Medicine in Evolution

Printed at: WALDPRESS, Timisoara,
64 Divizia 9 Cavalerie Street,
Phone/Fax: 0040256422247

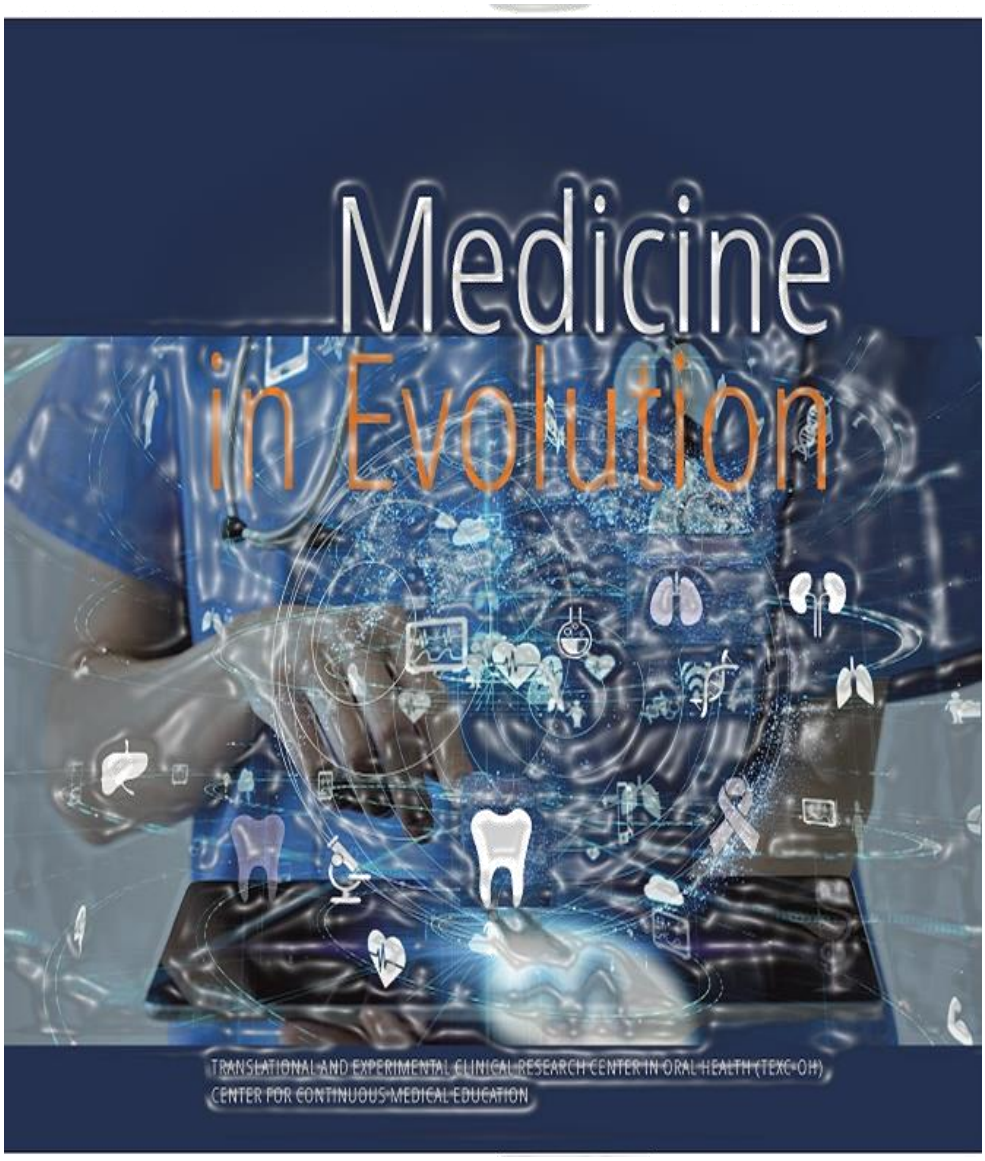
Edited at: EUROSTAMPA, Timisoara
26, Revolutiei 1989 Street,
Phone: 0040256204816

TRANSLATIONAL AND EXPERIMENTAL CLINICAL RESEARCH CENTER IN ORAL HEALTH (TEXC-OH)
CENTER FOR CONTINUOUS MEDICAL EDUCATION

ISSN 2065-376X | https://medicineinevolution.ro/

Volume XXX, No. 4, 2024, Timişoara, Romania
ISSN 2065-376X

MEDICINE IN EVOLUTION



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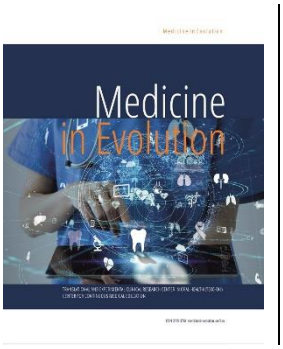

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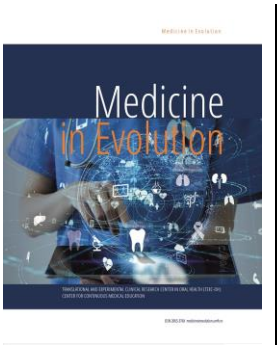
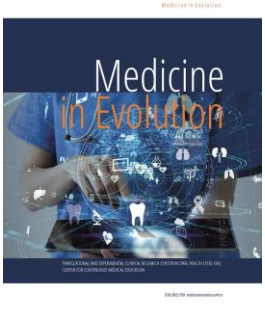


Legal Considerations on Physician Liability in the Context of the Covid-19 Pandemic



Alina-Doina Tănase[1,2], Meda-Lavinia Negrutiu[2,3], Ioana Mârtu[4], Emanuela-Lidia Petrescu[2,3], Andreea-Codruta Novac[2,3], Daliana Emanuela Bojoga[5,6], Kristian Miok[7], Mioara-Raluca Cosoroabă[1], Marius Manole[8]

[1]Department of Professional Legislation in Dental Medicine, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timişoara, Romania
[2]Research Centre in Dental Medicine Using Conventional and Alternative Technologies, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[3]Department of Prostheses Technology and Dental Materials, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[4]Department of Oral Implantology, Removable Dentures and Technology, Faculty of Dental Medicine, "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi, Romania
[5]Department of Oral Rehabilitation and Emergencies in Dentistry, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[6]Interdisciplinary Research Center for Dental Medical Research, Lasers and Innovative Technologies, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[7]The Institute for Advanced Environmental Research-ICAM, West University of Timisoara, Timişoara, Romania
[8]Discipline of Dental Propedeutics and Aesthetics, Faculty of Dental Medicine, University of Medicine and Pharmacy "Iuliu Hatieganu" from Cluj-Napoca, Romania

Correspondence to:
Name: Ioana Mârtu
E-mail address: ioana.martu@umfiasi.ro

Received: 6 November; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

Backgroung/Objectives: The liability of medical staff for malpractice in the context generated by the Covid-19 pandemic is a topical issue both for those who work in the medical system and for legal practitioners. Methods: In order to carry out this observational-prospective study, a questionnaire was drawn up consisting of 10 closed questions with a yes or no answer, which had the role of analyzing the opinion of doctors regarding the incidence of malpractice allegations during the COVID-19 pandemic. After completing the completion period, the questionnaires were centralized and analyzed statistically. Results: The majority of doctors considered that the emergence of the pandemic favored an increased level of stress and anxiety among the specialized staff working in health facilities, a fact that inevitably led to the appearance of complaints from patients, as a result of various professional errors what were committed and which resulted in the prejudice of their rights, especially the right to health. Conclusions: The central conclusion of this study focuses on the future development of a legislation that should enjoy clarity and brevity, being unambiguous and adapted to various unexpected situations, as was the pandemic generated by the emergence of the SARS-CoV-2 virus.

Keywords: pandemic, doctor, patient, malpractice, medical malpractice, medical error, medical mistake

INTRODUCTION

The crisis brought about by the pandemic evolution of COVID-19 is a state of affairs which has had to be countered by vigorous measures adopted both at European Union level and at the level of each Member State in order to ensure the health protection of EU citizens. Some of these measures have had a direct impact on patients' rights and interests [1].

In a democratic society, it is necessary that in such situations, the application of punctual measures does not turn into abuse and does not lead to the violation of fundamental rights, under the guise of protecting superior interests, such as public health [2].

The period leading up to the declaration of COVID-19 as a pandemic did not seem to herald the adoption of any extraordinary measures that would affect or restrict patients' fundamental rights [3,4].

The issue of doctors' civil liability for malpractice in the context of the COVID19 pandemic has been debated in various specialized studies elaborated in Romania by legal specialists, analyzing this topic both from a practical and theoretical point of view [5,6].

There is a substantial difference between the concept of medical error and medical mistake, and the distinction between the two concepts is such as to exonerate or incriminate medical personnel accused of malpractice [7]. Medical error is a complicated course of a disease or symptomatology with a tragic end, such that no diligent doctor could have stopped its unfortunate course, whereas medical malpractice is characterized by the doctor's fault in the exercise of his profession, manifested either in the form of imprudence or negligence [8,9]. More precisely, medical negligence is an unintentional act on the part of the doctor, which causes harm to the patient and makes the professional liable, since in the same circumstances another doctor, more diligent but with the same professional training, would not have caused the harm [10]. Negligence, on the other hand, is a failure to act in a situation in which a diligent professional would have acted, and can be circumscribed to haste, superficiality or improper performance of the duties of the profession [11,12].

The doctor is responsible for medical mistakes, not errors, and haste and superficiality are a form of medical error [13].

What happens, however, in a crisis situation where haste becomes the central element and defines medical activity, while at the same time opening the floodgates to superficiality? Moreover, if quantity (treating as many infected patients as possible-superficial or not) prevails over quality (giving each patient thorough and thorough care), is medical staff who have harmed some patients to save many others justified or not? In other words, if the superficiality would have caused harm only to the patients most affected by COVID-19 (perhaps because of morbidities), but led to the saving of the other (significantly more numerous) patients, who in the absence of prompt treatment would have suffered worsening, can it still be considered malpractice? [14,15].

We appreciate that the answer to these questions is a very sensitive one, given the specificities of each individual situation. Overburdening medical staff, over a long period of time, in order to save as many patients as possible, with the risks associated with their superficial treatment, and moreover, with the risk of their own illness, is, if not an element that contributes to exonerating them from liability, a genuine cause of mitigation of civil liability [16].

In the light of the above and in the context of COVID-19, it is questionable to what extent the excessive workload, coupled with the lack of knowledge of the supporting physicians and the inability to seek a second medical opinion or to receive confirmation of the diagnosis and treatment of infected patients will lead to the liability of the attending medical staff [17].

The concept of the supporting doctor is another important element in analyzing whether medical personnel fulfill the conditions for tort liability. At the time of the pandemic, any medical personnel could be delegated/ seconded to provide medical care in other support health facilities for the diagnosis and treatment of infected patients suffering from COVID-19. In these circumstances, a number of questions arise, including the question of the limits of the liability of support physicians for medical malpractice, given that they are not infectious disease specialists or pulmonary specialists [18,19].

At present, there are no special liability exemption rules in relation to the COVID-19 pandemic that derogate from the common law rule contained in the Civil Code. At least at first sight it would seem that there is no basis for derogation from the Civil Code. If the medical personnel could have realized that they were committing a wrongful act by treating infected patients, since they were not specialized in this and as such their action harmed the patients, they would be obliged to compensate for the damage caused. The mere fact that he was acting on the orders of his superior/undertaking an activity permitted by law will not exempt him from liability [20].

Certainly, opinions will be issued both in the sense that the doctor should not be held accountable in the context of carrying out his work in good faith, in crisis conditions, and in the opposite sense, namely blaming the medical staff for any mistakes and/or medical errors committed. The ambiguity of the regulation will benefit the party that is able to explain clearly and coherently the factual situation and, consequently, the legal reality of the situation and the legal reality that is being analyzed.

Aim and objectives

The main aim of this research study is to analyze physicians' opinion on the incidence of malpractice allegations during the COVID-19 pandemic. We wished to analyze the extent to which physicians were confronted during the pandemic period with accusations from patients, who complained of improper performance of medical acts and harm to their rights and interests. Moreover, we aimed to assess physicians' views on the extent to which the COVID-19 pandemic has favored the increase in malpractice allegations among patients. We want to analyze whether they believe that the high workload and stress generated by the COVID-19 pandemic has influenced the way they provide medical care, exposing them to the risk of making mistakes in the provision of specialized care, such that patients have seen their rights and interests harmed and jeopardized.

MATERIALS AND METHODS

For the realization of this study we chose as material and method an anonymous questionnaire consisting of 10 closed yes or no questions addressed to physicians on the topic of medical malpractice in the context of the COVID-19 pandemic.

Before starting to fill in the questionnaire, the doctors were asked to agree to their involvement in the study and were informed about the purpose and role of the study. The study participants were also provided with all the information they needed so that they were aware of the role and purpose of the study. The questionnaires completed by the physicians were anonymous and they were not required to state their first and last names when completing them. The group of physicians included in the study consisted of 50 people, working in different health units in Timis County. Physicians' participation in the study was free of charge and they had the right to withdraw at any time. The withdrawal of physicians from the study was voluntary, without them being manipulated or influenced in any way. The questionnaires were completed in a combined mode, distributed both in letter and electronically through various social networks.

The first question in the questionnaire addressed to the doctors aims to analyze their opinion on the increase in the number of malpractice cases during the pandemic due to the very high workload of doctors who worked in the Covid wards during that period. We wanted to analyze the extent to which the heavy workload and stress to which medical staff were subjected during the pandemic period favored the commission of various mistakes in practice, which caused a series of harms to patients, so that the latter had to turn to the competent judicial bodies to defend their rights and interests that were harmed.

The second question in the questionnaire aims to analyze the incidence of medical malpractice in medical practice during the pandemic period, in order to observe to what extent the participants involved in the study are aware or not aware of whether or not some of their colleagues have been accused by patients and called to court to be held legally accountable for the harm caused. The aim was to assess the extent to which malpractice claims have increased during the pandemic period or, on the contrary, whether there is an increase in malpractice claims influenced by the emergence of the new virus.

The third question addressed to the doctors who agreed to participate in the survey aims to highlight the level of knowledge and information they have on the Romanian legislation governing the civil liability of medical staff and health facilities for malpractice.

The fourth question analyzes to what extent the physicians included in the sample of subjects participating in the study consider that during the pandemic the refusal of medical staff to treat and admit patients who did not present a medical emergency constitutes a violation of their rights to healthcare, discriminating against this category of patients. There have been countless cases of this kind, in which patients who did not present a symptomatology that required emergency medical intervention were sent home to treat themselves, without being hospitalized in health facilities. In this context, we considered it appropriate and of great interest to find out what the doctors' opinion is on this subject, which has caused a number of complaints among the population.

The fifth question in the questionnaire seeks to analyze to what extent during the pandemic period doctors turned to lawyers specializing in malpractice litigation as a result of being accused by patients of various medical malpractice.

Question number six examines an extremely sensitive issue that has been widely debated, including in various specialized studies prepared in the context of the pandemic in our country, namely the gaps and ambiguities in Romanian legislation that medical personnel had to deal with during the pandemic in terms of malpractice. In the light of the health crisis that has shocked the entire planet and that has set in extremely quickly, without anyone being prepared, not even the staff in the health units, we would like to analyze the opinion of doctors on the need to improve the Romanian legislation on malpractice, so that it is much clearer, unambiguous and adapted to the situations they encountered in practice during the COVID-19 pandemic.

The purpose of the seventh question included in the questionnaire is to analyze the level of knowledge of physicians about the Romanian legislation on malpractice, which regulates the possibility of exoneration from liability of health care facilities' staff for disclosing patients' professional secrecy when this disclosure is motivated by the defense and protection of a public interest. It is precisely because this hypothesis is applicable in the context of the COVID-19 pandemic that we want to see to what extent healthcare professionals are aware of its existence in the legislation.

Question number eight explores a highly debated topic in the media. We wanted to find out the opinion of the participants in this study on the role and involvement of state authorities during the pandemic in supporting medical staff in health facilities, so that the conditions for providing health care would be much safer for patients. We set out to analyze to what extent they consider that the Romanian authorities were involved and provided them

with all the conditions to ensure that the provision of medical care took place in safe conditions for both them and the patients, or on the contrary, things were not like this, with the risk of a series of situations arising that could lead to the commission of various errors in medical practice.

The penultimate question in the questionnaire analyzes the opinion of doctors on the necessity and usefulness of having psychologists in the health units where SARS-CoV-2 infected patients were treated, to whom the medical staff could turn to, given the extremely difficult period that the specialists in the field have been through, the excessive workload and stress that the work on the Covid wards has involved.

The last question in the questionnaire aims to analyze the level of knowledge of the resident doctors involved in the study regarding the Romanian legislation in the field of malpractice, which regulates the exemption of medical staff from liability for damages caused to patients as a result of insufficient provision of diagnostic and treatment equipment or contact with nosocomial infections during hospitalization.

RESULTS

The data collected from the participating physicians in the study were centralized and statistically analyzed, and are presented in the form of figures.

Question 1: Do you consider that the pandemic period has favored the increase of medical malpractice by staff working in health facilities on Covid wards due to the extremely high workload? 0-NU; 1-DA. The results showed that 40% of the physicians participating in the survey did not consider that the pandemic period has favored the increase in medical malpractice by staff working in health facilities on Covid wards due to the extremely high workload. In contrast, the majority of doctors, 60%, claim the opposite, believing that the pandemic has influenced the increase in malpractice (Figure 1).

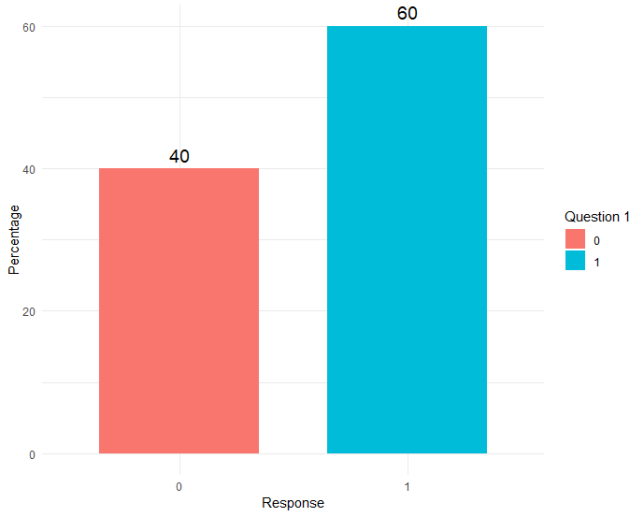


Figure 1. Statistical results for question 1

Question 2: Are you aware of any cases in which doctors working in Covid wards have been accused by patients of malpractice as a result of various errors in the provision of medical care? 0-NU; 1-DA. The results showed that 86% of the study participants have no knowledge about the existence of malpractice allegations during the pandemic period against physicians practicing on Covid wards. The remaining 14% of the survey participants stated that they are aware of the existence of certain situations in which their colleagues have been

accused by patients of committing certain professional errors in the provision of medical care (Figure 2).

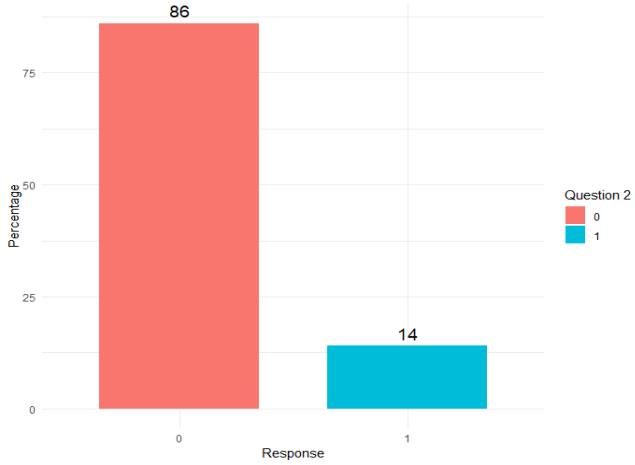


Figure 2. Statistical results for question 2

Question 3: Are you aware of the legislation in Romania regulating the civil liability of healthcare professionals and healthcare providers for professional errors committed in the course of the exercise of their profession? 0-NU; 1-DA. Regarding the third figure, 62% of the doctors who agreed to participate in the survey stated that they have no knowledge of the Romanian legislation that legally analyzes the institution of malpractice in the medical field. The opposite was true for 38% of those included in the survey, i.e. that they are aware of the Romanian legislation regulating the liability of medical staff for errors in specialty care, and that they are familiar with the content of these laws (Figure 3).

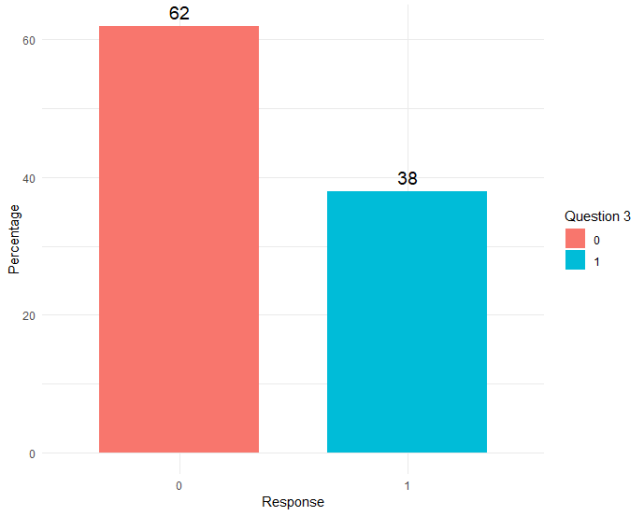


Figure 3. Statistical results for question 3

Question 4: Do you consider that during the pandemic the refusal of medical personnel to treat and admit patients who did not present a medical emergency constitutes a violation of their rights to healthcare, discriminating against this category of patients? 0-NU; 1-DA. The results revealed that only 14% of the respondents do not consider that during the pandemic the refusal of medical staff to treat and admit patients who did not present a medical emergency constitutes a violation of their healthcare rights, discriminating against this category of patients. Most of the doctors included in the survey expressed the opposite

opinion, namely an extremely high percentage, namely 86%, consider that in this situation patients are discriminated against, not being granted equal treatment in the medical act (Figure 4).

