.0	25	21.6	17	22.4	
	definitely yes	15	4.9	11	8.3	4	5.1	4	3.4	2	2.6	
	definitely no	1	0.3	1	0.8	2	2.5	0	0.0	2	2.6	
Q24. If you had learned that you are colorblind before choosing your profession, would it affect your choice of profession?	**unanswered**	109	35.6	45	33.8	34	43.0	50	43.1	34	44.7	0.691
	yes	58	19.0	25	18.8	10	12.7	16	13.8	15	19.7	
	no	53	17.3	23	17.3	13	16.5	20	17.2	11	14.5	
	indecisive	56	18.3	31	23.3	18	22.8	23	19.8	10	13.2	
	definitely yes	20	6.5	8	6.0	2	2.5	3	2.6	3	3.9	
	definitely no	10	3.3	1	0.8	2	2.5	4	3.4	3	3.9	

blindness test were completed online in order to evaluate the data on color blindness subjectively, without the influence of the practitioner. In the current study, most of the students selected 'genetic causes and acquired eye diseases' as the reasons for color blindness. Thus, the possible mechanism of color blindness generally might be congenital. Similar findings were reported by other studies (9,10).

We included students from two different university settings (private and state) to evaluate the level of awareness of color blindness according to the institution type and the prevalence of color blindness among students in private and state universities. There was no significant difference in terms of the knowledge level of the reasons for color blindness among the students attending the private versus the state university, with the students attending both institutions stating that that they had a "medium" level of knowledge.

According to previous research, the incidence of color blindness among dentistry professionals varied from 2.8–9.99%, with an incidence of 8% in males and 0.5% in females (1,3,6,11). In our study, as shown by the color blindness scores stratified according to gender (Table 1), 2.2% (males: 4.5%; females: 1%) of the study population had a moderate-to-high level of color blindness, similar to that reported in several previous studies (9,12). In common with the findings of the present study, previous studies reported a higher prevalence of color blindness among males. The prevalence of color blindness among males can be attributed to a gene defect in the X chromosome in the Xq28 band (13,14). The relatively low prevalence of color blindness among the males in our study may be due to the low number of males in our study population relative to that of females.

Previous studies highlighted the need for awareness of dentists and dental technicians of color blindness and its effect on clinical success (3,15). According to previous studies, many dentists have no knowledge of their color vision status, and others who are aware have of no knowledge of the degree of color blindness (15,16). According to the results of the color blindness test in the present study, 13.3% of participants who were unaware that they were color blind had a mild or moderate degree of color blindness. This result emphasizes the importance of individuals who wish to pursue a career in esthetic dentistry in clinic or laboratory settings undergoing the Ishihara test during their education and training.

In the present study, most of the students who were aware of their color blind status had become aware of this issue during their training. This result shows that faculty of dentistry and dental prosthesis technology curricula can have a direct impact on raising awareness among future dentists and dental technicians about color blindness (3).

In our study, there were statistically significant differences in terms of the color blindness distribution according to the educational institution and year of education ($p = 0.028$ and $p = 0.040$, respectively). The average score for color blindness among the students in the dental prosthesis technology program was statistically significantly higher than that of the students in the faculty of dentistry ($p = 0.028$). These results are supported by that of a previous study, which reported a higher percentage of color blindness in regions with lower education levels (16). However, there was no significant difference in the color blindness scores stratified by education year, except for second and fifth years ($p = 0.003$). Most of the participants thought that color blindness was important for a profession as a dentist or dental prosthesis technician. Most also stated that knowledge of color perception ability would affect their choice of profession. These findings demonstrate the necessity of performing color blindness tests at high-school level prior to students selecting a career path.

The present study had some limitations. One limitation was the small number of dental prosthesis technology students relative to the number of faculty of dentistry students. In addition, the rate of participation in the color blindness awareness survey between the different institutions was different. An additional limitation was that the color blindness test was performed online in the students' homes/classrooms. Thus, the conditions under which the tests were performed were not uniform.

Conclusion

The students in both the faculty of dentistry and dental prosthesis technology programme demonstrated medium levels of knowledge about color blindness. The prevalence of color vision deficiency among the faculty of dentistry and dental prosthesis technology students was 2.2%, with these students having a moderate-to-high level of color blindness. Awareness of color vision status was very low among the students attending both institutions. Our findings highlight the necessity of enriching the education of students of faculty of dentistry and dental prosthesis technology programs on color blindness. To eliminate the negative effects of color blindness on professional skills, practitioners should be advised to use electronic shade-matching devices or ask for assistance during shade selection/matching. The data in the present study can be expanded by increasing the number of institutions and the number of participants in order to reflect the awareness level of color blindness more comprehensively.

Türkçe özet: *Diş hekimliği fakültesi ve diş protezi teknolojisi programı öğrencilerinde renk körlüğü yaygınlığı ve farkındalık düzeyleri. Amaç: Bu çalışmanın amacı, iki farklı üniversitede diş hekimliği fakültesi ve diş protez teknolojisi programında okuyan öğrencilerde renk körlüğü yaygınlık ve farkındalık düzeylerinin değerlendirilmesidir. Gereç ve Yöntem: Gazi Üniversitesi ve Ankara Medipol Üniversitesi Diş Hekimliği Fakültesi ve Diş Protez Teknolojisi Programında 710 öğrenciye (erkek: n = 271; kadın: n = 439) 2019-2021 yıllarında renk körlüğü farkındalığı anketi yapıldı. Öğrencilerin 442'sinin (erkek; n = 155; kadın: n = 287) renk görme durumu, çevrimiçi bir Ishihara renk körlüğü testi kullanılarak değerlendirildi. Elde edilen veriler SPSS, versiyon 24.0 kullanılarak istatistiksel analize tabi tutuldu. Bulgular: Renk körlüğü skorlarında cinsiyete göre istatistiksel olarak anlamlı fark bulunmadı (erkekler: 0.75 ± 0.84; kadınlar: 0.64 ± 0.75) (p = 0.226). Diş protez teknolojisi öğrencilerinin renk körlüğü skorları diş hekimliği fakültesi öğrencilerine göre istatistiksel olarak daha yüksekti (p = 0.028). Eğitim yılı, renkleri sınırlı şekilde doğru tanımlama yeteneği ile önemli ölçüde ilişkilendirildi (p = 0.040). Eğitim alınan yıl sayısına göre renk körlüğü farkındalık düzeyleri açısından istatistiksel olarak anlamlı bir fark bulunmadı. Sonuç: Renk körlüğü yaygınlığı açısından, diş hekimliği fakültesi ve diş protez teknolojisi programı öğrencilerinin %2,2'si orta-yüksek düzeyde renk körlüğüne sahipti. Öğrencilerin kendi renk görme durumlarının farkındalığı çok düşüktü. Diş hekimliği fakültesi ve diş protez teknolojisi programlarının renk körlüğü ile ilgili eğitim içeriği zenginleştirilmelidir. Anahtar Kelimeler: renk görme kusurları, ishihara testi, diş hekimliği, diş protez teknolojisi, farkındalık*

Ethics Committee Approval: This study was approved by the non-interventional clinical research ethics board of Ankara Medipol University (74791132-109/311).

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: ASA, GE participated in designing the study. ASA, GE participated in generating the data for the study. ASA, GE participated in gathering the data for the study. ASA, GE participated in the analysis of the data. ASA wrote the majority of the original draft of the paper. GE participated in writing the paper. ASA, GE have had access to all of the raw data of the study. ASA, GE have reviewed the pertinent raw data on which the results and conclusions of this study are based. ASA, GE have approved the final version of this paper. ASA guarantees that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors declared that they have no conflict of interest.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Nilawar S, Budhiraja S, Waghmare R, Katekhaye S. Title of the article : prevalence of color blindness in dental professionals : A survey. J Interdiscipl Dent Sci 2019; 8: 6-9.
2. Polat S, Tuncdemir AR, Özturk C, Tunçdemir MT. Assesment of normal color vision and color vision-deficient dentists success ratio on color evaluation. Cumhuriyet Dent J 2012; 15: 320-6.
3. Gokce HS, Piskin B, Ceyhan D, Gokce SM, Arisan V. Shade matching performance of normal and color vision-deficient dental professionals with standard daylight and tungsten illuminants. J Prosthet Dent 2010; 103: 139-47. [CrossRef]
4. Landini G, Perryer DG. More on color blindness Increasing the dynamic range of in situ PLA. Nat Methods 2011; 8: 1-2. [CrossRef]
5. Naik A V, Pai RC. Colour blindness in dental students and staff an obstacle in shade selection for restorations. Ann Essences Dent 2010; 2: 25-8. [CrossRef]
6. Su Y, Behar-Horenstein LS. Color-blind racial beliefs among dental students and faculty. J Dent Educ 2017; 81: 1098-107. [CrossRef]
7. Landini G, Perryer DG. More on color blindness. Nat Methods 2011; 8:891. [CrossRef]
8. Davison SP, Myslinski NR. Shade selection by color vision-defective dental personnel. J Prosthet Dent 1990; 63: 97-101. [CrossRef]
9. Woldeamanuel GG, Geta TG. Prevalence of color vision deficiency among school children in Wolkite, Southern Ethiopia. BMC Res Notes 2018; 11: 1-5. [CrossRef]
10. Dohvoma VA, Mvogo SRE, Kagmeni G, Emini NR, Epee E, Mvogo CE. Color vision deficiency among biomedical students: a cross-sectional study. Clin Ophthalmol 2018; 12: 1121-4. [CrossRef]
11. Behar-Horenstein LS, Garvan CW. Relationships among the knowledge, efficacy, and practices instrument, color-blind racial attitudes scale, deamonte driver survey, and defining issues test 2. J Dent Educ 2016; 80: 355-64. [CrossRef]
12. Dargahi H, Einollahi N, Dashti N. Color Blindness defect and medical laboratory technologists: unnoticed problems and the care for screening. Acta Medica Iranica 2010; 48: 172-7.
13. Ugalahi M, Fasina O, Ogun O, Ajayi BK. Prevalence of congenital colour vision deficiency among secondary school students in Ibadan, South-West Nigeria. Niger Postgrad Med J 2016; 23: 93. [CrossRef]
14. Nazeer M, Bashir S, Rafiq N. Color vision deficiency in medical students in Jammu & Kashmir, India. Galician Med J 2019; 26: 2-7. [CrossRef]
15. Pramanik T, Khatiwada B, Pandit R. Color vision deficiency among a group of students of health sciences. Nepal Med Coll J 2012; 14: 334-6.
16. Alqahtani NA, Togoo RA, Alqahtani MM, Suliman NS, Alasmari FA, Alqahtani FM, et al. Frequency of color vision deficiency among Saudi dental students: a cross-sectional study. Eur J Dent. 2021;15: 27-32. [CrossRef]

eor.istanbul.edu.tr

Official Publication of Istanbul University Faculty of Dentistry

Eur Oral Res 2022; 56(3): 158-163

Original research

Effect of repolishing on the discoloration of indirect composite block, nanohybrid, and microhybrid resin composites

Muhittin Ugurlu[1]

Purpose
To comparatively assess the color stability of indirect composite block, nanohybrid, and microhybrid resin composites after immersion in red wine and repolishing.