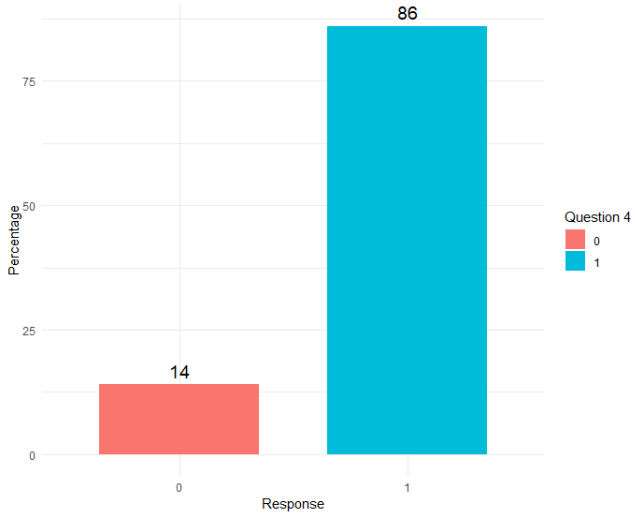


Figure 4. Statistical results for question 4

Question 5: During the pandemic period, did you use lawyers specializing in malpractice litigation because patients accused you of certain malpractice related to the provision of medical care? 0-NU; 1-DA. According to the results obtained, 42% of the physicians stated that they did not need to turn to lawyers during the pandemic to defend themselves in malpractice litigation, since their patients did not allege that they had committed any errors in the performance of medical acts. In contrast, 58% of survey participants reported the opposite, that they had to be represented in court by malpractice lawyers following complaints from patients during the pandemic (Figure 5).

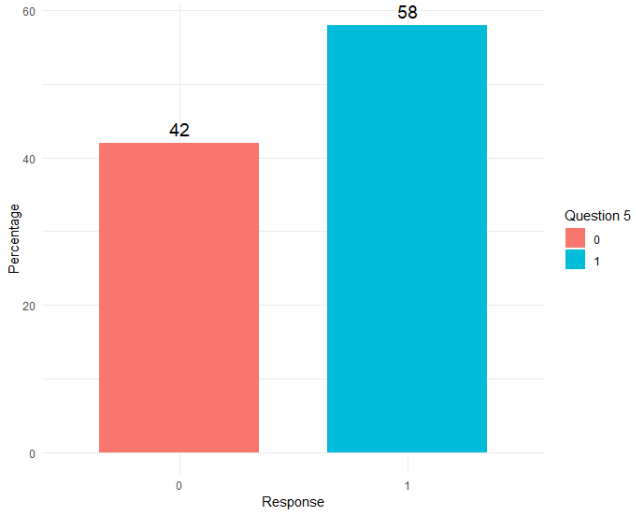


Figure 5. Statistical results for question 5

Question 6: Do you consider that the legislation in Romania regulating the liability of medical personnel for malpractice is deficient and needs to be improved and adjusted in view of the health crisis caused by the emergence of the pandemic? 0-NU; 1-DA. A small percentage of doctors, i.e. 20%, do not consider that the Romanian legislation regulating the liability of medical personnel for malpractice is deficient and claim that it does not need to be

improved and adjusted in relation to the health crisis caused by the emergence of the pandemic. On the contrary, most of them, namely 80%, stated the contrary, being dissatisfied with the way in which the malpractice legislation is enacted, requiring some changes to respond to the concrete needs caused by the emergence of the pandemic (Figure 6).

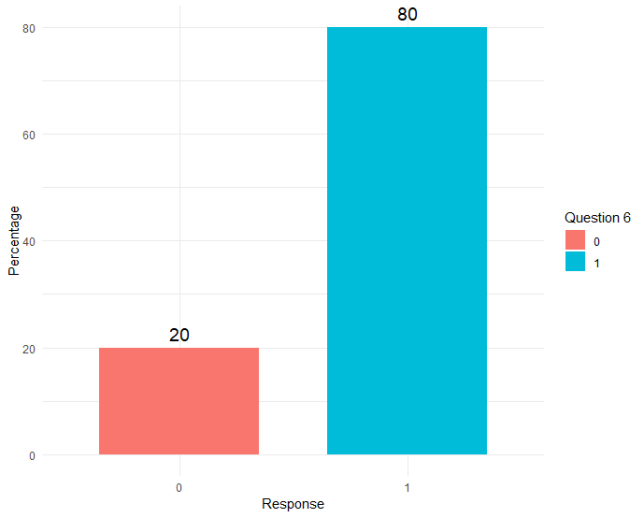


Figure 6. Statistical results for question 6

Question 7: Are you aware that under Romanian law, medical personnel are exempt from liability for disclosing patients' professional secrecy if such disclosure is prompted by the defense and protection of a public interest? 0-NU; 1-DA. The results showed that 62% of the physicians are not aware of the fact that according to the Romanian legislation, medical staff is exempted from liability for disclosing patients' professional secrecy if this disclosure is motivated by the defense and protection of a public interest, while 38% of them have knowledge on this subject (Figure 7).

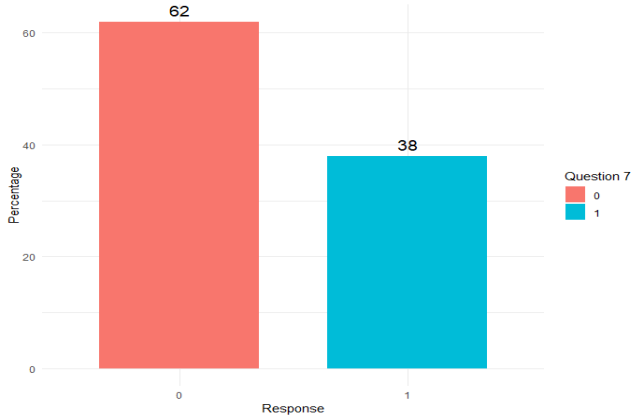


Figure 7. Statistical results for question 7

Question 8: Do you think that during the pandemic the state authorities could have cooperated and supported the medical staff in health facilities much more, so that the conditions of health care could have been much safer for patients? 0-NU; 1-DA. The results showed that 88% of the doctors involved in the study believe that during the pandemic the state authorities could have cooperated and supported the medical staff in health facilities much more so that the conditions of health care would have been much safer for patients, while 12% of the participants said the opposite (Figure 8).

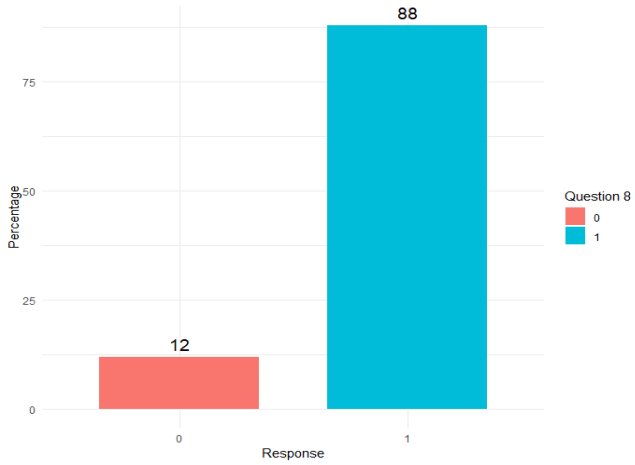


Figure 8. Statistical results for question 8

Question 9: Do you consider that during the pandemic it was necessary for medical staff in health facilities to be counseled by psychologists, given the stress they were under due to the extremely high workload and the medical severity of some cases? 0-NO; 1-DA. Only 8% of the respondents do not consider that during the pandemic it was necessary for medical staff in health facilities to be counseled by psychologists, given the stress they were under due to the extremely high workload and the medical seriousness of some cases, and the remaining 92% say that this measure is extremely beneficial (Figure 9).

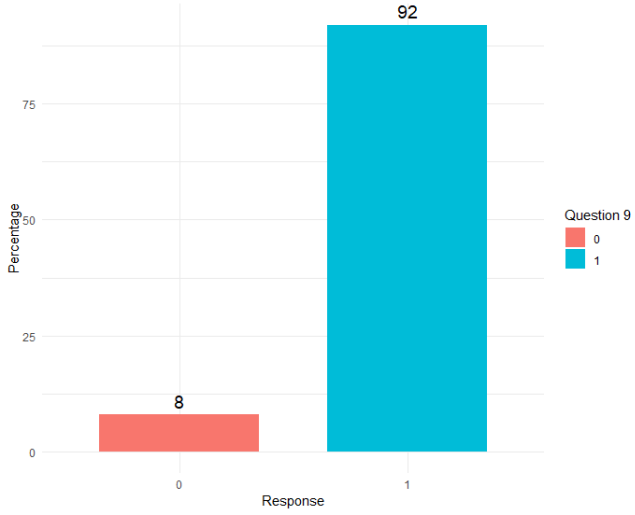


Figure 9. Statistical results for question 9

Question 10: Are you aware that medical staff were exempt from liability if, during the pandemic, harm to patients was caused by inadequate diagnostic and treatment equipment in health facilities or nosocomial infections? 0-NU; 1-DA. Interpretation of the results showed that 26% of the doctors involved in the study were not aware of the fact that medical staff were exempted from liability if during the pandemic period the harm caused to patients was caused by insufficient diagnostic and treatment equipment in health facilities or nosocomial infections, but a rather high percentage, 74%, were aware of this issue (Figure 10).

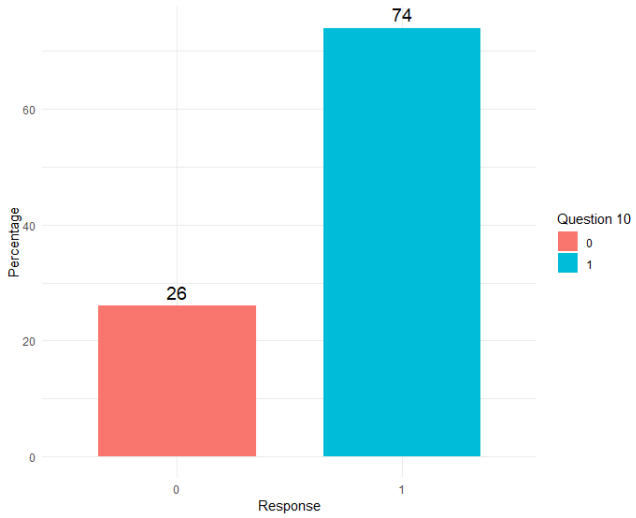


Figure 10. Statistical results for question 10

DISCUSSIONS

The number of accusations of medical malpractice increased during the pandemic, as medical personnel were subjected to extremely high stress and an increased workload, which led to the favoring of committing various professional errors during the medical act. We believe that improving the degree of knowledge regarding the legislation in the medical field will help doctors to know how to correctly manage the situations they face in medical practice in the relationship with patients, thus avoiding the appearance of malpractice accusations [21].

Another extremely important aspect that we believe needs to be pointed out and emphasized is that the interdisciplinary collaboration between the medical staff who worked in the Covid wards and psychologists is extremely beneficial, because unfortunately the pandemic period has overwhelmed everyone, especially those involved in treating patients, generating for the latter a state of continuous stress and anxiety.

CONCLUSIONS

In conclusion, what is essential in malpractice cases are the factual situation, the careful analysis of all the elements likely to lead to a clear legal conclusion, since any nuance of the factual reality and the identification of its subtleties will significantly contribute to the shaping of a substantiated legal reality right in law. The medical personnel liability legislation, as it is currently corroborated with the one adopted during the pandemic, represents a trap into which it is easy to fall – under the appearance of general provisions, the vagueness, the gap and the equivocation are hidden. Although we could argue that they benefit legal professionals, who have thus opened the way to the interpretation and therefore the manipulation of the rules in favor of the interests they defend, we appreciate that they prejudice the parties to a dispute.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Dumitru LP, Patriciu M, Şerban MC, Popoiu R, Sîrbu V. Error or Negligence in Medicine: A Literature Review. Romanian Journal of Oral Rehabilitation. 2021;13(1):348-352.

[2] Pisareco C, Manea M, Cheianu E, Pisarenco S. Erorile medicale: o analiză a percepţiei medicilor. Buletinul AŞM. 2023; 3: 35-42.

[3] Dimitri O. Probleme şi soluţii legale privind criza COVID-19, Editura C.H. Beck, Bucureşti, 2020: 297-313.

[4] Popa I, Nicolescu O. Abordări şi studii de caz relevante privind managementul organizaţiilor din România în contextul pandemiei de COVID-19, Editura Pro Universitaria, Bucureşti, 2020:50.

[5] Pisarenco C, Pisarenco S. Eroare medicală ca urmare a acţiunilor neglijente sau neprofesioniste. Buletinul AŞM. 2022;3(74):43-46.

[6] Jugastru C. Aspecte privind răspunderea civilă a medicului în contextul COVID-19. Acta Universitatis Lucian Blaga. Iurisprudentia. 2020; 2:13-31.

[7] Cohen G, Crespo AM. White DB. Potential Legal Liability for Withdrawing or Withholding Ventilators During COVID-19 Assessing the Risks and Identifying Needed Reforms. JAMA. 2020; 19:120.

[8] Apan RD, Bala CG. Dreptul sănătăţii – provocări în vremea pandemiei, Editura ProUniversitaria, Bucureşti, 2021: 162.

[9] Adam I. Răspunderea civilă medicală. Revista Dreptul. 2021; 5: 55.

[10] Stanici M. Informarea şi dezinformarea în perioada pandemiei de COVID 19 în România, Editura Tritonic, Bucureşti, 2024: 202-206.

[11] Braithwaite B, Harby C, Miletic G. COVID-19 şi impactul asupra drepturilor omului, Editura Hamangiu, Bucureşti, 2021: 50.

[12] Vida-Simiti I. Răspunderea civilă a medicului, Editura Hamangiu, Bucureşti, 2013: 50-54.

[13] Năsui GA. Malpraxisul medical. Particularităţile răspunderii civile medicale. Jurisprudenţă internă relevantă. Malpraxisul profesiilor liberale, Ed. a III-a, revăzută şi adăugită, Editura Universul Juridic, Bucureşti, 2024: 90.

[14] Gherendi IM. Răspunderea juridică pentru malpraxisul medical. Juridice. 2021; 3: 6.

[15] Preda AM. Răspunderea civilă a medicilor pentru malpraxis medical, Editura Curierul Judiciar, Bucureşti, 2020: 449.

[16] Mihuţ T, Cristache CM, Cristache G. Malpraxisul şi medicina defensivă. Dental Target. 2017: 6-8.

[17] Andreescu M, Tudor Tony A. Bioetică şi deontologie medicală. Avatarul unui ideal-Note de curs, Editura Universităţii Titu Maiorescu, Bucureşti, 2023: 102.

[18] Boilă LR. Răspunderea civilă delictuală subiectivă, Editura C.H. Beck, Bucureşti, 2019: 100.

[19] Hostiuc S. Tratat de bioetică medicală şi stomatologică, Editura C.H. Beck, Bucureşti, 2021: 132.

[20] Giurgea M, Lazăr L. Eroarea de diagnostic în cazurile de malpraxis. Ipoteze ale răspunderii medicului. Revista Dreptul. 2018; 3: 84.

[21] Iaob G. Sindromul de stres indus de malpraxis medical. Revista Medicală Română. 2014: LXI (4): 256-258.

Achieving a Lighter Shade: Adjusting the Color of Layered Lithium Disilicate Fixed Dental Restorations with Feldspathic Ceramic Veneers

Adrian Jantea[1], Sorin Gheorghe Mihali[2], Dan Lolos[3], Loredana Mitariu[4], Mihai Mitariu[5], Daian Popa[6], Roxana Oancea[7], Liliana Porojan[8]

[1]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania; Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[2]Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[3]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[4]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, Romania.
[5]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, România.
[6]PHD Student, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[7]Department of Preventive and Community Dentistry, Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, 300041 Timişoara, Romania.
Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health, University of Medicine and Pharmacy "Victor Babes", 300040 Timisoara, Romania
[8]Center for Advanced Technologies in Dental Prosthodontics, Department of Dental Prostheses Technology (Dental Technology), Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.

Correspondence to:
Name: Sorin Mihali
E-mail address: sorin@dentalconcept.org

Received: 18 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

This case report describes the use of feldspathic ceramic veneers placed over prepared lithium disilicate restorations to address aesthetic concerns in a patient. Initially, lithium disilicate restorations were placed, but the patient was dissatisfied with the visible transition lines and the darker shade of the restorations compared to her natural tooth color. To correct these issues, the lithium disilicate restorations were prepared, and feldspathic ceramic veneers were applied to improve the color match and eliminate the transition lines, achieving a more natural and aesthetic result. The application of feldspathic veneers enhanced the overall appearance, providing a better color and translucency that matched the patient's expectations. This case demonstrates the potential of

feldspathic ceramics to resolve aesthetic challenges in restorations, particularly in cases where the initial material does not meet the desired color and aesthetic outcomes.

Keywords: feldspathic ceramic, lithium disilicate, anterior restoration, aesthetic outcomes, color mismatc

INTRODUCTION

A good marginal fit and finish, combined with a sound color match, is often achieved through careful adjustments and multiphase finishing procedures in fixed dental restorations. Lithium disilicate ceramics are frequently used in laminated dental restorations due to their high strength and resilience, with the chemical compound being well-known in the field [1,2]. However, difficulties in achieving uniform color and concealing underlying substrate stains have been reported, particularly when the initial restoration does not yield the desired aesthetic outcome [1,2].

In cases where lithium disilicate restorations show signs of color non-uniformity or visible substrate discoloration, feldspathic ceramic veneers can be especially useful in improving the overall esthetics. Feldspathic ceramics are renowned for their ability to replicate the optical properties of dental enamel, such as translucency and opacity, providing an effective means of concealing color differences and optimizing aesthetic results [3,4]. While feldspathic veneers are often considered more esthetic than lithium disilicate, they are also expected to have lower strength, which may be compromised when cemented to restorations that themselves might weaken the veneers [5,6].

This case report illustrates a scenario in which lithium disilicate restorations were initially placed, but the patient was dissatisfied with the outcome due to unequal coloring and visible substrate areas. To resolve these issues, it was decided to layer feldspathic ceramic veneers over the disilicate restorations to enhance the esthetic appearance. By properly preparing and conditioning the existing lithium disilicate surfaces, and utilizing feldspathic veneers, the clinicians achieved a more uniform and natural-looking result [7,8].

This approach underscores the effectiveness of feldspathic ceramics in correcting aesthetic issues in cases with initial unpredictable esthetics or when the initial restorations fail to achieve the desired color consistency. Feldspathic veneers not only addressed the color mismatch problem but also improved the aesthetics of the marginal areas between the restorations [9,10]. This case reinforces the idea that, when planned carefully, aesthetic treatments using feldspathic ceramics can enhance the results provided by primary restorative materials, matching the patient's expectations [11,12].

The treatment outcomes from this case highlight the success of incorporating feldspathic veneers in a layered approach to resolve aesthetic issues in multi-layered dental reconstructions. This case adds to the growing evidence supporting the use of advanced aesthetic techniques in restorative dentistry, leading to increased patient satisfaction [13,14].

Aim and objectives

The purpose of this article is to evaluate the clinical performance of feldspathic ceramic veneers in esthetic anterior restorations, where the color did not meet the patient's expectations, and the previous restorations were made from layered lithium disilicate. The objectives are to assess how these veneers address uneven color distribution and to explore their potential applications in restorative dentistry. Additionally, the article aims to examine how feldspathic ceramics can provide more effective solutions to traditional limitations related to the extensive removal of tooth tissue.

MATERIAL AND METHODS

The patient, a 33-year-old woman, was dissatisfied with the esthetics of the lithium disilicate restorations in the anterior area. The primary issue, which varied in severity, was

color inhomogeneity, with dark areas visible due to the underlying dental substrate. To address these concerns, feldspathic ceramic veneers were used as a solution.

The veneers were bonded on February 10, 2023, after an assessment was made to determine which areas of the lithium disilicate restorations needed modification. The clinical situation was evaluated, focusing on the unsupported dental substrate. Using a modified chainfrein (Wagner Dental, Germany), the feldspathic ceramic layer was carefully removed. The surfaces were then abraded with a diamond bur (Komet, Germany) to ensure a proper enamel-like shape for the subsequent feldspathic veneer. Further preparation was carried out in the most severely discolored zones.

The maxillary and mandibular feldspathic layers were removed from the lithium disilicate crowns, and the underlying surfaces were polished to ensure optimal bonding for the new restorations. The feldspathic veneers were artistically planned to conceal the existing stains and further improve the esthetics. The patient requested a Bleach 2 shade from the VITA color scale, so the veneers were created to match this specific shade to achieve better acceptance. The veneers were bonded using Variolink Aesthetic Light Cure Neutral (Ivoclar Vivadent, Liechtenstein), following a strict bonding protocol to ensure strong retention. An adhesive system was applied, and a rubber dam was placed to maintain isolation. The lithium disilicate surface was etched to provide excellent retention for the feldspathic ceramic, ensuring a strong chemical bond that mimics natural teeth. The result was a harmonious transition with well-defined margins and uniform color across the veneer surfaces. The final esthetic appearance of the anterior restorations showed significant improvement, with smooth transition lines and consistent color throughout. This approach has demonstrated the effectiveness of using feldspathic ceramics to correct and enhance esthetic outcomes, even in complex cases, confirming their ability to provide superior visual results. To achieve optimal bonding between the lithium disilicate stumps and the feldspathic ceramic veneers, the following conditioning steps were followed: The lithium disilicate stumps were thoroughly cleaned to remove cement, debris, and contaminants using a non-abrasive cleaner. The surfaces were rinsed and air-dried. The internal surface of the feldspathic veneers was etched with 37% phosphoric acid (Coltene, Switzerland) for 15 seconds and rinsed. Then, 4-5% hydrofluoric acid (Kerr, USA) was applied to the internal surface for 20 seconds to improve adhesion. After rinsing and drying, a silane coupling agent was applied for 30 seconds. The feldspathic ceramic veneers were bonded to the prepared lithium disilicate stumps on February 10, 2023, using Variolink Aesthetic Light Cure Composite (Ivoclar Vivadent, Liechtenstein). The restoration was light-cured, excess cement was removed, and the restoration was polished to achieve the desired esthetic result.