Materials and Methods
Specimens (2x7x12 mm) were prepared using an indirect composite block (Cerasmart), a nanohybrid (Ceram X), and a microhybrid (Charisma Smart) resin composite. The specimens' color was recorded based on the CIE L*a*b* system in a spectrophotometer (Spectroshade). After recording the initial color, the specimens were immersed in red wine for 3 hours per day for 15 days. The color measurement was done again. The specimens were repolished with a multistep polishing system (SuperSnap). The color was measured for the third time. The color change values (ΔE) were calculated with the L*, a*, and b* coordinates obtained at baseline, after the immersion procedure, and after repolishing. Statistical analyses were performed with one-way ANOVA, Tukey's post hoc, and paired t-tests (p=0.05).

Results
The composite block presented the lowest ΔE value ($p<0.05$). No statistically significant difference was found between the ΔE values of the nanohybrid and microhybrid resin composites. The repolishing promoted a decrease in the color change of all three materials ($p<0.05$). The ΔE value of the composite block was clinically acceptable after repolishing.

Conclusion
The composite block showed higher color stability. The staining resistance of the nanohybrid and microhybrid resin composites was not different. The repolishing decreased the discoloration of all three materials.

Keywords: *CAD/CAM, color, composite dental resin, polishing, staining*

Introduction

The resin composites are restorative materials with increasing indications due to their tooth-like aesthetic appearance and improved mechanical properties (1). A variety of resin composite materials that differ from each other according to the resin matrix composition, number of filler particles, and filler particle size have been developed for restoration procedures (2). These characteristics of the resin composites influence the esthetic and physical properties of the materials (1,2). Although direct composite restorations are a widespread treatment choice for posterior teeth, the incomplete polymerization of the resin composites, resulting in a low degree of conversion, may cause a reduction in the mechanical properties and staining resistance (3,4). The discoloration resistance of the materials is as important as the mechanical properties of the material (3–5).

The conversion degree of materials has improved with the prefabricated resin-based blocks for computer-aided design and computer-aided

ORCID IDs of the authors: M.U. 0000-0002-8900-7449

[1]Department of Restorative Dentistry, Faculty of Dentistry, Süleyman Demirel University, Isparta, Turkiye

Corresponding Author: Muhittin Ugurlu

E-mail: dtmuhittinugurlu@gmail.com

Received: 1 February 2022
Revised: 4 March 2022
Accepted: 19 March 2022

DOI: 10.26650/eor.20221066456

How to cite: *Ugurlu M. Effect of repolishing on the discoloration of indirect composite block, nanohybrid, and microhybrid resin composites. Eur Oral Res 2022; 56(3): 158-163. DOI: 10.26650/eor.20221066456*

manufacturing technology (CAD/CAM) (6). The resin-based blocks have optimal physical and mechanical properties because they are polymerized under high temperatures and high pressure (7). The use of CAD/CAM has rapidly increased in recent years due to its facilitation of indirect restorations (6). New CAD/CAM materials have been introduced specifically for esthetic restorations to overcome the disadvantages associated with the use of direct resin composites (8). The ceramic and resin-based composite blocks are used with CAD/CAM technology (6,7). The mechanical and optical properties of the ceramic are superior to those of composites (9). However, the composite blocks do not require firing as ceramic materials in the finishing and polishing procedures (7,10). Thus, the restorations are completed after clinically manual polishing in a single visit (7). Besides, they have ease of manufacturing and repairability properties (10). Unfortunately, the indirect composite blocks may be sensitive to discoloration when exposed to different conditions (11,12).

Color stability of the restorations is a factor that affects the esthetic success (13,14). Color stability is the ability to resist color changes of material over time (14). It is affected by the environment, material composition, and technique procedures (15). Discoloration of the materials may form in the oral environment due to extrinsic and intrinsic factors (16). The properties of resin-based materials influence the intrinsic staining, including the resin matrix composition, the amount of filler particles, the size of filler particles, and the degree of polymerization (4,5,13,17). Extrinsic staining is caused by the adsorption and absorption of colorants in exogenous sources, such as food and beverages (15).

The discoloration is a prominent issue. The loss of the esthetic properties and inappropriate color match of restoration may be a reason for replacing the restoration (4,5). The superficial staining on the restorations may be removed by a repolishing procedure hence improving the longevity of restorations (5,9,18). Repolishing is a favorable and conservative treatment option to improve the esthetics of non-severely discolored composite restorations by removing the stains on the surface (5,9,16).

There is no universal material in restorative dentistry. The indirect restorations might currently be preferred for appropriate indications since they have higher mechanical properties and discoloration resistance than direct composite restorations (4). However, there are a limited number of studies that have comparatively evaluated the color stability of indirect composite blocks and direct resin composites and the influence of repolishing on the color change (3,19). Therefore, the aim of the current study was to comparatively assess the color stability of composite block, nanohybrid, and microhybrid resin composites after immersion in red wine and repolishing. The first null hypothesis tested was that the color stability of composite block, nanohybrid, and microhybrid resin composites would not be different. The second null hypothesis tested was that the repolishing would not affect the discoloration of the composite block, nanohybrid, and microhybrid resin composites.

Material and Methods

Study materials

In this in vitro study, an indirect composite block (Cerasmart; GC, Tokyo, Japan, LT, A2), a nanohybrid (Ceram X; Dentsply Sirona, Konstanz, Germany, A2), and a microhybrid (Charisma Smart; Heraeus Kulzer, Hanau, Germany, A2) resin composite was used. The characteristics of the materials are described in Table 1. The schematic representation of the study methodology is displayed in Figure 1.

Specimen preparation

The composite block was cut into sizes of 2x7x12 mm using a diamond saw mounted on a cutting machine under water cooling (Minitom, Struers, Denmark). Twenty test specimens were acquired from the block (n=20). The specimens were sequentially polished with #180, 320, 400, and 600 silicon carbide papers under a semi-automatic grinding and polishing device (Tegramin 25, Struers, Denmark) to achieve

Table 1: *The materials, chemical composition and application procedure.*

Material	Composition	Application procedure
Cerasmart Lot no: 1909277 (GC, Leuven, Belgium)	Bis-MEPP, UDMA, DMA, silica and barium glass nanoparticle (20 nm) (71% wt)	CAD/CAM material
Ceram X (Dentsply Sirona, Konstanz, Germany) Lot no: 0823	Bis-GMA, UDMA, TEGDMA, Barium-aluminum-borosilicate glass (1.1-1.5 µm), methacrylate functionalized silicone dioxide nano filler (10 nm) (76% wt)	1. Apply in 2 mm layers 2. Light-cure for 20 s
Charisma Smart (Heraeus Kulzer, Hanau, Germany) Lot no: K010516	Bis-GMA, UDMA, TEGDMA Barium aluminum fluoride glass filler (0.02-2 µm), 5 vol% pyrogenic silicon dioxide filler (0.02-0.07 µm) (78% wt)	1. Apply in 2 mm layers 2. Light-cure for 20 s

Composition as provided by the manufacturers: BisMEPP, 2,2-bis(4-methacryloxypolyethoxyphenyl) propane; DMA, dimethacrylate; Bis-GMA, bisphenol-glycidyl methacrylate; UDMA, urethane dimethacrylate; TEGDMA, triethylene glycol dimethacrylate.

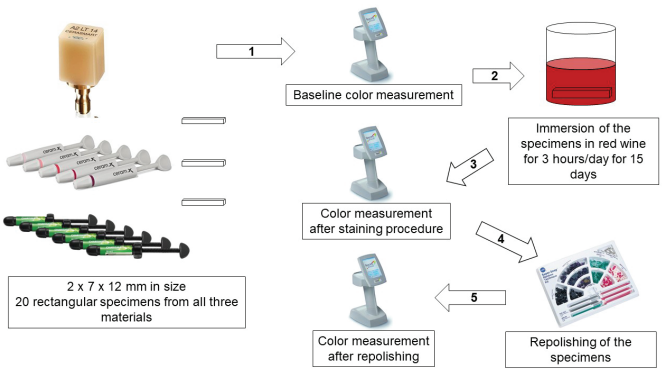

Figure 1. *Schematic illustration of the experimental design.*

a standardized smooth surface. Then, the specimens were polished with aluminum oxide discs of a multistep polishing system (SuperSnap; Shofu, Kyoto, Japan). The thickness of 2±0.05mm of the prepared specimens was confirmed by a digital micrometer (Digimatic Micrometer; Mitutoyo, Tokyo, Japan). The specimens were cleaned in an ultrasonic bath with distilled water.

Twenty rectangular specimens, 2x7x12 mm in size, were prepared using a Teflon mold from each resin composite (n=20). The resin composites were encased into the Teflon mold. A mylar strip (SS White Co., Philadelphia, PA, USA) was suppressed onto the mold surface and sandwiched between the two glass slides on both sides to promote smoothness and extrude the resin composite excess. The resin composites were polymerized on both sides for 20 seconds using a LED light-curing unit (Smartlite Focus, Dentsply, Milford, DE, USA) at 1000 mW/cm^2. After the polymerization process, the specimens were replaced from the mold and stored in distilled water at 37°C for 24 hours. Each surface of the specimens was polished with the multistep polishing system (SuperSnap) by thoroughly rinsing with water and air-drying to remove debris after each polishing step.

Baseline color assessment

Before the staining procedure, the baseline color values of all specimens were recorded under standardized ambient conditions according to the Commission Internationale de l'Eclairege L*a*b* (CIELAB) color space system using a spectrophotometer (Spectroshade; MHT Optic Research AG, Niederhasli, Switzerland). The spectrophotometer was calibrated on a white calibration tile before measurements. All color measurements were performed over a white background. The color of each specimen was measured three times in the center of the specimens and averaged (L_0, a_0, b_0). The color measurements were assessed regarding three coordinate values based on the CIE L*a*b* color space system.

The axis L* refers to the lightness coordinate, and its value ranges from zero (black) to 100 (white). The a* value represents redness (positive a*) or greenness (negative a*). The b* value represents yellowness (positive b*) or blueness (negative b*) (5).

Specimen staining

All the specimens were immersed in red wine for 3 hours a day for a total of 15 days. The specimens were stored in distilled water at 37°C until the following day's immersion. The specimens were dried and cleaned with blotting paper during transfers from red wine to distilled water. The red wine was refreshed every day. As previously described, the color of the specimens was measured with the spectrophotometer after the staining period (L_1, a_1, b_2).