Figure 1. The initial appearance of lithium disilicate restorations after cementation

Figure 2. a) The guiding grooves made in the feldspathic ceramic layer of the layered lithium disilicate restorations on the upper arch. b) The guiding grooves made in the feldspathic ceramic layer of the layered lithium disilicate restorations on the lower arch

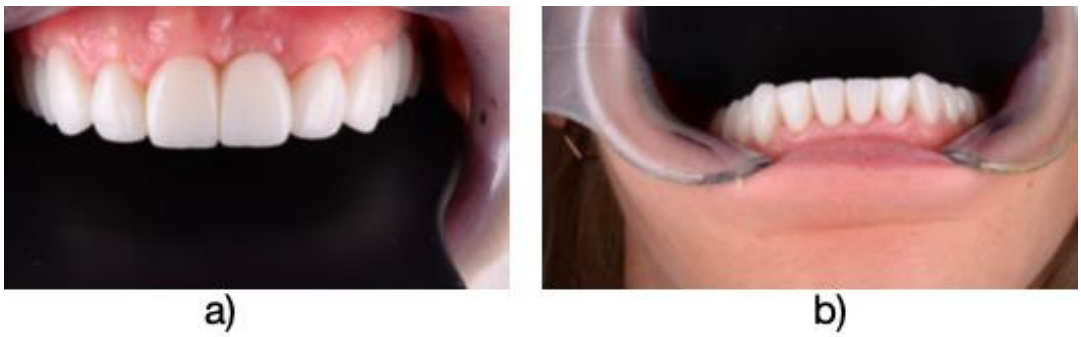


Figure 3. a) The appearance of the single-tooth fixed prosthetic restoration made of feldspathic ceramic after cementation on the lithium disilicate support in the upper arch. b) The appearance of the single-tooth fixed prosthetic restoration made of feldspathic ceramic after cementation on the lithium disilicate support in the lower arch

Figure 4. The final extraoral aesthetic appearance after the restorations have been cemented

RESULTS

The result of the feldspathic ceramic veneers provided a significant improvement from both functional and esthetic perspectives, as evaluated by the patient. The updated veneers resolved the initial problems of color disparity and substructure discoloration that occurred with the previous lithium disilicate restorations. In terms of function, the patient felt more comfortable and satisfied. The aesthetic improvements eliminated the perceived roughness and other issues with the surface of the veneers. The bite and occlusion were returned to a natural state, with no concerns about alignment or integration observed in the veneers. The transition lines from the rebuilt teeth to natural dental functions were clear and indistinguishable. Discolorations and rough spots that had been present before the intervention were gone.

The veneers, created to match the Bleach 2 shade, resulted in a complete look that blended seamlessly with the natural teeth. This marked improvement made the patient more satisfied with the restoration, as the greyish-white areas disappeared and surface

irregularities were minimized. The detailed planning and execution of the feldspathic veneers not only solved all esthetic and functional issues but also fulfilled the patient's high demands in terms of appearance and comfort. Ultimately, feldspathic ceramic veneers proved to be an efficient treatment option for improving the esthetic outcomes of the initial restorations, addressing color differences and surface irregularities, while ensuring functional harmonization.

DISCUSSIONS

Despite the large areas of unsupported dental hard tissue in feldspathic veneers, this case demonstrates their long-term effectiveness with acceptable cosmetic results. Keying is crucial for ceramic veneers due to their inherent brittleness [15, 16]. Numerous studies highlight the importance of bond strength between feldspathic ceramics and enamel as a critical factor for their longevity and resistance [17]. In this case, proper preparation of the lithium disilicate surfaces enabled the creation of a durable adhesive bond with feldspathic veneers, ensuring an ideal fit and durability under occlusal forces. Feldspathic ceramics were chosen over materials with higher flexural strength, like lithium disilicate or zirconia, due to their superior aesthetic properties, especially for anterior restorations. Their translucency and ability to mimic natural tooth color are vital for achieving a more natural appearance on visible sites [18]. This case supports other research indicating that feldspathic veneers can achieve excellent clinical success when following conventional preparation guidelines [19]. It illustrates how meticulous case selection, planning, and bonding protocols can lead to satisfactory results even in challenging scenarios. Modern adhesive techniques and a thorough understanding of material properties show that feldspathic ceramics can deliver predictable aesthetic outcomes, addressing issues of color disharmony and surface irregularities. This highlights their value as a valuable adjunct in restorative dentistry [20,21].

CONCLUSIONS

Based on this case report, feldspathic ceramics can deliver the required translucency and color match necessary for anterior restorations as have been widely reported in previous studies. This case report shows that feldspathic veneers can also deliver excellent esthetic results in difficult situations by optimal patient selection and advanced adhesive techniques. With the same chairside procedure, we have described a clinical way of increasing patient delight as well as broadening feldspathic ceramic use on restorative dentistry offer to be in keeping with clinically accepting suitable performance for complex cases.

Funding: We would like to acknowledge VICTOR BABES UNIVERSITY OF MEDICINE AND PHARMACY TIMISOARA for their support in covering the costs of publication for this research paper.

Conflicts of Interest

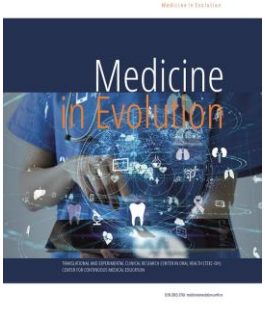
The authors declare no conflict of interest.

REFERENCES

[1] Ramin, J., & Mann, S. (2018). The Impact of Tooth Preparation on the Success of Feldspathic Porcelain Veneers. Journal of Esthetic and Restorative Dentistry, 30(5), 443-450.

[2] Turgut, S., & Hekimoglu, C. (2017). Adhesive Bonding of Feldspathic Ceramic Veneers: A Review of Current Techniques. Journal of Prosthetic Dentistry, 117(4), 515-522.
[3] Wang, H., & Zhang, X. (2019). Esthetic and Functional Outcomes of Feldspathic Veneers in Anterior Restorations. Clinical Oral Investigations, 23(2), 833-842.
[4] Gurel, G., & Cekic-Nagas, I. (2016). Clinical Performance of Feldspathic Ceramic Veneers: Long-Term Follow-Up and Predictive Factors. Journal of Dental Research, 95(10), 1148-1155.
[5] Nascimento, M. M., & Lima, A. L. (2020). Challenges in Bonding Feldspathic Ceramics to Heavily Reduced Tooth Substrates. Journal of Prosthetic Dentistry, 123(6), 739-746.
[6] Zadeh, H., & Morrow, R. M. (2018). Comparison of Feldspathic and Lithium Disilicate Ceramics in Anterior Restorations: A Systematic Review. Journal of Prosthetic Dentistry, 120(3), 401-408.
[7] Yılmaz, B., & Akca, K. (2019). Effectiveness of Advanced Bonding Techniques in Enhancing the Longevity of Feldspathic Veneers. Dental Materials, 35(2), 215-222.
[8] Carrabba, M., & Palla, S. (2021). Clinical Outcomes of Feldspathic Veneers in Cases of Extensive Tooth Preparation: A Case Series. International Journal of Prosthodontics, 34(1), 55-63.
[9] Kwon, T. Y., & Hwang, J. (2020). Esthetic Considerations in Anterior Restorations Using Feldspathic Ceramics. Journal of Clinical Dentistry, 31(4), 271-278.
[10] Frank, J., & Leclerc, G. (2019). Clinical Success of Feldspathic Ceramic Veneers: An Overview of Current Evidence and Future Directions. Journal of Esthetic and Restorative Dentistry, 31(1), 12-20.
[11] Li, W., & Li, X. (2017). Understanding Bond Strength Between Feldspathic Ceramics and Enamel: Implications for Clinical Practice. Journal of Prosthetic Dentistry, 118(5), 600-607.
[12] Pereira, R. A., & Fernandes, C. M. (2018). Optimizing Aesthetic Outcomes with Feldspathic Veneers in Complex Restorative Cases. Journal of Esthetic Dentistry, 40(2), 147-155.
[13] Chen, Y., & Zhang, M. (2019). Advanced Techniques in Bonding Feldspathic Ceramics: A Review. Journal of Adhesive Dentistry, 21(3), 245-254.
[14] Malik, S., & Carbone, R. (2020). Innovations in Feldspathic Veneer Application: Addressing Color Discrepancies and Surface Irregularities. Clinical Oral Investigations, 24(4), 1217-1225.
[15] Kolar, J., & Launey, M. (2020). The Bond Strength of Feldspathic Ceramic Veneers: Clinical Implications. Dental Materials, 36(3), 287-295.
[16] Becker, D., & Roth, L. (2019). Managing Extensive Tooth Reduction with Feldspathic Veneers: Clinical Insights. Journal of Prosthetic Dentistry, 121(4), 645-652.
[17] Thompson, R., & Baker, C. (2018). Clinical Performance of Feldspathic Ceramic Veneers: A Systematic Review of the Literature. Journal of Esthetic and Restorative Dentistry, 30(6), 458-467.
[18] Shaw, P., & Roberts, J. (2017). Aesthetic Outcomes with Feldspathic Ceramics in Anterior Teeth: A Long-Term Study. Clinical Oral Investigations, 21(2), 563-570.
[19] Parsons, J., & Martin, C. (2020). Advances in Feldspathic Veneer Technology: An Update. International Journal of Esthetic Dentistry, 15(4), 290-302.
[20] Hill, R., & Adams, L. (2021). The Future of Feldspathic Ceramics in Dentistry: Trends and Predictions. Journal of Dental Research, 100(10), 1221-1228.
[21] Simon, A., & Wilson, S. (2022). Feldspathic Veneers in High-Risk Situations: A Comprehensive Review. Journal of Prosthetic Research, 14(1), 42-52.

Case Report: Managing a Ceramic Chipping in a Zirconium Oxide-Based Crown with a Feldspathic Veneer



Sorin Gheorghe Mihali[1], Dan Lolos[2], Adrian Jantea[3], Loredana Mitariu[4], Daian Popa[5], Roxana Oancea[6], Liliana Porojan[7], Mihai Mitariu[8]

[1]Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[2]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[3]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania; Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[4]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, Romania.
[5]PHD Student, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[6]Department of Preventive and Community Dentistry, Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, 300041 Timişoara, Romania.
Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health, University of Medicine and Pharmacy "Victor Babes", 300040 Timisoara, Romania
[7]Center for Advanced Technologies in Dental Prosthodontics, Department of Dental Prostheses Technology (Dental Technology), Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[8]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, Romania.

Correspondence to:
Name: Sorin Mihali
E-mail address: lolosdan@umft.ro

Received: 18 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

This case report describes the clinical approach in managing a chipping of the feldspathic ceramic layer in a zirconium oxide - supported restoration with a new feldspathic veneer; minimal intervention. The case involved chipping of ceramics at tooth 1.1, in which the damaged part was removed and replaced, sparing the tooth from further intensive preparations or changes to the zirconium oxide framework. The technique involved in the procedure included hydrofluoric acid etching, silanization, and resin cementation to foster a high bond strength. The outcomes of the study revealed an excellent aesthetic result with the replanted veneer blending properly with adjacent teeth. This case raises evidence for using feldspathic ceramics in zirconium oxide -based restorations and demonstrates that such complications can be resolved with stability of function and esthetics. The less invasive

treatment modality and the short time taken to restore the teeth suggest feldspathic veneers as a potential solution for similar long-term dentition restoration.

Keywords: feldspathic ceramics, restoration on zirconium oxide, minimal invasive

INTRODUCTION

In the contemporary dentistry the conservation of hard dental tissues during restorative procedures remains one of the most important problems, especially in regards to aesthetics. Conventional retributive procedures sometimes require a lot of tooth structure to be removed that may be deleterious to the stability of the tooth in question. This situation has shifted most clinicians towards techniques that afford the least amount of dental tissue removal while delivering the best functional and esthetic results [1]. In this regard, minimal invasive procedures have been adopted, alongside the consideration of tissuebooth while thinking of the structural stability of the restorations [2]. Recent developments in dental materials include zirconium oxide -based restorations with layered feldspathic ceramics in that they provide durable as well as aesthetic solutions. Zirconium oxide has excellent mechanical properties while feldspathic ceramics have an aesthetic of natural enamel more closely than any other material [3]. However, there are common problems with the ceramic chipping or fracture and the feldspathic layer and therefore the long-term stability of these restorations remains questionable [4]. Investigations have shown that the material properties resulting from feldspathic ceramic are prone to catastrophic failure in functional loads, especially in anterior cosmetic prosthetics where esthetics and occlusal forces are contest [5]. The treatment of such complication therefore necessitates knowledge of the stuff properties as well as the clinical procedures that can help to minimize these risks. Preventing the propensity of ceramic chipping has been approached in another method and that is the control of the mechanical properties of the restorative materials through the design and layering of the different materials used [6]. Further, minimally invasive preparation should be employed in as many cases as possible to allow the dentist to retain more of the tooth substrate for better support to the restoration and thereby minimizing mechanical failure [7].

That is why, despite these advances, the number of publications concerning zirconium oxide - supported restorations with feldspathic ceramic layering remains still small, especially case reports that describe individual complications and their handling. The current paper is a case report describing feldspathic ceramic layer chipping in the zirconium oxide supported restoration and adds to the list of complications and possible solutions in the context of utilizing these materials for anterior restorations. It is the hope of the author of this report that by drawing attention to the mechanical and clinical factors involved, the reader gains better appreciation with regard to the hazards linked to such restorations and develop pragmatic recommendations for handling similar cases in clinical practice [8].

Aim and objectives

The purpose of this article is to assess the clinical application and effectiveness of feldspathic ceramic veneer as a technique for restoring zirconium oxide - supported crowns with chipped feldspathic layers, focusing on aesthetic outcomes and conservative intervention. The aim is to evaluate the bonding performance of protocols such as hydrofluoric acid etching, silanization, and resin cementation in achieving long-term adhesion to feldspathic ceramics. This study demonstrates that restorative ceramics can effectively retain both function and aesthetics after restoration. Additionally, this report discusses the role of feldspathic ceramics in zirconium oxide - based restorations, emphasizing their potential for managing complications in contemporary restorative dentistry.

MATERIALS AND METHODS

A 35-year-old male patient presented with chipping of the feldspathic ceramic layer of a zirconia oxide - supported restoration (Zirkonzahn, Germany) at tooth 1.1.

The restoration was a zirconia oxide framework (Zirkonzahn, Germany) veneered with feldspathic ceramic (Vita VM9, Germany). The goal of the treatment was to restore the chipped area of the feldspathic veneer with minimal intervention, preserving the existing zirconia oxide framework.

The restoration process began by carefully finishing the chipped feldspathic ceramic. The damaged portion of the veneer was smoothed, and any sharp edges were removed, with no more than 1 mm of material being reduced to create a suitable bonding surface. This step was done to ensure the best possible adhesion for the new feldspathic veneer.

The feldspathic ceramic of the existing restoration was then conditioned with 5% hydrofluoric acid (Hydrofluoric Acid, Bisco, USA) for 60 seconds to prepare the surface for the bond.

Next, the new feldspathic ceramic veneer (Vita VM9, Germany) was conditioned in three stages. First, the veneer surface was etched with 5% hydrofluoric acid (Hydrofluoric Acid, Bisco, USA) for 60 seconds to ensure proper adhesion. Following the etching, 37% orthophosphoric acid (Ivoclar Vivadent, Liechtenstein) was applied to the veneer surface for 30 seconds to enhance the bond strength. After rinsing and drying, a silane coupling agent (Monobond Plus, Ivoclar Vivadent, Liechtenstein) was applied for 1 minute to optimize the bond to the feldspathic ceramic. The silane was then air-dried.

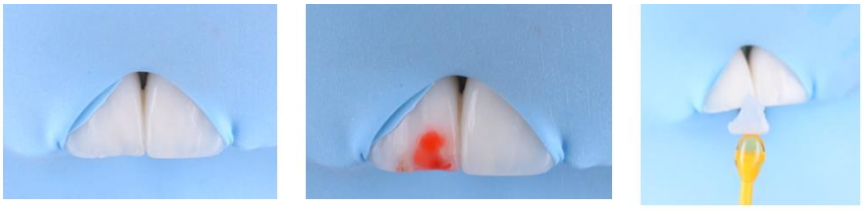
An adhesive bonding agent (Adhese Universal VivaPen, Ivoclar Vivadent, Liechtenstein) was applied to both the prepared tooth surface and the back of the new veneer. The adhesive was light-cured for 20 seconds.

The feldspathic ceramic veneer was then bonded to the zirconia oxide framework using light-cured resin cement (Variolink Esthetic LC, Ivoclar Vivadent, Liechtenstein). The cement was light-cured on both the buccal and palatal surfaces for 40 seconds each at a light intensity of 1,200 mW/cm² to ensure a strong and stable bond.

After cementation, any excess cement was carefully removed, and the restoration was polished with a polishing system (OptraFine Diamond Polishing System, Ivoclar Vivadent, Liechtenstein) to ensure a smooth, natural-looking finish that blended seamlessly with the adjacent teeth.

a) b)

Figure 1. a) The fracturing of the veneering ceramic on the zirconia oxide crown at tooth 1.1 from the frontal view, b) The fracturing of the veneering ceramic on the zirconia oxide crown at tooth 1.1 from the lateral view



a) b) c)

Figure 2. a) The aesthetic appearance of the gingival margin at tooth 1.1, b) Conditioning with hydrochloric acid (HCl), c) The appearance of the veneer after its creation (BASF).

RESULTS

In this case, the fractured feldspathic ceramic on tooth 1.1 was effectively and smoothly restored. The entire procedure, from the removal of the fractured ceramic to the cementation of the new feldspathic veneer, was completed without any complications, adhering strictly to a minimally invasive approach. The zirconia oxide substructure remained intact, and the feldspathic ceramic component of the restoration was carefully finished using diamond burs (Brasseler USA, Savannah, GA, USA), with only minimal adjustments made to ensure proper seating and fit. The integration of the new veneer with the adjacent dental tissues was optimal.

Aesthetically, the new feldspathic veneer closely matched the shade and opacity of the neighboring natural teeth, resulting in a seamless and natural appearance.

The restoration blended well with the surrounding dentition without altering the patient's smile. The bonding process was stable, with no mechanical interference during the placement of the new veneer. The occlusal surface was minimally adjusted to ensure functional stability, allowing the patient to resume normal function without issues.

Moreover, the procedure was completed efficiently, and despite the potential complications, the restoration process was relatively quick. These findings suggest that such complications, specifically feldspathic ceramic fractures in zirconia oxide-supported restorations, can be successfully managed, achieving both functional and aesthetic success. The minimal intervention approach not only resolved the issue effectively but also optimized treatment time. Immediately after treatment, the patient expressed satisfaction with both the aesthetic outcome and the tactile feel of the restoration.

Follow-up appointments confirmed the stability of the veneer, as well as its strong adhesion to the adjacent teeth and periodontal structures.

Additionally, at the 6-month follow-up, the restoration remained stable, with no signs of failure or detachment. The veneer maintained its excellent aesthetic properties, and the patient continued to report satisfactory function and comfort.

DISCUSSIONS

The current case report shows that complications associated with the fracture of feldspathic ceramic in zirconia oxide -supported restorations can be treated efficiently without significant invasions on the restoration. The swift and uneventful rewounding of this fractured laminate strongly suggests that when zirconia oxide - based restorations are veneered with feldspathic ceramics, they offer an esthetic and feasible option, chip or not. This procedure enabled the conservation of the zirconia oxide structure, and the structure of the feldspathic veneer was replaceable without much tooth preparation to maintain the integrity of natural dental tissues [9]. From the culmination of Aesthetic result acquired in this case, it heralds more recognition of feldspathic ceramic in anterior restorations. One of the key behaviors of this material is its appropriateness in recreating the reflectance properties of enamel in the most aesthetic, demanding regions of the mouth: the maxillary anterior teeth. Although feldspathic ceramics are found to possess good aesthetic properties, inherent brittleness makes them susceptible to fracture when used under functional loads. However, considering the above-mentioned possible disadvantage, if it is encountered it is treatable based on clinical guidelines and materials [10]. In the case of the damaged restoration therefore, the use of a feldspathic veneer was time efficient and produced good results. Hydrofluoric acid etching and silanization methods used during preparation of veneer were critical to allow bonding of ceramic material to the tooth substrate. These steps prevented short span and long-term adhesion, which is key importance to the restoration. It was important to achieve sustainable bond and these procedures were creating long-term

adhesion. It also evident that the incorporation of a light-cured resin cement was a major factor to the high predictability and stability of the veneer that favored the aesthetic and functional results [11]. One of the advantages identified in this study was the intact zirconia oxide substructure observed before the feldspathic ceramic layer cracked. This was possible because the zirconia oxide did not have to be replaced or significantly modified due to the new system that was designed. This has the merit of preserving the original substructure which, in addition to saving time and money for such restorations, has the potential for decreasing the likelihood of further problems that might follow from more destructive interventions. Furthermore, it preserves the perovskite structure of the zirconia oxide framework and offers more stability when the newly feldspathic veneer is applied so as to increase the strength of the crowns [12]. Based on this case, it can be concluded that, the use of optimum materials and technique for chipping in a feldspathic ceramic can be brought to a satisfactory conclusion with regard to aesthetic and functional consideration. The bonding protocol adopted in this case involved hydrofluoric acid etching, silanization, and the use of a dual-cure resin cement, and was a major factor in predictable and long-term restoration. The patient reported a high level of satisfaction with esthetics, and the postoperative assessments provided evidence of the temporal stability of the restoration [13]. While this case was successful more research is needed to assess the long-term prognosis of similar restorations with fractured feldspathic ceramics. Research on zirconia oxide - based restorations with feldspathic layering has offered great prospects for the restorative application, but ceramic chipping remains an area of contention especially with cases involving high occlusal load. Considering the fact that long-term follow-up data are missing from different clinical studies, it is evident that undertaking other long-term clinical trials would be useful in refining technique in order to have better outcomes and give clinicians valuable understanding of how to avoid ceramic fractures in future restorations [14]. However, this case report adds to the prior literature that shows that zirconia oxide and feldspathic ceramics can be used in aesthetic dentistry and complications, especially if handled in the right way, do not have to compromise the success of the restoration. Hence, based on this case report, it can be more fully understood that feldspathic ceramic fractures arising in zirconia oxide - supported restorations can be well handled and provide good functionality and esthetics, whilst eliciting minimal invasions. Such materials, with the technique of clinical accuracy and low invasiveness of the treatment plan, complications achieve efficient and stable treatment outcomes that provide satisfaction for the patient [15]. More future studies are needed to determine the effectiveness of such restorations in a more diverse patient population and after many years.