After this measurement, the stained surfaces of specimens were repolished using the multistep polishing system (SuperSnap) as in specimen preparation, simulating the clinical repolishing procedure. Then, the color measurement of the specimens was performed again for the third time with the same method (L_2, a_2, b_2).

Assessment of color change

The values of the changes of L* (ΔL), a* (Δa), and b* (Δb) were calculated from the color measurements at different times. The color difference (ΔE) was calculated from the mean ΔL, Δa, and Δb values for each specimen using the following formula: $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$. The color difference after staining to baseline was calculated as ΔE_1. The color change after repolishing to baseline was calculated as ΔE_2. In the present study, the perceptibility threshold of 1.2 and the acceptability threshold of 2.7 were accepted or color differences based on previous studies (18,20).

Table 3: *Means and standard deviations of color changes (ΔE values) after the staining and repolishing procedures.*

Materials	After staining/ ΔE_1	After repolishing/ ΔE_2	p‡
Cerasmart	4.82±0.88^a	2.62±1.00^a	0.000
Ceram X	7.04±2.17^b	3.45±1.27^{ab}	0.000
Charisma Smart	7.23±1.87^b	3.94±1.28^b	0.000
p†	0.000	0.004	

Table 2: *Mean and standart deviation of L, a, b values at baseline, and ΔL, Δa, Δb values at measurement intervals.*

Materials		Baseline		After staining		After repolishing
Cerasmart	L*	76.38±2.03	ΔL_1	-1.08±2.54	ΔL_2	0.54±1.92
	a*	0.76±0.67	Δa_1	2.90±1.14	Δa_2	-0.70±1.14
	b*	14.30±1.95	Δb_1	2.41±1.14	Δb_2	1.09±1.08
Ceram X	L*	78.26±0.45	ΔL_1	-4.52±1.96	ΔL_2	-1.34±1.63
	a*	1.07±0.37	Δa_1	3.27±2.21	Δa_2	-1.01±1.52
	b*	17.05±2.02	Δb_1	3.15±2.24	Δb_2	-1.66±1.82
Charisma Smart	L*	75.23±1.70	ΔL_1	-1.23±2.29	ΔL_2	1.69±2.09
	a*	0.45±0.88	Δa_1	2.80±1.50	Δa_2	-0.39±1.57
	b*	13.57±1.79	Δb_1	5.85±2.28	Δb_2	1.82±2.12

Same small superscript letter indicates no statistical difference in the column p†: The significance level of ΔE values between groups p‡: The significance level between ΔE_1 and ΔE_2 values

Statistical analysis

The SPSS program (Statistical Package for the Social Sciences version 20.0; SPSS, Chicago, IL, USA) was used to analyze the data. The normality of the data distribution was evaluated by the Kolmogorov–Smirnov test. Levene's test was used to check for homoscedasticity. The data were analyzed with a one-way analysis of variance test (ANOVA). Multiple comparisons were performed with Tukey's post hoc test. A paired t-test was conducted to compare ΔE values calculated after staining and repolishing. The statistical significance level was set at 0.05 for all analyses.

Results

The values of L^*, a^*, and b^* coordinates at baseline and ΔL, Δa, and Δb values at the experimental conditions are presented in Table 2. The mean and standard deviations of overall color change after staining and after repolishing are shown in Table 3. The statistical analysis results of ΔE values are also displayed in Table 3.

After the staining procedure, all the materials presented color change. The ΔE values were above the acceptability threshold. The composite block showed the lowest ΔE value ($p<0.05$). The ΔE values of the nanohybrid and microhybrid resin composites were statistically similar. The repolishing procedure caused a decrease in the color change of all three materials ($p<0.05$). After repolishing, the ΔE values of the composite block and the nanohybrid resin composite were not statistically different, but there was a significant difference between the ΔE values of the composite block and the microhybrid resin composite ($p<0.05$).

The ΔE value of the composite block was clinically acceptable after repolishing. However, the ΔE values of the two resin composites were above the acceptability threshold.

Discussion

Color match is a factor that affects the longevity of resin-based composite restorations (5). The complex oral environment may lead to a change in the color of materials (10). The restorative materials must show resistance to discoloration over the years (4,14). The color stability of materials may be objectively measured by instrumental methods like a spectrophotometer (21). The CIE $L^*a^*b^*$ coordinate system is used to evaluate the color change (22). Because this system has advantages such as accuracy, repeatability, sensitivity, and objectivity (3,5). In this study, a spectrophotometer and CIE $L^*a^*b^*$ coordinate system were used to determine the color alterations. CIEDE 2000 is another color difference evaluation system. However, it has been reported that the CIELab and CIEDE 2000 systems are highly correlated (12).

The perceptible color difference to the human eyes and the acceptable color change are crucial in the assessment discoloration degree (3,5). There is no consensus about the perceptibility and acceptability threshold. Increased esthetic demands of patients have led to a decrease in the acceptability threshold over the years (18). In the current study, the perceptibility threshold of 1.2 and the acceptability threshold of 2.7 were chosen, as reported in a prospective multicenter study (20).

In the present study, the color stability of composite block, nanohybrid, and microhybrid resin composites was evaluated. After the staining procedure, all three materials showed unacceptable color changes. However, the color change value of the composite block was lower than that of nanohybrid and microhybrid resin composites. Therefore, the first null hypothesis that the color stability of composite block, nanohybrid, and microhybrid resin composites would not be different was rejected. The result is in agreement with previous studies, which have concluded that the indirect composite blocks had lower color change values than direct resin composites (3,19).