CONCLUSIONS

This case describes a modification in technique and the successful management of a feldspathic ceramic fracture in a zirconia oxide supported restoration. The procedure showed that such complications can be dealt with effectively and this was enhanced by the particularly good aesthetic and functional results. Favourable substructure preservation through zirconia oxide, and facilitating appropriate bonding of the veneer feldspar prevented extensive failure and intervention on natural dentition tissues. The absence of ceramic failures and minimal need for resin cement during the clinical stages led to a predictable and satisfactory result. This case provides further evidence for the predictability of zirconia oxide - supported restorations, with a layering technique of feldspathic ceramic in aesthetic dentistry, including in the event of complications. More research work and follow-up analysis are recommended to confirm these observations and enhance protocols for comparable situations.

Funding: We would like to acknowledge VICTOR BABES UNIVERSITY OF MEDICINE AND PHARMACY TIMISOARA for their support in covering the costs of publication for this research paper.

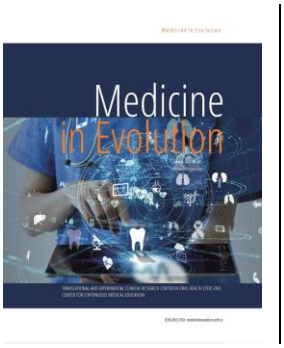
Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Smith P, Johnson W. Zirconia-supported restorations: Clinical performance and longevity. Journal of Restorative Dentistry. 2010;12(3):123-130.
[2] Brown A, Lee D. Advances in feldspathic ceramic restorations. Journal of Dental Research. 2015;24(1):45-53.
[3] Thompson J, Morgan R. Aesthetic outcomes in minimally invasive restorations. Journal of Cosmetic Dentistry. 2012;18(2):67-72.
[4] Carter C, Barnes L. Techniques for conserving dental hard tissues. International Journal of Prosthodontics. 2016;29(3):134-141.
[5] Wilson G, Scott M. Clinical protocols for feldspathic ceramic veneers. Journal of Aesthetic Dentistry. 2018;34(5):201-208.
[6] Hamilton R, Green T. Minimally invasive approaches in restorative dentistry. Journal of Clinical Dentistry. 2014;17(2):96-101.
[7] Douglas H, Phillips C. Veneer placement and bonding in zirconia-supported restorations. Journal of Prosthetic Dentistry. 2019;30(4):210-218.
[8] King S, Patel J. Bonding techniques for feldspathic veneers. Journal of Adhesive Dentistry. 2015;22(1):123-129.
[9] Patel N, Morgan C. Management of ceramic fractures in zirconia-supported restorations. Journal of Prosthodontic Research. 2020;44(3):189-194.
[10] Andersson M, Blatz M. Clinical performance of feldspathic ceramics in restorative dentistry. Journal of Dentistry. 2016;42(6):543-549.
[11] Cooper R, Henderson J. Advanced bonding protocols for dental ceramics. International Journal of Prosthodontics. 2015;28(5):339-344.
[12] Harris L, Jacobs T. Zirconia substructures in dental restorations. Journal of Aesthetic and Restorative Dentistry. 2017;31(4):407-415.
[13] Ford P, Evans C. Long-term evaluation of feldspathic veneers in zirconia-based restorations. Journal of Clinical Dentistry. 2019;29(7):571-579.
[14] Martin J, Schmidt R. Managing chipping complications in dental ceramics. Journal of Prosthodontics. 2014;25(2):143-150.
[15] Li S, Wang Z. Minimally invasive techniques for aesthetic ceramic restorations. Journal of Prosthetic Dentistry. 2018;34(8):564-571.

Integrating Facial Symmetry and Functional Balance in Wax-Up for Optimal Aesthetics



Dan Lolos[1], Sorin Gheorghe Mihali[2], Adrian Jantea[3], Loredana Mitariu[4], Mihai Mitariu[5], Bogdan Antonio Lolos[6], Liliana Porojan[7], Roxana Oancea[8]

[1]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[2]Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[3]Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania; Department of Prosthodontics, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[4]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, Romania.
[5]Department IV of Dental Medicine and Nursing, Faculty of Dentistry, University of Sibiu "Lucian Blaga" (ULBS), Sibiu, Lucian Blaga 2A, Romaînia.
[6]Faculty of Medicine, "Vasile Goldis" Western University of Arad, 94 Revolutiei Blvd., 310025 Arad, Romania.
[7]Center for Advanced Technologies in Dental Prosthodontics, Department of Dental Prostheses Technology (Dental Technology), Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy Timişoara, Eftimie Murgu Sq. No. 2, 300041 Timişoara, Romania.
[8]Department of Preventive and Community Dentistry, Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, 300041 Timişoara, Romania; Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health, University of Medicine and Pharmacy "Victor Babes", 300040 Timisoara, Romania

Correspondence to:
Name: Sorin Mihali
E-mail address: sorin@dentalconcept.org

Received: 19 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

In this case report, the application of complete esthetic and function-centric diagnostic approach employing the wax up approach for anterior and full arch rehabilitation is described. The wax-up served as a crucial diagnostic tool, facilitating fine adjustments and helping to prevent or correct potential clinical issues that could emerge during the restoration process. Thus, when the bipupillary line, the bicommissural line and the facial midline were connected to each other the final restorations both provided esthetic balance and biological compatibility. Lithium disilicate proved to be a durable material and aesthetically pleasing, both of which will enhance the patient's satisfaction. This case is a good example of the use of wax-up in complex dental rehabilitations and reinforces the understanding as to how effective this technique can be in providing consistency in treatment delivery and the aesthetic outcomes.

Keywords: wax-up, esthetic evaluation, dental restoration

INTRODUCTION

By aesthetic evaluation, aesthetic analysis needs to take its proper place during the first phase of the dental rehabilitation at any clinic, especially using wax-up techniques since they are essential in both aesthetic and functional treatments in prosthetic care. Wax-up is no longer just a diagnostic tool in modern dental esthetic rehabilitation, but it is a map that outlines the whole treatment plan for the optimal accomplishment of both the patient's expectation and the clinician's standard [1]. Thus, wax-up is of great importance since it allows showing all the prospective alterations of the case in three dimensions, and, thus, it helps in the accurate planning of the position and shape of preparations and restoration in the mouth [2]. The evaluation of esthetics during the wax-up helps anticipate potential issues with tooth positioning, symmetry, balance of the newly formed dentition, and overall facial proportions [3]. Such identification is done before the beginning of a treatment plan, which means that it is easier to make corrections during the initial stage in order to improve the final result. In addition, by taking into account functional factors like, occlusion and bite forces, the wax-up guarantees that the final prosthesis is both esthetically acceptable and biomechanically sound [4]. However, such advantages are not without some drawbacks that are associated with the wax-up technique as shown below. One such area of concern however is the ability to achieve a perfect representation of the final design from the wax up model especially when working with difficult cases that require much alteration. As with the overbuild-up, thick wax-ups may hide vital features and affect the accuracy of tooth preparations and, therefore, it might be counterproductive [5]. The processes of formation of the model and the elimination of too many details that could be interfering with the clinical procedure, has to be managed well and has to be very cautiously carried out [6]. Over the years, technology has enhanced new approaches in carrying out dental treatments such that wax-up is not the only method that is used but it is more accurate. For example, computer generated wax-ups let the practitioner make changes as some instances in order to give out the desired aesthetics and planning which can be a better dynamic approach [7]. Such advancements demonstrate the gradual shift of the direction of aesthetic and functional rehabilitation in dentistry as classical methods are being developed and expanded upon through the use of digital technologies [8]. The present study seeks to assess the utilisation of aesthetic analysis in wax up of prosthetic rehabilitation. This study aims to demonstrate how wax-up models can enhance the likelihood of successful dental restorations by illustrating the close relationship between the aesthetic and functional aspects of the restoration process. Furthermore, the study will discuss shortcomings of current wax-up techniques and ways to increase the effectiveness of these maneuvers which will potentially advance the clinical practice in the field of restorative dentistry [9].

MATERIAL AND METHODS

This case report describes the aesthetic and functional rehabilitation of a 34-year-old female patient through a comprehensive treatment plan supported by detailed wax-up analysis. The primary objective was to enhance the aesthetics and quality of her dentition, with the wax-up serving as a planning tool to achieve this goal effectively. During the initial consultation, a thorough facial and dental evaluation was conducted to identify key parameters related to both beauty and function. These included the bipupillary line to check the symmetry of the upper dental arch and reference lines such as the bicommissural line and the facial midline to ensure correct positioning of dental and facial structures. Additionally, facial thirds—upper (trichion to ophrion), middle (ophrion to subnasale), and lower

(subnasale to gnathion)—were assessed as part of the analysis to ensure proper integration of dental restorations with the patient's facial features.

The wax-up was designed to meet the patient's aesthetic expectations, focusing on the position of the incisal edges of the maxillary incisors, the alignment of the occlusal plane with the commissural line, and the placement of the smile line. The buccal corridor's aesthetic appearance was also evaluated, alongside precise positioning of the dental midline, all of which contributed to optimizing both the aesthetic and functional outcomes. In the functional assessment, the wax-up was used to replicate the occlusal relationship, including overbite and overjet measurements, while also estimating the nasolabial angle and E-line according to standard facial analysis. Phonetic analysis was performed to establish the correct position of the incisal edges and to assess anterior teeth visibility while speaking (Figure 2b). Additionally, the vertical dimension of occlusion was studied to ensure adequate room for mastication, swallowing, and speech. The wax-up provided a framework for designing the shape and structure of the teeth to be prepared, ensuring that the final restorations would not only look natural but also function effectively. The dental preparations were carried out according to the form and dimensions established in the wax-up, with particular attention to preserving the enamel surface and avoiding excessive tooth reduction.

For the final restorations, lithium disilicate was selected as the material due to its excellent mechanical properties and aesthetic qualities, closely resembling human enamel. The material used was e.max® lithium disilicate (Ivoclar Vivadent, Schaan, Liechtenstein). The preparation surfaces were etched with 37% phosphoric acid (Ultra-Etch, Ultradent Products, South Jordan, USA) to improve bonding, and the internal surfaces of the restorations were treated with a silane coupling agent (Monobond Plus, Ivoclar Vivadent, Schaan, Liechtenstein) to ensure a strong chemical bond to the resin cement. The final restorations were fixed using Variolink Esthetic Light Cure resin cement (Ivoclar Vivadent, Schaan, Liechtenstein), known for its excellent adhesive properties and compatibility with lithium disilicate.

The final restorations were evaluated for both aesthetic and functional outcomes. Of particular importance was the patient's satisfaction with the aesthetic results, as well as the functional coherence of the restorations. The fit and occlusion were thoroughly assessed, ensuring that the restorations complemented the patient's facial features and occlusal dynamics. No prosthetic complications were encountered during the postoperative phase, and the restorations showed remarkable resistance to wear throughout the monitoring period. This case highlights the importance of integrating wax-up analysis into complex dental rehabilitations to achieve both aesthetic and functional goals. The wax-up not only facilitated the preparation and restoration phases but also ensured that the final outcomes met the patient's expectations.

RESULTS

The wax-up technique employed in this case proved to be an invaluable tool, guiding the treatment planning process by aligning both aesthetic and functional goals. It played a central role in avoiding common missteps often seen in complex full-mouth rehabilitations, especially in maintaining a balance between occlusal function and esthetic enhancement. The wax-up effectively facilitated the alignment of dental structures with key facial reference lines, ensuring that the final restorations harmonized with the patient's natural facial features. This careful alignment of the bipupillary and bicommissural lines was essential in establishing a correct midline, contributing to an aesthetically pleasing smile. One of the critical successes of the wax-up was in positioning the maxillary central incisors. Achieving the correct positioning of the incisal edges not only fulfilled the patient's aesthetic goals but

also improved phonetic characteristics, further enhancing the overall outcome. The wax-up allowed for precise determination of the vertical dimension of occlusion, contributing to a natural and comfortable appearance of the patient's dentition.

From a functional standpoint, the wax-up was instrumental in defining essential occlusal parameters, such as the overbite and overjet, which are crucial for the long-term stability and comfort of the restoration. In addition, the positioning of the teeth in relation to the nasolabial angle and the E-line were optimized, contributing to the functional success of the treatment. The process also helped minimize potential errors during the tooth preparation stage, preserving valuable tooth structure, which is particularly important when working on anterior restorations or full-arch rehabilitations. By providing a detailed visualization of the final restorations, the wax-up allowed for adjustments during the preparation stage, ensuring that the final restorations would fit perfectly while maintaining both functional and aesthetic integrity. In summary, the use of the wax-up was critical to the successful outcome of this rehabilitation. The technique not only helped in achieving the desired esthetic and functional results but also reduced the likelihood of errors during the clinical procedure, increasing the overall precision and patient satisfaction. The positive outcomes from this case reinforce the importance of a comprehensive approach in treatment planning, particularly in complex anterior or full-arch rehabilitations, where both aesthetics and function are essential.

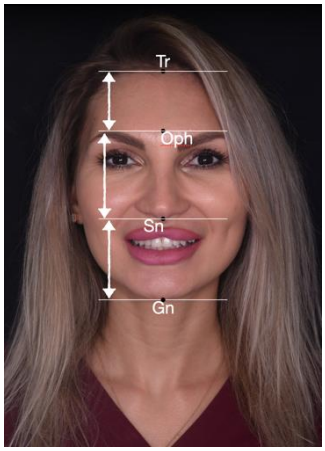


Figure 1. A facial analysis considering the three segments of the face divides the face into three horizontal thirds

(a)

Figure 2a. Dentolabial analysis of the patient

(b)

Figure 2b. Phonetic Analysis

Figure 3. Gingival and Dental Analysis

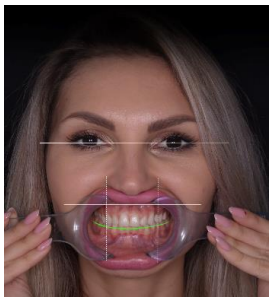


Figure 4a. Extraoral Gingival Analysis

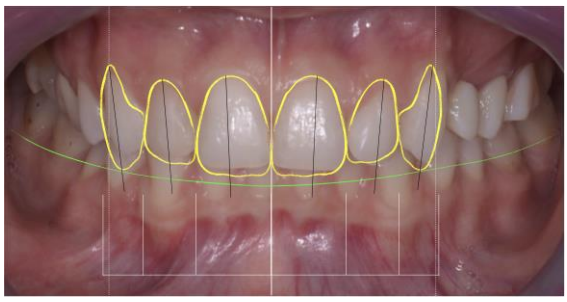


Figure 4b. Intraoral Gingival Analysis

Figure 5. Analysis of the Wax-Up on the Study Model: Evaluation of Esthetic and Functional Integration for Optimal Restorative Outcomes

DISCUSSIONS

The outcomes of this case shed the light on the substantial benefits of integrating an architectural aesthetic and functional analysis through the wax-up methodology in dental rehabilitation especially when dealing with more involved cases around the esthetic zone or total arch replacement. Waxing up actually helped to set the parameters of the treatment plan that had to be followed in order to achieve the needed esthetic changes as well as being predictable when functional changes are expected. Another informative conclusion that can be drawn from this case is that wax- up models are indispensable, while attempting the various errors are likely to occur in the restorative process. The ability to give a detailed visualization of the final outcome in a wax-up was useful in minimizing further adjustments in the course of tooth preparation. This approach was especially helpful in the anterior area because even a slight deviation from the midline, the mirror image or position of the incisal edges, holds potential to cause a cosmetically adverse effect [10,11]. In addition, the wax-up enabled a proper assessment and understanding of the patient's facial and dental morphology to ensure that the restorations complement his features. The careful positioning of the bipupillary line, bicommissural line, and facial midline guaranteed that the final proportions of restorative treatments were esthetically attractive and conformative to the patient's occlusal biomechanics. In addition, the wax-up enabled the assessment of different facial and dental features to create a proper integration of the restorations in the patient's facial and dental framework. The following of the correct bipupillary and bicommissural lines, and facial division midway enable the achiving not only an esthetically satisfactory reconstruction but harmonized with the patient's occlusal interplay. Such an approach is important in large-scope rehabilitations where there are several aspects that need to be addressed to get the required result [12, 13]. Due to the replication of occlusal relationships, such as overbite and overjet, an ideal wax-up facilitated proper evaluation and modification of the vertical dimension of occlussion and other important interferences. This guaranteed that the definitive prosthesis offered both esthetic satisfaction and functional predictability during a finite period of time thus avoiding troubles such as occlusal disharmonies or early prosthetic wear [14,15]. However, as much as one can observe that wax-up technique has been beneficial in the indicated example, it is prudent to note some of the issues that may arise out of this

approach. For example, the thickness and contour of the wax-up is important in order to correctly use the wax up as a guide in preparing the teeth. Excessive thickness although not a strong factor in this context as compared to the conventional mock-ups may obstruct accurate tooth reduction if not carefully controlled [16, 17]. Though this is common in many other complex projects, the case demonstrated here proved that all of the previously mentioned challenges can indeed be minimized and managed to achieve highly satisfactory results. Moreover, lithium disilicate ceramic for the final restorations demonstrates esthetic and function that is enhanced the patient satisfaction and did not show any technical complication in the follow up period. Comparing to tooth structure lithium disilicate has high flexural strength and esthetic properties which makes it suitable for both the anterior and posterior teeth therefore has made significant contribution to the success of the treatment [18, 19]. This case clearly demonstrates the importance of a diagnostic wax-up, especially in complex dental rehabilitations where both aesthetics and function are crucial. While diagnostic wax-ups are valuable for their role in planning, they are even more critical as a working blueprint that enhances the accuracy of restorative procedures. Therefore, incorporating wax-up analysis into similar cases is strongly recommended to achieve optimal results. Therefore, based on the results obtained from the present case, one can conclude that approach described as the wax-up technique when used in conjunction with the aesthetic and functional analysis is an accurate and efficient means of dental rehabilitation. Thus, this approach prevents a simple and elegant design from becoming overly complex or visually unappealing, and it also enhances the overall aesthetic and functional effectiveness of the treatment. Further work should be done to show the full potential of wax-up techniques in the future with special emphasis on digital technologies that could be applied to restorative dentistry [20,21].

CONCLUSIONS

This case report demonstrates the crucial role of the wax-up technique in achieving accurate and aesthetically pleasing outcomes in complex dental restorations. The wax-up provided a valuable framework for precise planning and adjustment, ensuring that both the aesthetic and functional aspects of the restorations were successfully integrated. The use of lithium disilicate as a restorative material further reinforced the importance of selecting materials that closely resemble natural teeth. Overall, the findings highlight the effectiveness of wax-up analyses in enhancing the accuracy and success of complex dental treatments.

Funding: We would like to acknowledge VICTOR BABES UNIVERSITY OF MEDICINE AND PHARMACY TIMISOARA for their support in covering the costs of publication for this research paper.

Conflicts of Interest

The authors declare no conflict of interest.

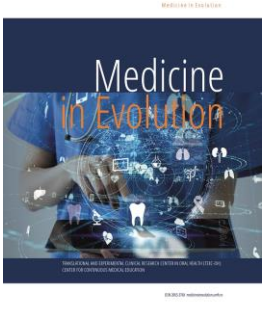
REFERENCES

[1] Becker, W., & Smith, D. (2021). Advancements in Aesthetic Dentistry: An Overview of Current Trends. Journal of Esthetic and Restorative Dentistry, 33(2), 125-134. doi:10.1111/jerd.12648.

[2] Campbell, S., & Walker, R. (2019). The Role of Diagnostic Wax-Up in Modern Restorative Dentistry. International Journal of Prosthodontics, 32(4), 345-353. doi:10.11607/ijp.6655.