The CAD/CAM blocks show better resistance to discoloration than direct resin composites, even with similar compositions (3). The polymerization techniques used in the production procedure of CAD/CAM blocks promote their discoloration resistance (23). The resin-based materials that are used with CAD/CAM systems are polymerized industrially at high temperatures and pressures (6,7). The materials have a high conversion degree, so the number of unreacted monomers is lower than direct resin composites (6). The low number of unreacted monomers provides superior physical properties, less water absorption, and better color stability to these materials (6,12).

The staining susceptibility of resin-based materials is associated with their hydrophilicity of the resin matrix and the amount of water sorption (17). The materials may absorb other fluids with colorant pigments besides water, which results in discoloration (24). Water sorption mainly occurs in the resin matrix of the materials. Therefore, the organic matrix content of the material may be more effective in discoloration potential than filler particles (5). The materials containing a hydrophilic resin matrix have a higher degree of water sorption and a higher potential for discoloration (3,5,8,17,18). It has been concluded that, under similar curing conditions, TEGDMA and Bis-GMA showed higher water sorption than UDMA (25).

The conversion degree of the resin matrix influences the water sorption of materials (17,25). The degree of conversion is directly related to the amount of unreacted monomer (17). The low monomer conversion causes the formation of a high number of unreacted monomers, leading to higher water sorption and discoloration (5,25). The conversion degree of resin-based materials under identical curing conditions is different according to their monomer content because some monomers have a lower degree of conversion (17,25). It has been reported that Bis GMA showed a lower conversion degree than UDMA and TEGDMA (25). Higher inorganic filler content might also cause lower water sorption, thus providing better staining resistance (18,26).

The treatment of silane on the filler particles of the resin-based materials is another factor that that affects the color stability of materials over time (27). A weak silanization results in insufficient filler-resin matrix binding, which induces large amounts of water sorption and thus less staining resistance(4,8). The effective silanization process in CAD/CAM materials might positively influence water sorption and color stability (8).

In this study, the composite block showed better color stability than the direct resin composites. The result might be attributed to the better silanization and the lower water sorption that result from the high conversion degree. Furthermore, the composite block Cerasmart does not contain

a hydrophilic Bis-GMA monomer. It has a Bis-MPEPP monomer. Bis-MPEPP causes lower discoloration because it is a more hydrophobic monomer compared to Bis-GMA (4). The color stability of the nanohybrid and microhybrid resin composites was not different, as concluded in a previous study (28). It might be due to the similar resin matrix composition and inorganic filler ratio of these resin composites.

The discoloration of restorations could be removed by repolishing, depending on the material and the severity of staining (9,16). Repolishing is a minimally invasive operative procedure, which may remove the extrinsic discoloration on the restoration's surfaces (5,18). Moreover, the surfaces become more resistant to discoloration again since they are smoother after repolishing (5,29). Thus, the repolishing may even prevent the replacement of the restorations (18,29). Repolishing might be more effective in direct resin composites because they are more susceptible to wear (5).

In this study, repolishing reduced the discoloration degree of all materials. Therefore, the second null hypothesis that the repolishing would not affect the discoloration of the resin-based block, nanohybrid, and microhybrid resin composites was rejected. This result is in agreement with previous studies in which the repolishing provided a significant improvement in the discoloration of resin composites (5,16,18), ceramics, and resin-based composite blocks (9). In a previous study, repolishing did not affect the color change of the composite block Cerasmart, and this was attributed to a low discoloration degree (19). Nonetheless, internal discolorations may not be completely removed by repolishing (9,30). In the current study, the ΔE value of the microhybrid resin composites was higher than the resin-based block after the repolishing procedure. It might result from more internal discoloration in this resin composite.

In the present study, the color measurement was performed on a white background. The white background can simulate better the light reflectance in restorations surrounded by tooth walls (8,27). The color differences in these restorations are more evident (27). In the present study, red wine was chosen as a staining solution. It has been reported that red wine was a more effective coloring agent, although different staining solutions were available (3,8–10). The specimens were immersed in red wine daily and continuously for a specified time. It has been stated that this method might be assumed equal to a long duration of exposure to stains in clinical conditions (31).

The present study has some limitations. Different *in vitro* conditions may be effective on the color stability of the materials. The laboratory setting does not fully simulate intraoral conditions. In the clinical environment, the discoloration potential of restorative materials might be influenced by different factors, including saliva, oral temperature, tooth brushing, toothpaste, and diet content (9). Moreover, the geometrical shape of the specimens is not similar to typical dental restorations (19). Thus, more *in vitro* and clinical studies must be conducted to assess the color stability of the materials.

Conclusion

The composite block was more resistant to discoloration than the nanohybrid and microhybrid resin composites. There was no significant difference in discoloration between the nanohybrid and microhybrid resin composites. The repolishing procedure reduced the color alteration of the materials. After repolishing, the ΔE value of the composite block was clinically acceptable, but not that of the nanohybrid and microhybrid resin composites.