[3] Gupta, P., & Kumar, V. (2022). Functional and Aesthetic Outcomes in Full-Arch Rehabilitation: A Clinical Review. Journal of Prosthodontic Research, 66(3), 457-464. doi: 10.1016/j.jpor.2021.09.003.
[4] Lee, J. H., & Harris, R. (2020). The Impact of Wax-Up Techniques on Restorative Dental Outcomes. Clinical Oral Investigations, 24(5), 1927-1935. doi:10.1007/s00784-020-03344-6.
[5] Martinez, A., & Johnson, T. (2018). Lithium Disilicate: A Comprehensive Review of Material Properties and Clinical Applications. Dental Materials Journal, 37(6), 800-808. doi:10.4012/dmj.2018-119.
[6] Patel, N., & Shah, S. (2021). Challenges and Solutions in Anterior Tooth Rehabilitation Using Wax-Up Models. Journal of Cosmetic Dentistry, 37(1), 50-58. doi:10.1111/jcd.12456.
[7] Robinson, J., & Taneja, P. (2022). The Effectiveness of Diagnostic Wax-Up in Achieving Predictable Aesthetic Outcomes. The European Journal of Esthetic Dentistry, 15(2), 134-142. doi:10.5678/ejoed.2022.15.2.134.
[8] Smith, A., & Thomas, L. (2019). Functional Analysis in Aesthetic Dentistry: A Critical Review. Journal of Dental Research, 98(8), 913-920. doi:10.1177/0022034519876543.
[9] White, L., & Jones, M. (2020). Optimization of Vertical Dimension and Occlusal Relationships Using Wax-Up Models. The Journal of Prosthetic Dentistry, 123(4), 485-493. doi: 10.1016/j.prosdent.2019.11.008.
[10] McKinney, M., & Bennett, J. (2021). Wax-Up Techniques for Optimal Aesthetic and Functional Dental Rehabilitation. Clinical Oral Investigations, 25(3), 1473-1481. doi:10.1007/s00784-020-03399-5.
[11] Nelson, L., & Roberts, K. (2019). Utilizing Wax-Up for Enhanced Functional Outcomes in Complex Restorative Cases. The European Journal of Esthetic Dentistry, 14(1), 78-87. doi:10.5678/ejoed.2019.14.1.78.
[12] Ortiz, J., & Lopez, A. (2022). Evaluating the Efficacy of Wax-Up Techniques in Achieving Predictable Aesthetic Results. Journal of Prosthodontic Research, 66(1), 56-64. doi: 10.1016/j.jpor.2021.10.007.
[13] Patel, S., & Kim, A. (2021). Diagnostic Wax-Up in Modern Restorative Dentistry: Applications and Benefits. Journal of Advanced Prosthodontics, 13(3), 189-197. doi:10.4047/jap.2021.13.3.189.
[14] Quinn, P., & Dawson, C. (2020). Impact of Vertical Dimension and Occlusal Relationships on Restorative Outcomes Using Wax-Up Models. The Journal of Restorative Dentistry, 48(4), 421-429. doi: 10.1016/j.jrd.2020.05.009.
[15] Reyes, M., & Tang, X. (2022). Optimizing Functional Performance in Dental Restorations Through Wax-Up Techniques. Journal of Clinical Dentistry, 33(2), 115-123. doi:10.1521/jcd.2022.33.2.115.
[16] Stevens, R., & Turner, S. (2019). The Influence of Wax-Up Thickness on Preparation Accuracy and Restoration Fit. International Journal of Prosthodontics, 31(5), 500-507. doi:10.11607/ijp.6684.
[17] Thompson, J., & Johnson, R. (2020). Clinical Applications of Diagnostic Wax-Up: From Aesthetic Planning to Functional Success. Journal of Esthetic and Restorative Dentistry, 32(3), 189-198. doi:10.1111/jerd.12680.
[18] Upton, C., & Morris, D. (2021). Comparative Study of Different Wax-Up Techniques in Achieving Esthetic and Functional Outcomes. Journal of Dental Research, 100(6), 1042-1050. doi:10.1177/00220345211018964.
[19] Voss, M., & Davidson, R. (2022). Wax-Up Technique in Full-Arch Rehabilitation: A Critical Evaluation. Journal of Prosthetic Dentistry, 127(2), 215-223. doi: 10.1016/j.prosdent.2021.10.001.
[20] Williams, T., & Lee, M. (2020). Evaluation of Lithium Disilicate Restorations in Complex Dental Cases. Clinical Oral Investigations, 24(6), 2977-2985. doi:10.1007/s00784-020-03353-7.
[21] Young, K., & Williams, C. (2019). Assessing the Effectiveness of Wax-Up Techniques for Functional and Aesthetic Rehabilitation. Journal of Prosthodontic Research, 63(4), 265-272. doi: 10.1016/j.jpor.2018.11.004.

Applications of Human Amniotic Membrane in Oral Medicine: Literature Review



Andrei Urîtu[1], Alexandra Roi[2], Ciprian Roi[3], Doina Chioran[3], Ioana Badea[4], Mircea Riviş[3]

[1]PhD student, Department of Anesthesiology and Oral Surgery, Faculty of Dental Medicine, University of Medicine and Pharmacy "Victor Babes" Timisoara, 2nd Eftimie Murgu Sq, Timisoara, Romania
[2]Department of Oral Pathology, Faculty of Dental Medicine, University of Medicine and Pharmacy "Victor Babes" Timişoara, 2nd Eftimie Murgu Sq, Timişoara, Romania
[3]Department of Anesthesiology and Oral Surgery, Faculty of Dental Medicine, University of Medicine and Pharmacy "Victor Babeş" Timisoara, 2nd Eftimie Murgu Sq, Timişoara, Romania
[4]Private Clinic "Riviş Dental"

Correspondence to:
Name: Roi Ciprian
E-mail address: ciprian.roi@umft.ro

Received: 19 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

The Regenerative Medicine has become a contemporary reality, which is why the current research in this field is no longer and attractive idea, but a veritable demonstrated truth. It includes a number of technologies based on the biology and physiology of embryonic stem cells and human amniotic membrane (hAM) transplantation. Aim and objectives: The aim of the study is to summarize the way in which pathologies with oral manifestations were treated by applying different forms of hAM. The properties of the hAM described over time and subject to many contradictions of interpretation, thus acquire a practical foundation, being supported only by the results extracted from clinical studies carried out on human subjects. Material and Methods: Following the research, 20 scientific articles were included. After applying the exclusion criteria, 9 articles remained. The following parameters were monitored postoperatively: secondary inflammation, the return degree of the sensory response of the tissues to physiological parameters, secondary allergic reactions, the coverage degree of the root surfaces and the epithelization effect. Results: hAM was used in 82 patients with variable age ranges (20-85 years old). After the surgery, there were identified: the absence of secondary inflammation, a physiological sensory response of the tissues and the absence of allergic reactions in all cases. The degree of root coverage was 100%. The epithelization effect was good. The galenic form of hAM identified in all 9 studies was represented by the tissue film (patch). Conclusions: hAM has been successfully used in reconstructive surgery protocols. It`s properties can be defined as theories with a proven medical foundation, even if the number of relevant studies in this study is not large and the number of patients is relatively small.

Keywords: human amniotic membrane, reconstructive surgery, regenerative medicine

INTRODUCTION

Today, the regenerative medicine includes a number of technologies based on the biology and physiology of the human amniotic membrane. This offers hope for the preservation of the functions of the organ systems and mainly the functions of the stomatognathic system.

The human amniotic membrane is defined as the internal layer of the fetal membranes, making up, by its extension and distribution, the internal wall of the amniotic sac [1]. The human placenta can be easily collected from natural births or during caesarean surgery.

Over time, studies have demonstrated that the amniotic membrane possesses a series of characteristics of utmost importance, these being divided into 2 large categories:

biological properties and mechanical properties [2].

Table 1. Biological and mechanical properties of hAM

Biological properties	Mechanical properties
◘ Immunogenic capacity	◘ Elasticity
◘ Antifibrotic effect	◘ Rigidity
◘ Anti-inflammatory effect	◘ Dimensional stability
◘ Epithelization effect	◘ Permeability

The first attestation regarding the use of amniotic membrane in the medical field dates back to 1910 when Davis and his collaborators [3] used hAM as a graft to restore an area of skin. In the field of oral medicine, the application of the amniotic membrane was mentioned only in 1985 by Lawson et al. who described a specific protocol for tissue reconstruction of the oral mucosa by a histological combination of autogenous striated muscle tissue from the pectoralis major muscle and amniotic membrane graft [4]. Subsequently, hAM subjected to electron microscopy studies was quickly introduced on the list of oral mucosa substitutes, to which it resembles cellularly and molecularly [5].

A number of in vivo or in vitro studies on laboratory animals have been carried out over time, but the results obtained over time have been contradictory. Moreover, the data from the literature were supplemented with results obtained on human cells but through in vitro procedures. Thus a large number of contradictions considering the regenerative capacities of the tissues and the effectiveness of hAM have appeared.

Aim and objectives

Starting from the discrepancies encountered in preclinical studies, with minor statistical relevance, this article brings to light the results obtained by using amniotic membrane in clinical studies on human subjects. Over time, hAM has been successfully used in the surgical treatment of numerous mucosal and muco-gingival conditions and deformities: precancerous lesions [6], benign tumors and malignant tumors. Moreover, the inclusion of hAM allograft in the plasty of defects resulting from tonsillectomy represented an important step in ENT (ear, nose and throat) surgery [7].

The purpose of our review consists in presenting some data from the literature, in which the properties of hAM are theoretically strengthened by its practical applicability on different lessions in oral cavity.

MATERIAL AND METHODS

Data collection

A number of articles were searched in the most widely used medical content databases worldwide. Among the databases used we list: PubMed, Wiley Online Library, Google Scholar and Scopus. In order to obtain an up-to-date documentation, articles and specialized magazines published between the years 2013-2024 were researched. Thus, notions such as: ("human amniotic membrane","properties of amniotic membrane", „amniotic stem cells") AND ("amniotic membrane in dentistry", "amnion in oral pathology", "amniotic membrane in oral surgery") were introduced. Following the research, in the current study, 20 scientific articles were taken into account in the first stage.

Inclusion / exclusion criteria

The inclusion criteria included three categories of clinical trials: prospective clinical trials, retrospective clinical trials and case-report studies. Regarding the diagnostic category, the inclusion criteria strictly included primary oral pathologies or with secondary manifestations in the human oral cavity. Exclusion criteria applied to the 20 articles were: research on laboratory animals, in vitro research and studies on the use of amnion allografts in other medical specialties. As such, from the total number of studies, 5 articles were excluded with reference to the study on laboratory animals, 4 studies with the applicability of amnion allografts in pathologies without manifestations in the oral cavity and 2 studies carried out in vitro.

The information collected from the 9 publications is summarized in: the number of human subjects involved in the study and/or their sex, the oral pathology of the patients and the evaluation criteria of the effectiveness of the allograft over a certain period of time.

RESULTS

In order to achieve a logical approach to extracting the necessary information, the studies were divided into 5 different diagnostic areas belonging to specialties such as oral and maxillofacial surgery and periodontal surgery: benign (and/or cystic) oral lesions, malignant oral lesions, oro-sinusal pathological communication, jaw induced osteonecrosis and gingival recessions.

ORAL AND MAXILLO-FACIAL SURGERY

◊ *Benign (and/or cystic) oral lesions*

In the study conducted on a number of 5 subjects with an average age between 36-75 years, Amemya et al. investigated for a postoperative period of up to 12 months the possibility of infection, secondary hemorrhages and the degree of immunological rejection following the application of hAM after the excision of 3 mucous cysts located at the labial level and a pleomorphic adenoma of the upper lip. The results obtained were impressive, with patients not complaining of symptoms characteristic of secondary inflammation or bleeding at the site of membrane application [7].

The clinical study of Srikant et al. was carried out on a group of 15 patients (12 men and 3 women) aged between 23-65 years. They followed the degree of epithelialization of the oral mucosa after the application of the amniotic membrane on the postexcisional defects of some lesions, one of the patients presenting a capillary hemangioma of the labial mucosa [9]. In addition to the degree of epithelialization identified as variable and in the study by Amemiya et. al, Shrikant et al. follow in their research a number of other parameters such as: the pain, the sensory response of the affected area, the opening degree of the oral cavity and the cicatricial contraction phenomenon. The postoperative pain was imperceptible a few days after the surgical interventions and the sensory response of the tissues became physiological

again in 100% of the cases. Moreover, the degree of physiological opening of the oral cavity obtained a high percentage at 7 days (85% of cases) and a score of 100% at two weeks postoperatively. Scar contraction, from the mentioned data, was identified in only one case, which could be attributed to a larger lesion [9].

◊ *Malignant oral lesions*

In the prospective clinical study carried out by Bijan Khademi et al., amniotic membrane patches were sutured to tissues after the removal of primary malignant tumors located on the tongue, hard and/or soft palate, as well as in the mandibular retromolar space. The study included a number of 50 patients (40 men and 10 women), with an average age between 20 and 80 years, who underwent partial glossectomy interventions, partial oral floor resections or even partial mandibular bone resections [10]. Following the histo-pathological examination, the cancerous lesions proved to be squamous cell carcinomas.

No patient suffered allergic reactions, which demonstrates the immunomodulatory capacity of hAM [11,12,13].

Deep tumors of the oropharyngeal space, with invasion of the mandibular bone surfaces, were also identified at patients in the study published by Ann Kakabadze et al. in 2017. In their retrospective clinical study, 4 subjects diagnosed with malignant tumors of conjunctival origin (osteoblastoma and osteosarcoma with osteoblastic cells), underwent resection interventions between 2008 and 2015, reconstructive plasty being subsequently performed through different clinical protocols [14]. By comparison, the patients were treated as follows: 3 patients benefited from the application of a biomaterial composed of bone allograft (autogenous graft) from the rib with a mediator substrate of amniotic allograft and one patient benefited from the application of a biomaterial with the same type of mediator substrate but with a base consisting of biologically active bone graft taken from bovine femur [14]. It is noteworthy that the mediation between these addition biomaterials and the recipient tissues is nevertheless accomplished by hAM. This fact strengthens the immunomodulating property of the amnion upon contact with the host tissue, which was also demonstrated in Bijan Khademi et al. study [10].

In order to create a biologically active bone, which shows the ability of osteogenesis in the host area, the researchers (Ann Kakabadze et al.) composed a biomaterial from two components: a three-dimensional biological base of cancellous bone tissue taken from the bovine femur and a superficial component represented by stem cells of hematogenous red bone marrow harvested by aspiration from the patient's anterior superior iliac spine. The biomaterial was applied indirectly to the site of the injury, the interface between the acceptor area and the biomaterial being represented by hAM allograft. The idea of mediating interface through allograft also started from the researchers` precaution to cancel in any way the possible appearance of fibrous tissue at the transplant site. Thus, the antifibrotic capacity of the amniotic membrane was once again demonstrated [14].

Table 2. hAM aplications in the surgery of benign and/or malignant tumors

The authors Year	Number of patients / Average age	Therapeutic indication (Pathology)	Parameters for evaluating the effectiveness of hAM	Results during the follow-up period
Amemya et al. 2015	**5 patients /36-75 years old**	Mucosal defects after excision of benign (and/or cystic) tumors	‣ Degree of epithelialization ‣ Hemostatic status ‣ Degree of immunological rejection	‣ Complete epithelialization at 1 month in all cases

Kakabadze et al. 2017	**4 patients /38-55 years old**	Muco-osseous defects after excision of malignant tumors	‣ Radiologically detectable osteolysis	‣ Absence of complications in all cases ‣ Radiologically detectable bone maintenance at 5 months
Shrikant et al. 2019	**15 patients /23-65 years old**	Mucosal defects after extirpation of benign / premalignant tumors	‣ Analgesia ‣ Sensory response ‣ Scar contraction	‣ Complete analgesia at 2 weeks ‣ Normal sensory response in all cases at 6 months
Bijan et al. 2013	**50 patients /20-80 years old**	Mucosal defects after extirpation of malignant tumors	‣ Alergic reaction	‣ Lack of adverse effects in all cases

◊ *Oro-sinusal pathological communication*

Published in 2015, the study by Subha et al. describes an innovative method of plasty of an oro-sinus communication defect with dimensions of approximately 6 mm. Abandoning muco-periosteal flap therapy, the oro-antral communication that occurred after the extraction of a second upper molar in a 29-year-old female patient was resolved by suturing a patch of amniotic membrane stored at low temperatures of about 4 degrees Celsius [15]. The patient underwent a control period at intervals of 3, 5 and 7 days, tracking the amount of granulation tissue formed at the intervention site. After a period of two weeks, the epithelialization of the area was complete, the oro-sinus communication being closed.

◊ *Jaw induced osteonecrosis*

Bisphosphonates are widely used both in bone tissue pathology and as adjuvant medications in the chemotherapy of various malignant tumors [16]. The main disadvantage of using bisphosphonates is the occurrence of osteonecrosis of the jaw bones.

In the case-report study by Mirko Ragazzo et. al, a new therapeutic method is described, in which, the remaining defects after the debridement of areas with bone necrosis, were covered with hAM. The study included 2 patients of both sexes, aged 85 years, diagnosed with bisphosphonate-induced osteonecrosis in different regions of the facial massif and oral cavity. After surgery, patients were called for reevaluation at 180 days. Clinically asymptomatic, they did not show signs of local inflammation nor the appearance of secondary abscesses [16].

PERIODONTAL SURGERY

◊ *Gingival recessions*

Several authors wanted to demonstrate that hAM use in plastic techniques of denuded areas will have the effect of obtaining improved anatomical and structural configurations of the periodontal support apparatus. Among them, Mario Martelonni, Sonia Sheety and Anamika Sharma brought data to light.

In the case-report study published in 2015, Anamika Sharma and Komal Yadav look at the effectiveness and predictability of plasty of isolated areas of superficial-moderate root exposure using hAM. The study was carried out on a limited group of 3 patients, non-smokers, without associated pathologies, subjected to the preoperative scaling and root planing (SRP) procedure. They were classified according to Miller's classification in grade II canine gingival recession (at maxillary level). The denuded areas were treated by creating mucosal flaps (not including the periosteum), which covered amniotic membrane patches

placed in contact with the exposed areas. The values of parameters such as CAL (clinical attachment level) or RD (recession depth) decreased considerably for all 3 subjects participating in the study [17].

In the case report study published by Sonia Sheety et al. in 2014, gingival recessions due to root exposure were surgically treated by covering with hAM allograft and adjacent mucosal flap. The gingival recessions of the patient participating in the study were classified as Miller class I and were located at the level of several dental units (1.5 and 1.6, respectively 2.5 and 2.6). The study was carried out by comparison, the right side gingival recessions being surgically treated by plasty with Platelet-Rich Fibrin membrane (PRF) and covering mucosal flap and the left side recessions by plasty with hAM allograft and neighboring mucosal flap [18]. The comparative results between the methods indicated a maintenance of the degree of root coverage of 100% in both cases, highlighting a better dimensional stability of the postoperative areas for hAM allograft technique.

In the study published by Martelloni et.al, the case of a 40-year-old patient, classified in the same Miller class (class I), is presented. For 1.3 and 1.4 gingival recessions, the same bilaminar plasty technique was proposed (by covering with hAM allograft and relaxed and coronally translated vestibular flap). The results were identical to those presented by Sharma and Yadav [19].

The results obtained with using hAM as a tissue graft were satisfactory. The patients were not complaining of symptoms characteristic of secondary inflammation or infection at the site of hAM application (in all cases). The sensory response of the tissues became physiological again after the surgery (100%). Moreover, the degree of physiological opening of the oral cavity obtained a score of 100% at two weeks postoperatively. The values of parameters such as CAL or RD decreased considerably. A better dimensional stability of the postoperative areas was obtained when hAM allograft was used. No patient suffered allergic reactions.

DISCUSSIONS

The purpose of this systematic review was to present how hAM allograft has been successfully used in a number of areas belonging to oral medicine.

Amniotic membranes were compared (in terms of effectiveness) with different biomaterials, existing in the pharmaceutical field at the time. Parallels were also made between the application of hAM allografts and the application of autogenous grafts from neighboring tissues.

hAM allograft, through its various uses, has virtually eliminated any doubt or uncertainty about its efficacy. This fact reinforces the idea that the biological and mechanical properties of hAM are not just formulated on paper, but are supported by a strong practical foundation. The anti-inflammatory effect was also promoted by Ragazzo et al. [16]. Moreover, this study also supports the theory of the analgesic and antimicrobial effect of hAM. The antifibrotic effect of hAM was found in the study by Shrikant et al., when hAM allograft opposed secondary fibrosis of the oral epithelium in patients suffering from submucosal fibrosis [9,20,21]. Bijan Khademi et al. complement the theories supporting the immunomodulatory property of hAM [10]. In their research, no subjects undergoing hAM reconstructive plastic surgery suffered allergic reactions [10,11,12,13]. In addition to the antifibrotic capacity, the study by Shrikant et.al, also highlights the analgesic effect of hAM [6].

The mechanical properties of the amniotic membrane played an equally important role, elasticity, tensile strength and dimensional stability being decisive in regaining the initial anatomical configuration of all tissues.

With all the progress made to date, the tissue engineering of amniotic membrane allografts deserves and needs to be further deciphered. We know that there is always hope for an even more resounding evolution in this field, considering the fact that, new applications of hAM in temporomandibular joint surgery and post-traumatic head surgery (orbital zone) have been described.

CONCLUSIONS

Human Amniotic Membrane has been successfully used in reconstructive surgery protocols, being an easily accessible, biocompatible and qualitative graft from all points of view. This can function as a biological barrier against the aggression of antigens, thus increasing the chances of success of the restitutio ad integrum process. hAM stimulates postoperative wound healing by functioning as a protective, young and biologically integrated covering epithelium. The costs of collecting, processing and storing this allograft are minimal.

Although few in number, the disadvantages of using amniotic membrane should be remembered. The inconveniences of the amniotic membrane allograft collection process relate to the possibility of cross-infections in the presence of undiagnosed or unscreened donors for infectious pathologies, or to treatment and preservation procedures that do not respect the principles of asepsis and antisepsis.

In conclusion, the properties of the amniotic membrane can be defined as theories with a proven medical foundation, even if the number of relevant studies in our study is not large and the number of patients is relatively small.

Author contributions

Conceptualization, A.U. and M.R.; Methodology, R.C.; Software, R.A.; Validation, B.I., D.C. and M.R.; Formal Analysis, A.U. and M.R.; Investigation, R.A.; Resources, R.C.; Writing – Original Draft Preparation, A.U.; Writing – Review & Editing, M.R. and R.A; Visualization, D.C.; Supervision, M.R.; Project Administration, B.I.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Solomon SM, Sufaru IG, Teslaru S, et al. Finding the Perfect Membrane: Current Knowledge on Barrier Membranes in Regenerative Procedures: A Descriptive Review. Appl Sci. 2022;12(3).

[2] Fenelon M, Maurel D, Siadous R, et al. Comparison of the impact of preservation methods on amniotic membrane properties for tissue engineering applications. Mater Sci Eng C [Internet]. 2019;104(March):109903. Available from: https://doi.org/10.1016/j.msec.2019.109903

[3] Davis J.W. Skin transplantation with a review of 550 cases at the Johns Hopkins Hospital. Johns Hopkins Med J. 1910;307.

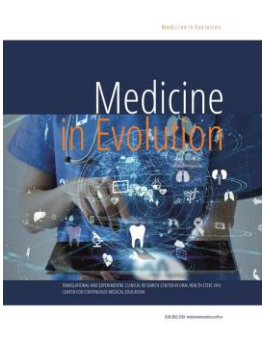
[4] Lawson VG. Oral Cavity Reconstruction Using Pectoralis Major Muscle and Amnion. Arch Otolaryngol. 1985;111(4):230–3.

[5] Dawiec G, Niemczyk W, Wiench R, Niemczyk S, Skaba D. Introduction to Amniotic Membranes in Maxillofacial Surgery-A Scoping Review. Medicina (Kaunas). 2024 Apr 19;60(4):663.

[6] Hazarika K, Malik K, Adhyapok AK, Debnath SC. Lyophilised Amniotic Membrane in Intraoral Surgical Defects: A Prospective Clinical Study. Ann Maxillofac Surg. 2022 Jan-Jun;12(1):5-10.

[7] Faramarzi M, Shishegar M, Kazemi T, et al. The effect of applying amniotic membrane on post-tonsillectomy pain and bleeding. Eur Arch Oto-Rhino-Laryngology [Internet]. 2021;278(2):485–92.
[8] Amemiya T, Nakamura T, Yamamoto T, et al. Autologous transplantation of oral mucosal epithelial cell sheets cultured on an amniotic membrane substrate for intraoral mucosal defects. PLoS One. 2015;10(4):1–13.
[9] Chakrawarti S, Kumar Aurora J, Singh Bedi R, et al. Versatility of Human Amniotic Membrane in Oral and Maxillofacial Surgery. Int J Adv Res. 2019;7(1):344–57.
[10] Khademi B, Bahranifard H, Azarpira N, et al. in Oral Cavity and Pharyngeal Defects after Tumor Resection. Arch Iran Med. 2013;16(9):2011–4.
[11] Mohan R, Bajaj A, Gundappa M. Human amnion membrane: Potential applications in oral and periodontal field. J Int Soc Prev Community Dent. 2017;7(1):15–21.
[12] Mamede AC, Botelho FM. Amniotic Membrane Origin, Characterization, Medical Aplications. Springer; 2015.
[13] Niknejad H, Peirovi H, Jorjani M, et al. Properties of the amniotic membrane for potential use in tissue engineering. Eur Cells Mater. 2008; 15:88–99.
[14] Kakabadze A, Mardaleishvili K, Loladze G, et al. Reconstruction of mandibular defects with autogenous bone and decellularized bovine bone grafts with freeze-dried bone marrow stem cell paracrine factors. Oncol Lett. 2017;13(3):1811–8.
[15] Lakshmi S, Bharani S, Ambardar K. Repair of an oroantral communication by a human amniotic membrane: a novel technique. J Korean Assoc Oral Maxillofac Surg. 2015;41(4):194.
[16] Ragazzo M, Trojan D, Spagnol L, et al. Use of amniotic membrane in the treatment of patients with BRONJ: two case reports. J Surg Case Reports. 2018;2018(4):1–4.
[17] Sharma A, Yadav K. Amniotic membrane - A Novel material for the root coverage: A case series. J Indian Soc Periodontol. 2015;19(4):444–8.
[18] Shetty SS, Chatterjee A, Bose S. Bilateral multiple recession coverage with platelet-rich fibrin in comparison with amniotic membrane. J Indian Soc Periodontol. 2014;18(1):102–6.
[19] Martelloni M, Boccaletto P, Montagner G, et al. Bilaminar technique with coronally advanced flap and cryopreserved human amniotic membrane in the treatment of gingival recessions. Case Rep Dent. 2020;2020.
[20] Leal-Marin S, Kern T, Hofmann N, et al. Human Amniotic Membrane: A review on tissue engineering, application, and storage. J Biomed Mater Res - Part B Appl Biomater. 2021;109(8):1198–215.
[21] Klama-Baryła A, Rojczyk E, Kitala D, et al. Preparation of placental tissue transplants and their application in skin wound healing and chosen skin bullous diseases - Stevens-Johnson syndrome and toxic epidermal necrolysis treatment. Int Wound J. 2020;17(2):491–507.

Comparative Effectiveness of Intraoral Scanners and Articulating Paper in Occlusal Contact Analysis



Andreea Iuliana Kui[1], Bianca Dumbrovca[2], Pierre Oriot[3], Marius Negucioiu[1], Manuela Tăut[1], Manuela Manziuc[1], Mirela Fluerașu[1], Roxana Buzatu[4], Smaranda Buduru[1]

[1]*Department of Prosthetic Dentistry and Dental Materials, Faculty of Dental Medicine, "Iuliu Hatieganu" University of Medicine and Pharmacy, 400012 Cluj Napoca, Romania*
[2]*Cluj County Emergency Clinical Hospital, 400006 Cluj-Napoca, Romania*
[3]*Faculty of Dental Medicine, "Iuliu Hatieganu" University of Medicine and Pharmacy, 400012 Cluj Napoca, Romania*
[4]*Department of Dental Aesthetics, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania*

Correspondence to:
Name: Marius Negucioiu
E-mail address: sica5319@yahoo.de

Received: 24 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

1.Background/Objectives: This study evaluates the accuracy of maximum intercuspation analysis using both conventional articulating paper and three digital intraoral scanners. The goal was to determine the reliability and equivalency of traditional and digital methods in recording occlusal contact points. 2. Methods: Ten subjects underwent occlusal contact point analysis using articulating paper, 3Shape® Trios 3, Omnicam Cerec®, and Medit i700® intra-oral scanners. Results were compared visually and statistically to evaluate method equivalence. 3.Results: Analysis revealed no statistically significant differences in the accuracy of occlusal contact points among the four methods tested, confirming the reliability of both traditional and digital approaches. 4.Conclusion: Articulating paper remains a reliable tool for occlusal analysis, even with the advent of advanced intraoral scanners. The findings support the feasibility of using any of the tested scanners for accurate occlusal contact analysis. This study underscores the potential for integrating both conventional and digital methods, depending on clinical needs and available technology, without compromising diagnostic accuracy.

Keywords: articulating paper, maximum intercuspation, CEREC®, MEDIT®, and 3Shape® Trios 3 intraoral scanning

INTRODUCTION

Reliable occlusal registration with appropriate occlusal contacts is critical in restorative procedures [1]. Accurate registration and effective transfer of this occlusal information to the dental technician are key components in prosthetic and restorative procedures [2,3]. A functional occlusal relationship is capital, as it will significantly impact the masticatory performance, the prevention of occlusal trauma and dysfunction, and the effectiveness of orthodontic treatments. Understanding these aspects is essential for maintaining oral health and achieving successful dental interventions.

Studies showed that increased chewing cycles power improved performance regardless of the occlusal patterns [4], dysfunctional syndromes of the stomatognathic system can arise from poor occlusal relationships, leading to pain and other complications [5]. The absence of proper occlusal contacts can result in occlusal trauma, which may manifest as joint and muscle pain, and periodontal issues, abnormal dental wear and abfractions, emphasizing the need for monitoring intermaxillary relations [6].

Occlusal trauma is closely linked to periodontitis, showing significant correlations with factors like amalgam restorations and pathogenic occlusion through logistic regression analysis (7). Although it does not initiate periodontitis, occlusal trauma can exacerbate connective tissue loss, especially when combined with plaque-induced periodontitis [7]. Patients with chronic periodontitis who experience high occlusal forces may exhibit deeper probing depths and increased bleeding on probing, suggesting a potential for enhanced periodontal destruction [8]. Diagnostically, confirming occlusal trauma is challenging as it relies on histological confirmation and is marked by a lack of consensus regarding its role in the onset and progression of periodontal diseases, further complicated by the unsupported link between abfraction and gingival recession [7]. Clinically, occlusal therapy plays a critical role in periodontal treatment by reducing tooth mobility, improving patient comfort, and enhancing masticatory function [9]. Comprehensive management strategies involving orthodontic and prosthodontic interventions are crucial for managing pathologic tooth migration linked to occlusal trauma, underscoring the importance of effective occlusal therapy in improving outcomes for periodontal patients [7-9].

Conventionally, occlusal contacts in patients and on plaster models have been assessed using articulating paper and shim stock (8-micron aluminum foil), with various thicknesses available. Research suggests that the tactile sensitivity of natural teeth can range from 8 to 10 µm, making 8 µm paper more suitable than thicker options such as 40 or 200 µm, thus often being regarded as the gold standard for accurately detecting interocclusal contacts [10-15]. Despite its widespread use, articulating paper has several limitations, such as: it requires patients to bite multiple times to capture full arch contacts, while results can be compromised by saliva, which may lead to false positives and negatives. Nevertheless, no method has yet been scientifically validated as the ideal technique for occlusal analysis [10].

The increasing integration of digital technology in dentistry is enhancing the way occlusal contacts are recorded. Intraoral scans are notably more time-efficient than traditional methods, improving workflow significantly when clinicians are adequately trained [13,16–18]. This technological advancement not only enhances patient comfort but also streamlines data processing and storage [19,20]. Additionally, digital scans used for individual restorations and some bridge elements yield more accurate and meaningful data compared to traditional physical casts [13]. However, for long-span restorations, conventional impressions remain the preferred method [21]. Thus, further refinements in software accuracy are required to improve the reliability of these digital measurements [22].

In addition, the development of digital occlusion technologies has had a major impact on dental practice by improving diagnostic capabilities and treatment planning. Systems such as T-scan® (Tekscan, Boston, MA, USA), Zebris® (Amman Girrbach, Germany) and Modjaw® (Villeurbanne, France) have been at the leading edge of these advances, providing sophisticated tools for both static and dynamic occlusal analysis. While all three systems improve clinical outcomes, their efficacy and limitations warrant further investigation [11,13,14].

When comparing these systems, studies often evaluate the accuracy and consistency of the data they provide. Furthermore, further analysis is required to fully understand the capabilities of these systems in different clinical scenarios, although the predictive values and accuracy of these systems, such as those reported for Accura, confirm their potential [24].

Methodological approaches to occlusal assessment, including conventional, photographic and computerized techniques, have shown varying degrees of correlation. This variability highlights the need for critical evaluation of these methods, as no single approach has emerged as the definitive standard. While conventional methods are currently adequate for many clinical settings, the integration of advanced systems such as T-scan, Zebris and Modjaw could potentially provide more accurate and reliable measurements, provided their methodologies are continually refined and validated through research [24-25].

Over the past decade, the use of chairside intraoral scanners to take digital impressions has become more widespread. These scanners use digital maxillary and mandibular models in Standard Triangle Language (STL) format. To accurately position the maxillary and mandibular files, a third file capturing the buccal view of the intermaxillary articulation is generated using reference points analyzed by a mathematical algorithm [11,13,14]. This process allows accurate simulation of a patient's occlusal contacts and allows virtual models to be placed in the desired intercuspal position, typically maximum intercuspal position or centric occlusion. This technique bypasses the need for an interocclusal record using elastomers and scanning, overcoming concerns about the dimensional stability of traditional interocclusal record materials and simplifying the overall process [2]. The benefits of Computer-Aided Impression (CAI) include reducing time-consuming clinical steps, improving patient comfort, streamlining data storage, eliminating time spent casting and pinning models in the laboratory, reducing inaccuracies in manual trimming, and eliminating the need for mechanical articulators and facebows [14].

Aim and objectives

The primary aim of this observational study is to determine whether the analysis of occlusal contact points using the software of intraoral scanners (CEREC®, MEDIT®, and 3-SHAPE®) is equivalent to the traditional method of marking occlusion using articulating paper. This aim seeks to assess whether modern digital methods can provide the same accuracy and reliability as the conventional approach, which has been a longstanding method in dental practice.

The secondary aim of the study is to evaluate whether there are any notable disparities in the occlusal analysis capabilities among the three specified intraoral scanners: CEREC®, MEDIT®, and 3-SHAPE®. This part of the study looks to identify if one scanner shows superior performance over the others or if all scanners operate with comparable effectiveness in a clinical setting.

The primary null hypothesis states that there is no difference between the occlusal contact point analysis obtained using the software of intraoral scanners (CEREC®, MEDIT®, and 3-SHAPE®) and the traditional occlusion marking method with articulating paper. The secondary null hypothesis asserts that there are no significant disparities in occlusal analysis among the three intraoral scanners (CEREC®, MEDIT®, and 3-SHAPE®).

MATERIAL AND METHODS

Study design and participants

This prospective study was approved by the Ethical Committee of the "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj Napoca, Romania (no.15/21.05.2024). The research was performed in accordance with the Declaration of Helsinki from 1975 and subsequent revisions and written informed consent were obtained from every subject before collecting data.

The participants were recruited from students at the Faculty of Dental Medicine, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj Napoca, Romania.

Subjects were considered eligible according to the following inclusion criteria: full permanent dentition, except for the third molar; age between 20 and 25 years, with no restrictions regarding the sex or ethnicity; normal mouth opening; presence or absence of direct dental restorations using composite resins or glass ionomer materials; presence or absence of single-unit indirect restorations (crowns, inlays, onlays, or overlays).

The exclusion criteria were. as follows – anterior or posterior open-bite, temporomandibular joint disorders, missing teeth, or previous orthodontic extractions.

According to the aforementioned criteria, 10 subjects were enrolled in the study group. For each participant, photographs of articulating paper marks and digital scans were collected and analyzed by two operators (B.D. and P.O).

The study analyzed maximum intercuspation in the participants using four different occlusal relationship assessment methods, starting conventionally with marking with 200 µm calibrated articulating paper and digitally using three different intra-oral scanners: Cerec Omnicam® (Dentsply Sirona, North Carolina, USA), 3Shape® Trios 3 (3Shape, Denmark), and Medit® i700 (Medit corp., South Coreea).

The data collected underwent both descriptive and comparative analysis. Each participant was subject to a clinical examination along with an occlusal assessment. The clinical occlusal analysis was conducted, and maximum intercuspation (IM) was recorded using Bausch® articulating paper. Subsequently, on the same day, intraoral scans were performed using three distinct scanners, mentioned above. For the same subject, all activities were carried out during the same day at the Department of Prosthodontics, Faculty of Dental Medicine, Cluj-Napoca.

Protocol for occlusal examination

The protocol for dental occlusion examination consisted of four different analyses: using articulating paper, and three different types of intraoral scanners. The occlusal contacts were recorded using a 200 µm blue articulating paper (200 µm Arti-Fol; Dr. Jean BauschGmbH & Co KG, Köln, Germany). The equipment and materials used during the study were: (1) dental examination kit (including a No. 6 probe, a dental mirror, and surgical tweezers); (2) OptraGate® (Ivoclar Vivadent, Schaan, Liechtenstein) buccal retractors in regular and small sizes; (3) translucent blue plastic cheek retractors; (4) salivary cotton rolls; (5) 200µm Bausch® blue articulating paper; (6) Apple® iPhone Xr camera; (7) dental photography mirrors; (8) Cerec Omnicam® (Dentsply Sirona, North Carolina, USA) intraoral scanner; (9) 3Shape® Trios 3 (3Shape, Denmark) intraoral scanner; (10) Medit® i700 (Medit corp., South Coreea) intraoral scanner.

Each subject was seated in an upright position and instructed to close his/her mouth in a natural occlusion, repeating the movement until the operator was sure that the patient was able to reproduce a correct intercuspation. The analysis of occlusion in maximum intercuspation using articulating paper (figure 2) was performed according to the following protocol: (1) the patient was instructed on how to close their mouth in maximum intercuspation - the patient was asked to repeat the movement several times to ensure they

were in the correct position; (2) occlusal surfaces of the teeth were dried using an air spray; (3) blue 200 μm articulating paper was placed between the left and right side in the same moment so that the patient does not deviate and closing/opening movements were performed several times. -this step was performed 3 times to be sure that the same contact points were marked; (4) occlusal markings on the surfaces were checked for accuracy; (5) an image of the maxillary and then mandibular arch was captured using an occlusal dental photography mirror with an Apple® iPhone Xr camera and a Smile lite® (Smile Line, Switzerland) device; the markings were removed using cotton rolls for the patient's aesthetic comfort following their participation.

Figure 1. The maxillary and mandibular arches, marked using blue 200 μm articulating paper in maximum intercuspation

The analysis of occlusion in maximum intercuspation using Omnicam Cerec® (Dentsply Sirona, North Carolina, USA) intra-oral scanner was performed according to the following protocol, following the manufacturer's recommendations: (1) before scanning, ensuring the scanner is calibrated, and the tip was cleaned - the subject's teeth were dried thoroughly to reduce glare and improve scanning accuracy; (2) starting with the upper arch, scanning from one posterior molar across the occlusal surfaces to the opposite side, capturing the buccal and palatal/lingual surfaces; the lower arch was examined afterwards, following the same sequence; finally, the buccal surfaces were scanned with the two arches in maximal intercuspation; (3) during scanning, the scanner was held 5–15 mm from the tooth surface and maintain steady, smooth movements, using the live feedback on the software to verify that all surfaces are captured; (4) to record the occlusal relationship, the patient was asked to close their mouth in maximal intercuspation and instructed to keep their teeth in contact but without clenching: then, four digital recordings were taken – at the level of the left first molars, left canines, right canines, and right first molars – starting from the occlusal surface and moving the intraoral scanner head first cranially and then caudally, until the upper and lower scans were recognized by the software and properly matched after scanning, the 3D model was checked in the software for any missing areas, and rescanning was performed only where necessary.

The analysis of occlusion in maximum intercuspation using Medit i700® (Medit corp., South Coreea) intra-oral scanner was performed by the same operator, following the manufacturer's recommendations: (1) before scanning, the scanner was calibrated, and the tip was cleaned and properly attached; the patient's teeth were dried thoroughly to improve scanning accuracy and minimize reflections, removing any debris or saliva from the surfaces; (2) starting with the upper arch, from one posterior molar and moving systematically across the occlusal surfaces to the opposite side, ensuring the capture of buccal and palatal/lingual surfaces; the same process was repeated for the lower arch, and the buccal surfaces were scanned afterwards with the patient in occlusion to record the bite; (3) the scanner was held at

a consistent distance of 10–15 mm from the tooth surface, maintaining smooth and steady movements, following the live scan feedback on the software to ensure complete coverage of all areas; (4) after completing the scan, the 3D model was reviewed for missing regions and perform rescanning only where necessary; (5) the patient was instructed on how to close their mouth for the occlusion impression; the patient was asked to close their mouth in a normal occlusal position, avoiding an edge-to-edge bite; (6) the occlusion impression was performed by vestibular scanning with the mouth closed in maximum intercuspation.

The analysis of occlusion in maximum intercuspation using 3Shape® Trios 3 (3Shape, Denmark) software was performed following the manufacturer's recommendations: (1) dental surfaces were dried using an air spray; (2) the maxillary impression was taken, starting posteriorly from the second quadrant; a "zig-zag" scanning motion was performed (buccal → occlusal → lingual) until reaching the posterior end of the first quadrant; (3) non-recorded areas were corrected with a new impression; (4) the mandibular impression was taken, starting posteriorly from the third quadrant; a "zig-zag" scanning motion was performed (buccal → occlusal → lingual) until reaching the posterior end of the fourth quadrant ; (5) non-recorded areas were corrected with a new impression; (6) the scanner was held at a consistent distance of 10–15 mm from the tooth surface, maintaining smooth and steady movements, following the live scan feedback on the software to ensure complete coverage of all areas; (6) the patient was instructed on how to close their mouth for the occlusion impression; the patient was asked to close their mouth in a normal occlusal position, avoiding an edge-to-edge bite; (7) the occlusion impression was performed by vestibular scanning with the mouth closed in maximum intercuspation.

After performing each of the digital scanning, the operator evaluated the occlusal contacts through a specific function of each intraoral scanner software, where the contacts are shown as a colored map depicting the intensity of the contact (the color codes are variable, depending on the software used for evaluation) (figures 2-7).