Türkçe özet: *Yeniden polisaj işleminin indirek kompozit blok, nanohibrit ve mikrohibrit rezin kompozitlerin renk değişimine etkisi. Amaç: İndirek kompozit blok, nanohibrit ve mikrohibrit rezin kompozitlerin kırmızı şaraba daldırıldıktan ve yeniden polisaj yapıldıktan sonra renk stabilitesini karşılaştırmalı olarak değerlendirmek. Gereç ve Yöntem: Örnekler (2x7x12 mm) bir indirek kompozit blok (Cerasmart), bir nanohibrit rezin kompozit (Ceram X), ve bir mikrohibrit rezin kompozit (Charisma Smart) kullanılarak hazırlandı. Örneklerin rengi CIE L*a*b* renk sistemine göre bir spektrofotometre ile kaydedildi (Spectroshade). Başlangıç rengi kaydedildikten sonra örnekler 15 gün boyunca günde 3 saat kırmızı şaraba daldırıldı. Renk ölçümü tekrar yapıldı. Örnekler, çok aşamalı bir polisaj sistemi (SuperSnap) ile polisajlandı. Renk ölçümü üçüncü kez yapıldı. Renk değişimi değerleri (ΔE) başlangıçta, daldırma ve yeniden polisaj işlemlerinden sonra elde edilen L*, a* ve b* değerleri ile hesaplandı. İstatistiksel analizler, tek yönlü varyans analizi, Tukey çoklu karşılaştırma ve eşleştirilmiş t testleri ile yapıldı. (p = 0,05) Bulgular: Kompozit blok en düşük ΔE değerini gösterdi (p<0,05). Nanohibrit ve mikrohibrit rezin kompozitlerin ΔE değerleri arasında istatistiksel olarak anlamlı bir fark bulunmadı. Yeniden polisaj işlemi, her üç materyalin de renk değişiminde bir azalma sağladı (p<0,05). Kompozit bloğun ΔE değeri, polisaj işleminden sonra klinik olarak kabul edilebilirdi. Sonuç: Kompozit blok, daha yüksek renk stabilitesi gösterdi. Nanohibrit ve mikrohibrit rezin kompozitlerin renklenme direnci farklı değildi. Yeniden polisaj işlemi, her üç materyalin de renk değişikliğini azalttı. Anahtar kelimeler: boyama, cad/cam, kompozit dental rezin, parlatma, renk*

Ethics Committee Approval: Not required.

Informed Consent: Not required.

Peer-review: Externally peer-reviewed.

Author contributions: MU participated in designing the study. MU participated in generating the data for the study. MU participated in gathering the data for the study. MU participated in the analysis of the data. MU wrote the majority of the original draft of the paper. MU participated in writing the paper. MU has had access to all of the raw data of the study. MU has reviewed the pertinent raw data on which the results and conclusions of this study are based. MU has approved the final version of this paper. MU guarantees that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that they have received no financial support.

References

1. Ilie N, Hickel R. Resin composite restorative materials. Aust Dent J 2011;56:59-66. [CrossRef]
2. Ferracane JL. Resin composite--state of the art. Dent Mater 2011;27:29-38. [CrossRef]
3. Alharbi A, Ardu S, Bortolotto T, Krejci I. Stain susceptibility of composite and ceramic CAD/CAM blocks versus direct resin composites with different resinous matrices. Odontology 2017;105:162-169. [CrossRef]
4. Ardu S, Duc O, Di Bella E, Krejci I, Daher R. Color stability of different composite resins after polishing. Odontology 2018;106:328–33. [CrossRef]
5. Mundim FM, Garcia L da FR, Pires-de-Souza F de CP. Effect of staining solutions and repolishing on color stability of direct composites. J Appl Oral Sci 2010;18:249–54. [CrossRef]

6. Mainjot AK, Dupont NM, Oudkerk JC, Dewael TY, Sadoun MJ. From Artisanal to CAD-CAM Blocks: State of the Art of Indirect Composites. J Dent Res 2016;95:487–95. [CrossRef]
7. Ruse ND, Sadoun MJ. Resin-composite blocks for dental CAD/CAM applications. J Dent Res 2014;93:1232–4. [CrossRef]
8. Kang YA, Lee HA, Chang J, Moon W, Chung SH, Lim BS. Color stability of dental reinforced CAD/CAM hybrid composite blocks compared to regular blocks. Materials (Basel) 2020;13:1–17. [CrossRef]
9. Seyidaliyeva A, Rues S, Evagorou Z, Hassel AJ, Rammelsberg P, Zenthöfer A. Color stability of polymer-infiltrated-ceramics compared with lithium disilicate ceramics and composite. J Esthet Restor Dent 2020;32:43–50. [CrossRef]
10. Aydın N, Karaoğlanoğlu S, Oktay EA, Kılıçarslan MA. Investigating the color changes on resin-based CAD/CAM Blocks. J Esthet Restor Dent 2020;32:251–6. [CrossRef]
11. Choi YS, Kang KH, Att W. Evaluation of the response of esthetic restorative materials to ultraviolet aging. J Prosthet Dent 2021;126:679–85. [CrossRef]
12. Stamenković DD, Tango RN, Todorović A, Karasan D, Sailer I, Paravina RD. Staining and aging-dependent changes in color of CAD-CAM materials. J Prosthet Dent 2021;126:672–8. [CrossRef]
13. Sulaiman TA, Rodgers B, Suliman AA, Johnston WM. Color and translucency stability of contemporary resin-based restorative materials. J Esthet Restor Dent 2021;33:899–905. [CrossRef]
14. Muhittin U, Burak TU, Kam HO. Color stability of microhybrid and nanofilled composite resins: Effect of surface sealant agents containing different filler content. J Contemp Dent Pract 2019;20:1045–50. [CrossRef]
15. Ren YF, Feng L, Serban D, Malmstrom HS. Effects of common beverage colorants on color stability of dental composite resins: the utility of a thermocycling stain challenge model in vitro. J Dent 2012;40 Suppl 1. [CrossRef]
16. De Alencar e Silva Leite ML, Da Cunha Medeiros e Silva FDS, Meireles SS, Duarte RM, Maciel Andrade AK. The effect of drinks on color stability and surface roughness of nanocomposites. Eur J Dent 2014;8:330–6. [CrossRef]
17. Fonseca ASQS, Labruna Moreira AD, de Albuquerque PPAC, de Menezes LR, Pfeifer CS, Schneider LFJ. Effect of monomer type on the CC degree of conversion, water sorption and solubility, and color stability of model dental composites. Dent Mater 2017;33:394–401. [CrossRef]
18. Mailart MC, Rocha RS, Mondragón Contreras SC, Torres CRG, Borges AB, Caneppele TMF. Effects of artificial staining on bulk-filled resin composites. Am J Dent 2018;31:144–8.
19. ERSÖZ B, Karaoğlanoğlu S, Oktay EA, Aydın N. Color stability and surface roughness of resin based direct and indirect restorative materials. Eur Ann Dent Sci 2021;48:1–6. [CrossRef]
20. Paravina RD, Ghinea R, Herrera LJ, Bona AD, Igiel C, Linninger M, et al. Color difference thresholds in dentistry. J Esthet Restor Dent 2015;27:S1–9. [CrossRef]
21. Liberato WF, Barreto IC, Costa PP, de Almeida CC, Pimentel W, Tiossi R. A comparison between visual, intraoral scanner, and spectrophotometer shade matching: A clinical study. J Prosthet Dent 2019;121:271–5. [CrossRef]
22. Saegusa M, Kurokawa H, Takahashi N, Takamizawa T, Ishii R, Shiratsuchi K, et al. Evaluation of Color-matching Ability of a Structural Colored Resin Composite. Oper Dent 2021 ;46:306–15. [CrossRef]
23. Stawarczyk B, Sener B, Trottmann A, Roos M, Özcan M, Hämmerle CHF. Discoloration of manually fabricated resins and industrially fabricated CAD/CAM blocks versus glass-ceramic: effect of storage media, duration, and subsequent polishing. Dent Mater J 2012;31:377–83. [CrossRef]
24. Bagheri R, Burrow MF, Tyas M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials. J Dent 2005;33:389–98. [CrossRef]
25. Gajewski VES, Pfeifer CS, Fróes-Salgado NRG, Boaro LCC, Braga RR. Monomers used in resin composites: degree of conversion, mechanical properties and water sorption/solubility. Braz Dent J 2012;23:508–14. [CrossRef]
26. Randolph LD, Palin WM, Leloup G, Leprince JG. Filler characteristics of modern dental resin composites and their influence on physico-mechanical properties. Dent Mater 2016;32:1586–99. [CrossRef]
27. Ardu S, Braut V, Gutemberg D, Krejci I, Dietschi D, Feilzer AJ. A long-term laboratory test on staining susceptibility of esthetic composite resin materials. Quintessence Int 2010;41:695-702.
28. Poggio C, Scribante A, Colombo M, Beltrami R, Chiesa M. Surface discoloration of composite resins: Effects of staining and bleaching. Dent Res J (Isfahan) 2012;9:567. [CrossRef]
29. Anfe TEDA, Agra CM, Vieira GF. Evaluation of the possibility of removing staining by repolishing composite resins submitted to artificial aging. J Esthet Restor Dent 2011;23:260–7. [CrossRef]
30. Fontes ST, Fernández MR, de Moura CM, Meireles SS. Color stability of a nanofill composite: effect of different immersion media. J Appl Oral Sci 2009;17:388–91. [CrossRef]
31. Malhotra N, Shenoy RP, Acharya S, Shenoy R, Mayya S. Effect of three indigenous food stains on resin-based, microhybrid-, and nanocomposites. J Esthet Restor Dent 2011;23:250–7. [CrossRef]

56th Volume Index

Subject Index

56th Volume Index

Author Index

56th Volume Index

Acknowledgement to Reviewers
September 2021 - September 2022

Editor-in-Chief and Editorial Staff would like to thank following reviewers who have shared their valuable time and expertise to evaluate manuscripts submitted to European Oral Research in 2022.

Akay, Gülsün
Aren, Gamze
Aydın, Ülkem
Baksi Şen, Güniz
Balci, Nur
Balık, Ali
Bani, Mehmet
Cabbar, Fatih
Cansız, Erol
Çankaya, Burak
Çınar, Çağdaş
Dayan, Süleyman
Dixit, Avani
Egilmez, Ferhan
Emes, Yusuf
Erdilek, Ayşe
Gursel Surmelioglu,Derya
Jaju, Prashant P.
Kadioglu, Onur
Karayılmaz, Hüseyin
Kayhan, Kıvanç Bektaş
Kılınç, Delal Dara
Kümbüloğlu, Övül
Mishra, Richa
Özçakır Tomruk, Ceyda
Özdemir Özenen, Didem
Sar Sancaklı, Hande
Sayar, Gülşilay
Sungurtekin Ekçi, Elif
Tekçe, Neslihan
Tuncer, Safa
Turp, Volkan
Türk, Ayşe Gözde
Ureyen Kaya, Bulem
Üstün, Nilüfer
Yaman, Batucan
Yener, Murat
Yılmaz Atalı, Pınar
Yılmaz, Nergiz


E
R