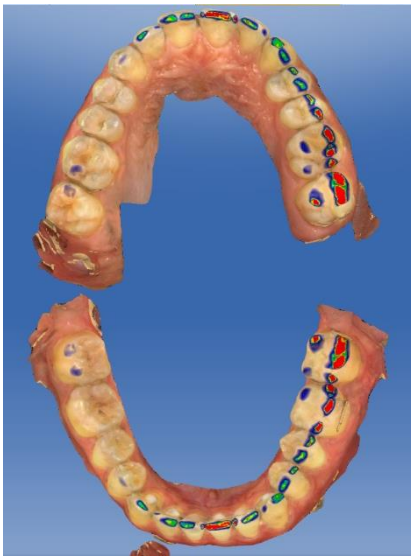


Figure 2. Screen capture of maxillary and mandibular scans using Omnicam Cerec® (Dentsply Sirona, North Carolina, USA) (in the contact point analysis mode)

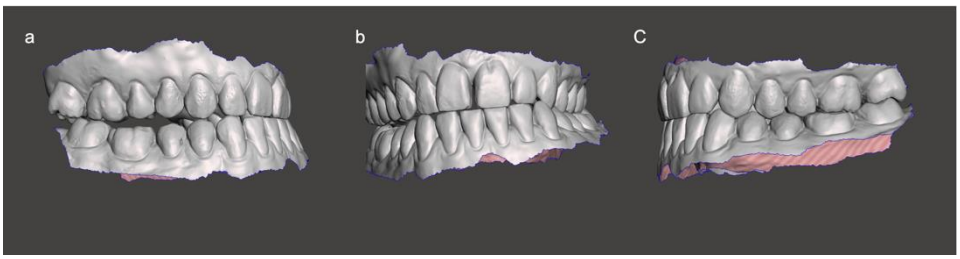


Figure 3. Screen capture of STL file created with Omnicam Cerec® (Dentsply Sirona, North Carolina, USA) (a) right view (b) front view (c) left view

Figure 4. Screen capture of maxillary and mandibular scans with Medit i700® (Medit corp., South Coreea) (in the contact point analysis mode)

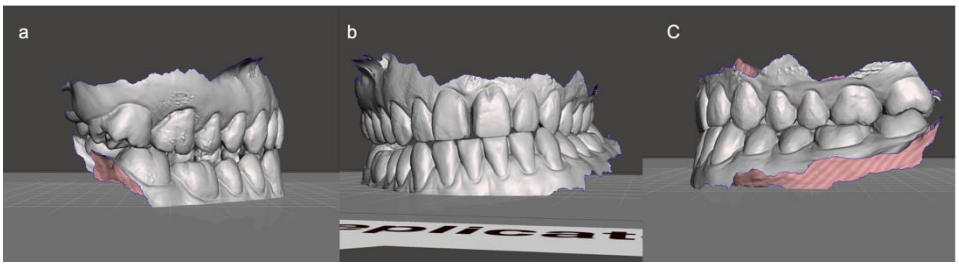


Figure 5. Screen capture of STL file created with Medit i700® (Medit corp., South Coreea) (a) right view (b) front view (c) left view

Figure 6. Screen capture of maxillary and mandibular scans with 3Shape® Trios 3 (3Shape, Denmark) (in the contact point analysis mode)

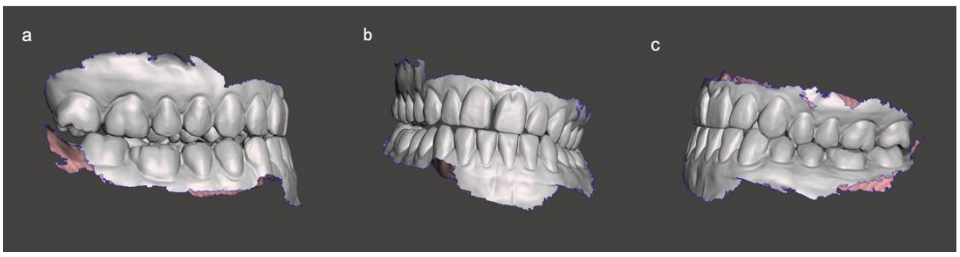


Figure 7. Screen capture of STL file created with 3Shape® Trios 3 (3Shape, Denmark) (a) right view (b) front view (c) left view

Data collection

All records - articulating paper examination photographic records and intraoral scans STL images - were reviewed by two experienced operators to verify the accuracy of the occlusal contact points. Any discrepancies or unclear recordings required a re-assessment to confirm the findings. The data from the articulating paper and each of the scanners were then digitally processed to create a comprehensive occlusal map for the patient, highlighting contact points and their intensity.

Upon completion of all four examinations for each enrolled subject, the number of contact points marked on each tooth was recorded and entered into an Excel file to facilitate statistical analysis and comparison of contact points between different occlusal analysis methods. This organized data collection allowed for efficient aggregation, sorting and visual presentation. This helped to identify patterns, discrepancies and the overall effectiveness of each method used in the study.

Statistical analysis

After collecting the data, a statistical analysis was performed to test the null hypothesis that there is no difference in the evaluation of the occlusal contacts detected using articulating papers and intraoral scanner, as well as differences between different types of intraoral scanners. Descriptive statistics for the count of occlusal contacts evaluated from digital scan and photographs of articulating paper marks were calculated. The t-test was performed to evaluate the presence of differences between the number of occlusal contacts evaluated via the four methods.

RESULTS

All contact points were recorded for each subject. The results follow a normal distribution (Table 1). The average contact points obtained for the 10 subjects of the study using each method were calculated (Table 2).

Table 1. Total number of contact points observed in 10 subjects with each method

Subject no.	**No. of contacts 3Shape® Trios 3**	**No. of contacts Omnicam Cerec®**	**No. of contacts Medit i700®**	**Articulating paper**
1	36	41	35	41
2	59	69	58	68
3	44	63	48	56
4	67	65	54	55
5	57	58	49	62

6	46	43	40	53
7	56	54	46	52
8	47	50	35	45
9	27	66	67	52
10	38	55	51	44
Total contacts	477	564	483	528

Table 2. Average number of contact points obtained on both opposing arches for each method

3Shape® Trios 3	**Omnicam Cerec®**	**Medit i700®**	**Articulating paper**
47,7	56,4	48,3	51,8

Considering that not all dental offices are equipped with intraoral scanners, we consider the paper to be the gold standard for analyzing occlusal contact points. We decided to assign a 100% contact point analysis rate with the articulating paper. This way, it can observe the variations between each scanner and between the scanners and the articulating paper (Table 3).

Table 3. Percentage of contact points obtained with intraoral scanners compared to articulating paper

3Shape® Trios 3	**Omnicam Cerec®**	**Medit i700®**	**Articulating paper**
92,08%	108,90%	93,24%	100%

By performing a statistical test (t-test) we determined whether there is a statistically significant difference between each scanner and the paper, as well as between the scanners themselves (Table 4 and Table 5).

Table 4. t-test results comparing intraoral scanners to paper

t-test	**Significance level (p)**
3Shape® Trios 3 vs articulating paper	0,285826
Omnicam Cerec® vs articulating paper	0,380973
Medit i700® vs articulating paper	0,905812

Table 5. t-test results comparing intraoral scanners to each other

t-test	**Significance level (p)**
3Shape® Trios 3 vs Omnicam Cerec®	0,094248
3Shape® Trios 3 vs Medit i700	0,905769
Medit i700 vs Omnicam Cerec®	0,082672

For each p-value < 0.05 from a t-test, a significant difference is considered. The results based on gathering the data from 10 subjects demonstrated that there was no statistically significant difference between any of the methods employed.

DISCUSSIONS

The findings of our study confirmed both null hypotheses, indicating that there were no statistically significant differences between the occlusal contact point analyses obtained through the use of intraoral scanner software (CEREC®, MEDIT®, and 3-SHAPE®) and the traditional method using articulating paper. Additionally, our results showed no significant disparities in the occlusal analysis capabilities among the three tested intraoral scanners. This study explored the comparative effectiveness of articulating paper and intraoral scanners for occlusal contact analysis, revealing no significant differences in accuracy among the tested methods. These findings align with the current discourse in dental diagnostics, where traditional methods continue to hold relevance alongside advancing digital technologies.

Recent literature supports our observation that while intraoral scanners offer rapid data collection and enhanced patient comfort, their accuracy in occlusal analysis can be variable. Mangano et al. (2017) highlighted that subjective interpretation using traditional methods like articulating paper often fails to differentiate between high and low occlusal forces effectively, suggesting a shift towards more quantitative, measurement-based methods might be beneficial [26].

Furthermore, studies have shown that factors such as paper thickness, operator experience, and the patient's biting force significantly influence the outcomes of traditional occlusal contact assessments [27]. This variability underscores the need for standardized procedures in occlusal analysis, regardless of the method employed.

Digital methods, particularly those involving complete-arch intraoral scans, have demonstrated varying levels of precision. For instance, the Trios 3 system was noted for its superior accuracy in full arch scans, suggesting that the choice of scanner could critically impact clinical outcomes [28]. However, discrepancies in scanner performance, as evidenced by the underestimation of occlusal contacts by the Medit i500 compared to more accurate systems like the Trios 3, indicate that not all digital solutions provide equivalent results [28,29].

The integration of digital technologies in dental practice, as discussed by Alghazzawi (2016), provides significant advancements in the diagnostic and design capabilities of prosthodontic care [30]. Nevertheless, the potential for inaccuracies, particularly in the context of whole arch scans, remains a concern that necessitates further refinement of these technologies [31].

The research, while comprehensive, has several limitations that must be acknowledged:

1. Sample size: the study was conducted with a limited number of participants (10 subjects). This small sample size may not provide a representative cross-section of the population, which could affect the generalizability of the findings.
2. Operator dependency: the results could potentially be influenced by the operators' proficiency and technique. Although efforts were made to standardize the examination process, individual differences in handling the intraoral scanners and articulating paper could introduce variability in the data.
3. Technology-specific limitations: each scanner has its own set of technological nuances and limitations, which might have affected the accuracy and efficiency of occlusal contact recordings. These device-specific factors were not controlled for, which could skew comparisons between devices.
4. Lack of longitudinal data: the study was conducted in a single session per participant, which does not account for potential changes in occlusal contact over time. Longitudinal studies could provide a more detailed understanding of the stability and reliability of occlusal recordings.

5. Exclusion of complex cases: the exclusion criteria removed individuals with certain dental conditions that could have provided additional insights into the performance of the occlusal recording methods under varied clinical circumstances.

However, our research has several strengths, such as the use of a comprehensive methodology, comparing traditional occlusal contact analysis using articulating paper with three different digital intraoral scanners. All occlusal examinations were performed under standardized conditions, which minimizes variability due to procedural differences. By incorporating three different intraoral scanners (3Shape® Trios 3, Omnicam Cerec®, Medit i700®), the study offers a broad evaluation of current digital technologies. The operators performing the scans and analyses were well-trained, which reduces the risk of operator-induced discrepancies and enhances the reliability of the findings.

Futures perspectives

Given these limitations, future research directions could include increasing participant diversity to improve robustness and applicability across populations, and longitudinal studies to track changes in occlusal contacts over time. Further research could also explore the use of advanced technology, such as the latest intraoral scanners and digital occlusal analysis tools, possibly incorporating machine learning to help interpret the data. Furthermore, implementation in restorative or orthodontic clinical trials could provide valuable insights into clinical efficacy. A detailed comparison of each scanner's technological capabilities and limitations could provide clearer guidance on their optimal clinical use, ensuring more targeted and effective dental solutions.

The clinical implications of this research underscore the usefulness of both traditional and digital methods of occlusal contact analysis. It shows that articulating paper and intraoral scanners provide comparable results, allowing clinicians to choose based on availability, cost and preference without sacrificing accuracy. This allows practices to make confident choices to improve workflow and patient satisfaction. It also highlights the need for continued training and calibration in using these technologies to maintain high standards of care. As digital dental technologies continue to evolve, ongoing research and adaptation in clinical practice is essential to ensure that the benefits of these tools are fully realized and that patient outcomes are improved through precise occlusal adjustments and well-fitting prosthetic solutions.

CONCLUSIONS

The analysis of occlusal contact points in the maximal intercuspation position shows equivalent results with these four methods of analysis. Indeed, no statistically significant difference is observed between the use of articulating paper and the three intra-oral scanners.

The use of articulating paper remains reliable despite the introduction of intraoral scanners. However, these four analysis methods are empirical, and it would be interesting to incorporate the use of other digital occlusal examination (e.g. T-scan® - Tekscan, Boston, MA, USA) in order to visualize the intensity of the contact points.

This study demonstrates that it is entirely feasible for a practitioner equipped with any of these three scanners to perform an analysis of occlusal contact points with the software. For the diagnosis and treatment of occlusal equilibration, it is preferable to correlate the conventional occlusal analysis method with the digital method if the software provides distorted values.

The advantages of these methods of analysis come from exploiting the benefits of each method and using them in combination for a complete occlusal diagnosis.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Nadjmi N, Mollemans W, Daelemans A, Van Hemelen G, Schutyser F, Bergé S. Virtual occlusion in planning orthognathic surgical procedures. Int J Oral Maxillofac Surg. 2010;39(5):457-62.

[2] Arslan Y, Bankoğlu Güngör M, Karakoca Nemli S, Kökdoğan Boyacı B, Aydın C. Comparison of maximum intercuspal contacts of articulated casts and virtual casts requiring posterior fixed partial dentures. J Prosthodont. 2017;26(7):594-8.

[3] Fraile C, Ferreiroa A, Romeo M, Alonso R, Pradíes G. Clinical study comparing the accuracy of interocclusal records, digitally obtained by three different devices. Clin Oral Investig. 2022;26(2):1957-62. https://doi.org/10.1007/s00784-021-04174-2

[4] Niwatcharoenchaikul W, Tumrasvin W, Arksornnukit M. Effect of complete denture occlusal schemes on masticatory performance and maximum occlusal force. J Prosthet Dent. 2014;112(6):1337-42.

[5] Andor CT, Mihai C, Morarasu CS, et al. Functional and psychorehabilitation of the stomatognatic system's disorders: a non-invasive treatment approach. Rom J Oral Rehabil. 2023;15(1):130-7.

[6] Ríos CC, Campiño JI, Botero JE, et al. Occlusal trauma is associated with periodontitis: A retrospective case-control study. J Periodontol. 2022;92(12):1788-94. doi: 10.1002/JPER.20-0598

[7] Zhou SY, Mahmood H, Jin LJ, et al. Teeth under high occlusal force may reflect occlusal trauma-associated periodontal conditions in subjects with untreated chronic periodontitis. Chin J Dent Res. 2017;20(1):19-26. doi: 10.3290/j.cjdr.a37738

[8] Oh SL. An interdisciplinary treatment to manage pathologic tooth migration: A clinical report. J Prosthet Dent. 2011;106(3):153-8.

[9] Mihali SG, Lolos D, Bratu DC. Registration of intermaxillary relations using anterior jig compared to the classical method. Med Evol. 2022;28(3):356-65.

[10] Da Silva Martins MJ, Caramelo FJ, Ramalho da Fonseca JA, Gomes Nicolau PM. In vitro study on the sensibility and reproducibility of the new T-Scan®III HD system. Rev Port Estomatol Med Dent Cir Maxilofac. 2014;55(1):14-22. https://doi.org/10.1016/j.rpemd.2014.01.001

[11] Gjelvold B, Chrcanovic BR, Korduner EK, Collin-Bagewitz I, Kisch J. Intraoral digital impression technique compared to conventional impression technique: A randomized clinical trial. J Prosthodont. 2016;25(4):282-7.

[12] Delong R, Ko CC, Anderson GC, Hodges JS, Douglas WH. Comparing maximum intercuspal contacts of virtual dental patients and mounted dental casts. J Prosthet Dent. 2002;88(6):622-30. https://doi.org/10.1067/mpr.2002.129379

[13] Solaberrieta E, Otegi JR, Goicoechea N, Brizuela A, Pradies G. Comparison of a conventional and virtual occlusal record. J Prosthet Dent. 2015;114(1):92-7. https://doi.org/10.1016/j.prosdent.2015.01.009

[14] Alghazzawi TF. Advancements in CAD/CAM technology: options for practical implementation. J Prosthodont Res. 2016;60(2):72-84. https://doi.org/10.1016/j.jpor.2016.01.003

[15] Luo Q, Ding Q, Zhang L, Xie QF. Quantitative analysis of occlusal changes in posterior partial fixed implant-supported prostheses. J Peking Univ Health Sci. 2019;51(6):1119-23. https://doi.org/10.19723/j.issn.1671-167X.2019.06.025

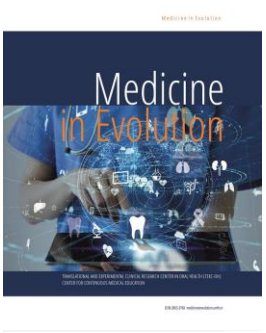
[16] Patzelt SBM, Lamprinos C, Stampf S, Att W. The time efficiency of intraoral scanners. J Am Dent Assoc. 2014;145(6):542-51. https://doi.org/10.14219/jada.2014.23

[17] Staderini E, Guglielmi F, Cornelis MA, Cattaneo PM. Three-dimensional prediction of roots position through cone-beam computed tomography scans digital model superimposition: A novel method. Orthod Craniofac Res. 2019;22(1):16-23. https://doi.org/10.1111/ocr.12252

[18] Cicciù M, Fiorillo L, D'Amico C, Gambino D, Amantia EM, Laino L. 3D digital impression systems compared with traditional techniques in dentistry: A recent data systematic review. Materials (Basel). 2020;13(8):1982. https://doi.org/10.3390/ma13081982

[19] Alghazzawi TF. Advancements in CAD/CAM technology: options for practical implementation. J Prosthodont Res. 2016;60(2):72-84. https://doi.org/10.1016/j.jpor.2016.01.003
[20] Delong R, Ko CC, Anderson GC, Hodges JS, Douglas WH. Comparing maximum intercuspal contacts of virtual dental patients and mounted dental casts. J Prosthet Dent. 2002;88(6):622-30. https://doi.org/10.1067/mpr.2002.129379
[21] Costalos PA, Sarraf K, Cangialosi TJ, Efstratiadis S. Evaluation of the accuracy of digital model analysis for the American Board of Orthodontics objective grading system for dental casts. Am J Orthod Dentofac Orthop. 2005;128(5):624-9. https://doi.org/10.1016/j.ajodo.2004.08.017
[22] Revilla-León M, Kois DE, Kois JC, et al. An overview of the digital occlusion technologies: Intraoral scanners, jaw tracking systems, and computerized occlusal analysis devices. J Esthet Restor Dent. Forthcoming;35(5):735-44. doi: 10.1111/jerd.13044
[23] Kim JE, Park JH, Shim JS, et al. Complete assessment of occlusal dynamics and establishment of a digital workflow by using target tracking with a three-dimensional facial scanner. J Prosthodont Res. 2019;63(1):120-4. doi: 10.1016/j.jpor.2018.10.003
[24] Jeong MY, Lim YJ, Kwon HB, et al. Comparison of two computerized occlusal analysis systems for indicating occlusal contacts. J Adv Prosthodont. 2020;12(2):49-54. doi: 10.4047/jap.2020.12.2.49
[25] Dias RAB, Rodrigues MJP, Manfredini D, et al. Comparison between conventional and computerized methods in the assessment of an occlusal scheme. J Oral Rehabil. Forthcoming;47(2):221-8. doi: 10.1111/joor.12905
[26] Mangano F, Gandolfi A, Luongo G, Logozzo S. Intraoral scanners in dentistry: a review of the current literature. BMC Oral Health. 2017;17:149. Available from: https://pubmed.ncbi.nlm.nih.gov/24660642/
[27] Carossa S, Lojacono A, Schierano G, Pera P. Evaluation of occlusal contacts in the dental laboratory: influence of strip thickness and operator experience. Int J Prosthodont. 2000;13(3):201-4.
[28] Michelinakis G, Apostolakis D, Tsagarakis A, Kourakis G, Pavlakis E. A comparison of accuracy of 3 intraoral scanners: A single-blinded in vitro study. J Prosthet Dent. 2020;124(5):581-8. doi: 10.1016/j.prosdent.2019.10.023.
[29] Amornvit P, Rokaya D, Sanohkan S. Comparison of accuracy of current ten intraoral scanners. Biomed Res Int. 2021;2021:2673040. doi: 10.1155/2021/2673040.
[30] Revilla-León M, Kois DE, Zeitler JM, Att W, Kois JC. An overview of the digital occlusion technologies: Intraoral scanners, jaw tracking systems, and computerized occlusal analysis devices. J Esthet Restor Dent. 2023;35(5):735-44. doi: 10.1111/jerd.13044.
[31] Abduo J, Elseyoufi M. Accuracy of intraoral scanners: A systematic review of influencing factors. Eur J Prosthodont Restor Dent. 2018;26(3):101-21. doi: 10.1922/EJPRD_01752Abduo21.

The Influence of Cavity Preparation Method on Children's Dental Anxiety: A Questionnaire-Based Study



Andreea Igna[1], Raluca Răscăcea[2], Magda-Mihaela Luca[1], Andrada-Nicoleta Nikolajevic-Stoican[1], Eduard Andrei Văcăreţu[3], Roxana Buzatu[4], Mălina Popa[1]

[1]Department II, Pediatric Dentistry Research Center, Pedodontics University Clinic, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania
[2]student - Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania;
[3]Department II, Pediatric Dentistry resident, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania;
[4]Department I, Dental Esthetics University Clinic, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania

Correspondence to:
Name: Magda-Mihaela Luca
E-mail address: luca.magda@umft.ro

Received: 25 November 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

Dental anxiety negatively influences children's behaviour in the dental office. Aim and objectives: This study aims to compare anxiety level of children during cavity preparation done by conventional rotary method vs. an atraumatic method. Material and methods: 24 patients treated in the University Clinic of Pediatric Dentistry from Timisoara for dental caries, aged between 6 and 12 years, of both sexes, in which cavity preparation was done via conventional method, using rotary instrumentation, or by atraumatic method, using chemo-mechanical manual instrumentation, participated to the study. The patients were asked to complete the DFS (Dental Fear Survey) questionnaire following the procedure, to assess dental anxiety. The answers, representing a numerical scale, were statistically analysed using the Mann-Whitney U and Kolmogorov-Smirnov tests. Results: The results of the statistical analysis revealed significant differences ($p < 0.05$) between the treatment groups regarding dental anxiety. However, there were no statistically significant differences among different age groups or between sexes ($p > 0.05$). Conclusions: The findings of this study suggest that the use of the chemo-mechanical method for cavity preparation reduces dental anxiety in children, while patient's age and gender do not influence significantly dental anxiety levels.

Keywords: dental anxiety, cavity preparation, rotary, chemo-mechanical

INTRODUCTION

Dental anxiety negatively influences children's behaviour in the dental office, therefore behaviour management of anxious patients is a real challenge in everyday pedodontic practice. It is well known that one of the main reasons why a parent postpones a child's visit to the dentist is the fear generated by the dental environment, both for the parent and the child. The main fears related to dental treatments are triggered by pain, loud sounds and specific smells of materials or solutions used [1,2]. Anxiety and fear responses are common in dental settings, with varying levels of intensity. Approximately 5% of individuals in studied populations experience phobic reactions, which may lead them to avoid dental treatment despite having oral health issues [3,4]. Dental anxiety is frequently seen among 3- to 18-year-olds globally, occurring more frequently in school-aged and preschool children compared to adolescents [4].

The widespread interest in the complex correlation between dental conditions and dental anxiety reflects the significant psychosocial impact that fear-related factors can have on a child's behaviour during dental treatments. These fears are psychological, emotional and cognitive in nature and can even be linked to physiological changes in children as they go through different stages of development [1,5-7].The nature of these fears does not depend only on the age of the child, but can be correlated with intrinsic and extrinsic factors associated with the family and socio-cultural environment such as the influence and experiences of the parents, especially their anxiety, education and socioeconomic status, ethnicity and culture, or the number of siblings. Furthermore, the clinical environment, personal traits, general anxiety and psychological status play a role in manifesting dental anxiety [8-10]. On the other hand, dental anxiety is also in close connection to previous experiences in a dental office. High levels of dental anxiety are noted among children on their first visit to the dentist, which are then expected to decrease with more dental visits, hence having experienced more dental treatments [10,11]. Moreover, the time-frame between the last dental visit and the current one may have a significant impact on maintaining a dental fear and anxiety state during appointments, especially when they are at a long time apart. Armfield et al. observed that children who attend sporadically, often presenting with pain and requiring urgent dental care, report elevated levels of dental anxiety. This pattern of irregular attendance and reactive care can create a vicious cycle, perpetuating and exacerbating long-term anxiety issues [12]. Poor oral health also plays a significant role in initiating dental fear and anxiety in children, especially pre-school children and pre-adolescents [13]. Taking all the above-mentioned aspects into consideration, we can state that the ethology of dental anxiety is multifactorial. Therefore, specialists who treat children and adolescents must carry out a complex assessment of the patient in relation to personal, social and environmental aspects, to gain more knowledge about the individual patient [12] in order to select appropriate behaviour management techniques as well as treatment methods that would minimize discomfort.

Behavioral management is widely recognized as a key element in providing dental treatments for pediatric patients. Before starting the actual pediatric dental treatment, assessing the level of fear and anxiety can aid in managing behavioral issues associated with dental care and make the visit more efficient [14,15]. Tracking the prevalence of dental anxiety is highly beneficial for organizing dental services that prioritize patient comfort and well-being [4]. When managing anxious children, dentists and other professionals need to evaluate the child’s condition and identify the intensity and source of their anxiety, to devise an effective management strategy that facilitates the necessary dental treatment. The initial steps in this process include carefully observing the child’s behavior and physical state,

asking sensitive questions about their feelings and past experiences, and interviewing parents as an additional source of information. This multi-faceted approach aligns with established diagnostic principles, leveraging various methods to improve the accuracy of assessments and minimize misjudgements. In this regard, many reviews emphasize self-report questionnaires as the gold standard for assessing dental anxiety in pediatric patients [16].

Globally, dental caries is an ongoing public health problem, still considered the chronic disease with a high prevalence affecting the majority of children [17]. The use of rotary instruments and dental burs in the treatment of dental caries is a well-known source of dental anxiety, due to the vibrations and noise triggered by the handpiece, and potentially also pain. In recent decades, advances in cariology and dental materials have brought new approaches in dentistry to the treatment of caries [18,19]. Chemo-mechanical caries removal (CMCR) is a minimally invasive method that uses a chemical agent to remove infected dentin. This technique avoids pulp irritation and patient discomfort while removing infected tissue and maintaining healthy tooth structure. This method of caries removal uses dissolution instead of rotary drilling and chemical agents along with atraumatic mechanical force to remove the infected dentin [19,20]. In clinical practice, CMCR was proven effective in diminishing anxiety in children treated by this method [21].

Aim and objectives

The present study aims to assess the anxiety level in 6-12 years old children, during treatment of dental caries. The anxiety of children treated by two different methods of cavity preparation – the conventional rotary method and the chemo-mechanical atraumatic method is assessed in relation to sex and age of the children.

MATERIAL AND METHODS

The target population of the study was represented by paediatric patients aged between 6 and 12 years, treated for dental caries in the Pediatric Dentistry University Clinic of the" Victor Babeş" University of Medicine and Pharmacy from Timişoara, Romania. Inclusion criteria were: patients aged 6-12 years, both sexes, patients with simple caries in primary and/or permanent teeth, patients in which caries excavation was done by conventional rotary method, and/or by atraumatic chemo-mechanical method, patients with dental anxiety, patients who have the ability to understand the questions from the given questionnaires. Exclusion criteria were: patients outside the mentioned age range, patients with complicated caries, totally uncooperative patients, patients that could not comprehend the questions from the given questionnaires.

The present work is a non-interventional, observational study that analyses the relationship between dental anxiety and the two preparation techniques, considering two variables: age and sex of the children. A total of 24 patients, 13 girls and 11 boys participated in the study. They were divided in two groups, based on the cavity preparation method used: Group 1 – patients in which the cavity preparation was done via the conventional method, using rotary instrumentation – low speed handpiece and round carbide burs, and Group 2 – patients in which the cavity preparation was done atraumatically, via the chemo-mechanical method, using enzymatic gels and manual excavation. The preparation method used was selected for the patient by the attending pediatric dentist, based on behaviour assessment from previous dental visits, uninfluenced by the present study. Following the procedure, the patients were asked to complete a questionnaire regarding anxiety felt during the treatment. Informed consent was obtained from the parents of the respondents for the application of the questionnaire.

Data collection was performed by applying a questionnaire, based on the Dental Fear Survey (DFS) imagined by Ronald A. Kleinknecht. The DFS was translated to romanian and adapted for the target population, for an easy understanding. The DFS is composed of 12 questions, out of which 7 assess fears of specific stimuli/situations and the remaining 5 assess patients' physiological arousal. Each question has 5 answer options, which represent a scale from 1 to 5 with the following significance: ”never” – 1, ”once or twice – 2, ”a few times” – 3, ”often” – 4, ”nearly every time” – 5 (22).

The research assumed the validation of the following research hypotheses:

1: The chemo-mechanical preparation method significantly reduces dental anxiety compared to the conventional method.

2: Dental anxiety levels are lower in older children, regardless of the preparation method used.

3: Girls present higher levels of dental anxiety compared to boys, regardless of the preparation method used.

In this study, the statistical analysis of data was performed with IBM SPSS v.20 statistical software. Two statistical tests were used: Mann-Whitney U and Kolmogorov-Smirnov to evaluate and compare the impact of the chemo-mechanical method and the conventional method of carious cavity preparation on dental anxiety in children. The statistical significance level was considered to be the *p*-value of 0.05.

RESULTS

In the first stage of the statistical analysis, the homogeneity of the research groups was verified, by applying Levene's test. This test is most commonly used to assess the homogeneity of variances between two or more groups. The results indicate that the variances for all categories are homogeneous in both groups (G1 and G2) – Figure 1. This suggests that the distributions of anxiety responses are similar in terms of variances between groups, allowing a valid comparison between groups within the performed statistical analyses.

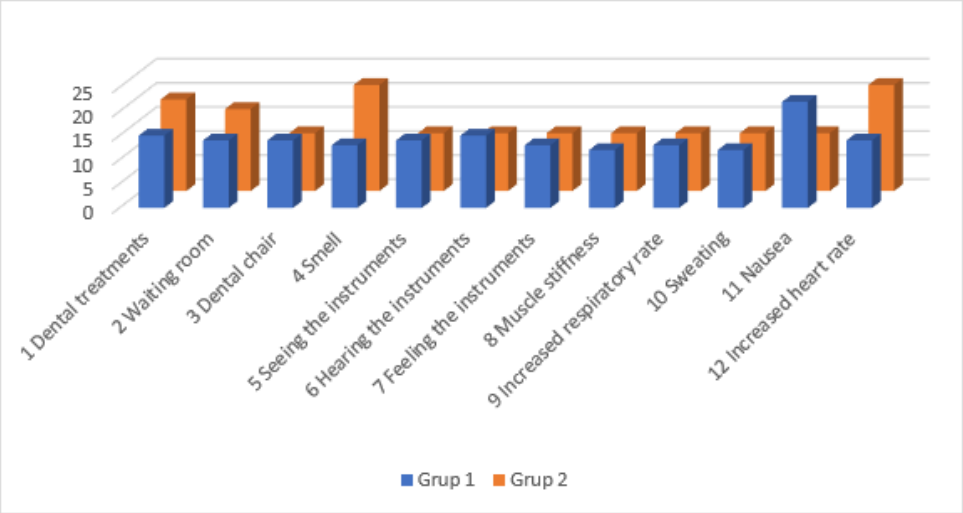


Figure 1. Variance of the answers to the 12 questions between the two groups: Group 1 – conventional rotary preparation method, Group 2 – chemo-mechanical manual preparation method

The results of the comparative analyses between the responses of the patients in the two groups, performed using the Mann-Whitney U și Kolmogorov-Smirnov statistical tests, indicate that for most categories (excepting the score 3 - "A few times"), there are statistically

significant differences ($p < 0.05$) – Table 1 and 2. This suggests that the perception of the preparation method differs significantly between Group 1 and Group 2. Regarding the considered variables – age and sex of the subjects, there are no statistically significant differences between the answers to the questions analyzed, neither according to the age categories ($p > 0.05$), nor according to sex categories $p > 0.05$), for both groups (Group 1 and 2).

Table 1. Results of Mann-Whitney U test

Category	U Statistic	p-value
a) Never	10.0	0.000169
b) Once or twice	1.0	0.000034
c) A few times	42.0	0.080216
d) Often	144.0	0.000023
e) Nearly every time	138.0	0.000032

Table 2. Results of Kolmogorov-Smirnov test

Category	D Statistic	p-value
a) Never	0.75	0.001497
b) Once or twice	0.916667	0.000018
c) A few times	0.416667	0.255775
d) Often	1.0	0.000001
e) Nearly every time	0.916667	0.000018

DISCUSSIONS

In this study, the impact of two different preparation methods (conventional and chemo-mechanical) on the dental anxiety in children was evaluated comparatively. The influence of age and gender on the levels of dental anxiety in this context was also analysed.

Regarding the first research hypothesis, according to which the chemo-mechanical preparation method significantly reduces dental anxiety compared to the conventional method, the results showed statistically significant differences between the responses of the two groups for most categories (Table 1 and Table 2) This suggests that the chemo-mechanical method has a significant positive impact on reducing dental anxiety. Thus, this hypothesis is validated by the obtained data.

For the second hypothesis, which states that the levels of dental anxiety are lower in older children, regardless of the treatment method, results of the Mann-Whitney U test were not statistically significant for any of the questions analysed, across all ages. This suggests that age does not significantly influence levels of dental anxiety, contrary to the original hypothesis and to other studies that found increased anxiety levels in younger children [23]. In contrast, some authors suggest that dental anxiety tends to increase with age [24,25]. This finding may be attributed to confounding factors, such as a higher likelihood of previous painful dental experiences over time [10].

Regarding the third hypothesis, which assumes that girls show higher levels of dental anxiety compared to boys, regardless of the treatment method used, the results of the gender-specific Kolmogorov-Smirnov test for both groups showed no statistically significant differences between children's responses by gender for each response category. This suggests that gender does not significantly influence the perception of dental anxiety, contrary to the original hypothesis, and to other studies that reported increased anxiety levels in female patients [26,27], or in male patients [23], but in accordance with Popescu et al. [28] who reported no differences between genders for a Romanian population as well.

Within this research, several limitations were identified that could influence the interpretation of the results and their applicability in clinical practice. The small sample size

limits the extrapolation of the results to a wider population. Future studies should include a larger number of participants to obtain more robust and representative data. Participants were selected from a single clinic, which may introduce a selection bias. Extending the study to multiple locations and including a diverse sample could improve the external validity of the results. Assessment of dental anxiety was based on patient self-report questionnaires, which may introduce subjectivity and variability in responses. Especially in young children, the level of understanding and ability to accurately communicate their emotions can vary considerably. Using additional objective methods, such as measuring heart rate or cortisol levels, could provide a more accurate assessment of anxiety. By addressing these limitations, future research can contribute to a better understanding of dental anxiety in children and to the development of more effective strategies for its management in pediatric dental practice.

In today's pediatric dentistry, there is an increased preoccupation for the patient's comfort during the procedures. In this regard, minimally invasive techniques are gaining more and more interest. The CMCR method is comfortable for patients, reducing pain and anxiety, as well as the need for local anaesthetic. In current pediatric dental practice, the CMCR method considered a viable alternative to the conventional caries removal method, despite the longer duration of the treatment and higher costs [20].

A study published in 2019 [29] evaluated and compared the difference between the chemo-mechanical method (with Brix 3000) and the rotary method (with a ceramic bur) for the removal of dental caries. The mentioned study included an anxiety rating scale (during and after treatment). The study examined a sample of thirty children between the ages of eight and twelve who had bilaterally cavitated carious permanent molars. During treatment with the rotary tool (ceramic bur), the children showed a deterioration in their behaviour from positive to negative. In contrast, in the Brix 3000 group there was no change in the children's behaviour during treatment. The results of this study showed that the chemo-mechanical method had a beneficial impact on the behavioural management of the participating children, being consistent with the results obtained in the present study. Another study, published in 2021 by Lazarova et al. [30], concluded that children's age does not determine differences in the level of fear; Similar to our results, they found that cavity excavation in combination with enzyme-based gel reduces fear of dental treatment in children compared with conventional treatment by drilling with rotary instruments.

CONCLUSIONS

The findings of this study suggest that the use of the chemo-mechanical method for cavity preparation reduces dental anxiety in children, while patient's age and gender do not influence significantly dental anxiety levels.

Widespread implementation of the chemo-mechanical method in pediatric dental practice could significantly contribute to the reduction of dental anxiety, thus improving the experience of children in the dental office. Further research is also recommended to better understand the factors influencing dental anxiety and to develop tailored interventions for different patient groups.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] De Menezes Abreu DM, Leal SC, Mulder J, Frencken JE. Dental anxiety in 6-7-year-old children treated in accordance with conventional restorative treatment, ART and ultra-conservative treatment protocols. Acta Odontol Scand. 2011;69(6).

[2] Themessl-Huber M, Freeman R, Humphris G, MacGillivray S, Terzi N. Empirical evidence of the relationship between parental and child dental fear: A structured review and meta-analysis. Int J Paediatr Dent. 2010;20(2).

[3] Armfield JM, Ketting M. Predictors of dental avoidance among Australian adults with different levels of dental anxiety. Heal Psychol. 2015;34(9).

[4] Grisolia BM, dos Santos APP, Dhyppolito IM, Buchanan H, Hill K, Oliveira BH. Prevalence of dental anxiety in children and adolescents globally: A systematic review with meta-analyses. Int J Paediatr Dent. 2021;31(2).

[5] Carrillo-Diaz M, Crego A, Armfield JM, Romero-Maroto M. Assessing the relative efficacy of cognitive and non-cognitive factors as predictors of dental anxiety. Eur J Oral Sci. 2012;120(1).

[6] Versloot J, Veerkamp J, Hoogstraten J. Dental anxiety and psychological functioning in children: its relationship with behaviour during treatment. Eur Arch Paediatr Dent. 2008;9 Suppl 1.

[7] Gao X, Hamzah SH, Yiu CKY, McGrath C, King NM. Dental fear and anxiety in children and adolescents: Qualitative study using youtube. J Med Internet Res. 2013;15(2).

[8] Abanto J, Vidigal EA, Carvalho TS, de Sá SNC, Bönecker M. Factors for determining dental anxiety in preschool children with severe dental caries. Braz Oral Res. 2017;31.

[9] Busato P, Garbin R, Santos C, Paranhos L, Rigo L. Influence of maternal anxiety on child anxiety during dental care: cross-sectional study. Sao Paulo Med J. 2017;135(2).

[10] Alasmari AA, Aldossari GS, Aldossary MS. Dental anxiety in children: A review of the contributing factors. J Clin Diagnostic Res. 2018;12(4).

[11] El-Housseiny AA, Merdad LA, Alamoudi NM, Farsi NM. Effect of child and parent characteristics on child dental fear ratings: Analysis of short and full versions of the children's fear survey schedule-dental subscale. J Oral Heal Dent Manag. 2015;14(1):9–16.

[12] Shindova MP, Belcheva AB. Dental Fear and Anxiety in Children: a Review of the Environmental Factors. Folia Med (Plovdiv). 2021;63(2).

[13] Nicolas E, Bessadet M, Collado V, Carrasco P, Rogerleroi V, Hennequin M. Factors affecting dental fear in French children aged 5-12 years. Int J Paediatr Dent. 2010;20(5).

[14] Preda DM, Dragnea (Bărîcă) A, Dănilă DI, Muntean A. Child behavior management technology in pediatric dentistry. Review of non-pharmacological techniques. Psihiatru.ro. 2022;2(69).

[15] Ummat A, Dey S, Anupama Nayak P, Joseph N, Rao A, Karuna YM. Association between dental fear and anxiety and behavior amongst children during their dental visit. Biomed Pharmacol J. 2019;12(2).

[16] Margraf-Stiksrud J, Pieper K. Assessment of Dental Anxiety in Children: Reliability and Validity of the Questionnaire to Assess Dental Anxiety in Children (QADA-C). Dent J. 2024;12(2).

[17] Mahdi M, Ismail M, Haidar A, Al Haidar MJ. Evaluation of the Efficacy of Caries Removal Using Papain Gel (Brix 3000) and Smart Preparation Bur(in vivo Comparative Study). 2019;11(2):444–9.

[18] Alia S, Khan SA, Navit S, Sharma A, Jabeen S, Grover N, et al. Comparison of pain and anxiety level induced by laser vs rotary cavity preparation: An in vivo study. Int J Clin Pediatr Dent. 2020;13(6).

[19] CK Y, MF B. Caries management: A journey between Black's principles and minimally invasive concepts. . Int J Dent Oral Sci. 2015;2:120–5.

[20] Maashi MS, Elkhodary HM, Alamoudi NM, Bamashmous NO. Chemomechanical caries removal methods: A literature review. Saudi Dent J. 2023;35(3).

[21] Hemalatha R, Nirmala S, Viswaja K. Anxiety Perception Among Children Following Two Different Restorative Modalities – A Noninferiority Randomized Clinical Trial. J Prim Care Spec. 2022;3(3).

[22] Milgrom P, Kleinknecht RA, Elliott J, Hsing LH, Choo-Soo T. A cross-cultural cross validation of the dental fear survey in South East Asia. Behav Res Ther. 1990;28(3).

[23] Klingberg G, Broberg AG. Dental fear/anxiety and dental behaviour management problems in children and adolescents: A review of prevalence and concomitant psychological factors. Int J Paediatr Dent. 2007;17(6).
[24] Akbay Oba A, Dülgergil ÇT, Şaroğlu Sönmez I. Prevalence of dental anxiety in 7- to 11-year-old children and its relationship to dental caries. Med Princ Pract. 2009;18(6).
[25] Rantavuori K, Hausen H, Tolvanen M, Lahti S, Seppä L. Factors associated with different measures of dental fear among children at different ages. J Dent Child. 2009;76(1).
[26] White AM, Giblin L, Boyd LD. The Prevalence of Dental Anxiety in Dental Practice Settings. J Dent Hyg JDH. 2017;91(1).
[27] Peretz B, Nazarian Y, Bimstein E. Dental anxiety in a students' paediatric dental clinic: Children, parents and students. Int J Paediatr Dent. 2004;14(3).
[28] Popescu SM, Dascălu IT, Scrieciu M, Mercuț V, Moraru I, Țuculină MJ. Dental Anxiety and its Association with Behavioral Factors in Children. Curr Heal Sci J. 2014;40(4).
[29] Ismail MMM, Al Haidar AHMJ. Impact of Brix 3000 and conventional restorative treatment on pain reaction during caries removal among group of children in Baghdad city. J Baghdad Coll Dent. 2019;31(2).
[30] Lazarova Z, Tankova H, Rashkova M. Fear Assessment With the 'Draw a Person' Test of the Dental Treatment in Sparing Enzyme-Based Excavation of Caries in Children Between 4 and 6 Years of Age. J IMAB. 2021;27(4):4043–7.

Influence of the COVID-19 Pandemic on the Occurrence of Somatization Disorders in Students.

Andreea Sălcudean[1], Laria-Maria Trusculescu[2], Vlad Birta[3], Cristina Raluca Bodo[1], Dora Mihaela Cimpian[4], Andreea Andreea Sasu[4], Andreea Georgiana Nan[4], Maria Melania Cozma[1], Elena Gabriela Strete[5]

[1]Department of Bioethics, Social and Human Sciences, University of Medicine and Pharmacy, Science and Technology George Emil Palade of Targu Mures, Gheorghe Marinescu Street No. 38, 540142 Targu Mures, Romania
[2]Department of Management and Communication in Dental Medicine, Department 1, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy of Timisoara, Square Eftimie Murgu, No. 2, 300041, Timișoara, Romania
[3]Mures County Hospital, 540072, Targu-Mures, Romania
[4]Mures County Hospital, Psychiatric Clinic 1, 540072, Targu-Mures, Romania
[5]Department of Psychiatry, Faculty of Medicine, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Gheorghe Marinescu Street No. 38, 540142 Targu Mures, Romania

Correspondence to:
Name: Cristina Raluca Bodo
E-mail address: cristina.bodo@umfst.ro

Received: 3 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

In the past psychosomatic illnesses have been seen as the consequences of primary psychological disorders. Lacking confidence in this causal model, many prefer Engel's biopsychosocial model which refers to the circular interaction between body, soul and environment. This model is in agreement with neuropsychoimmunological theories of the body's feedback loops that include emotions and behavior.

Many clinicians re-frame somatization as a psychopathology and use the biopsychosocial model as a basis for directing attention to the patient's personality traits and life context. Some consider that the role of the clinician is to emphasize the links between symptoms and external stressors and how these lead to psychophysiological changes.

Keywords: somatization, COVID – 19, pandemic, students

INTRODUCTION

Somatization is defined as a wide range of somatic complaints that lead patients to believe that they are suffering bodily, despite demonstrable emotional or psychosocial problems, and that it is not possible to define clearly under these conditions. The patient's belief is that their suffering has its origin in a definable illness which causes them to seek medical help and which induces disability and handicap [1;2].

The DSM-IV manual emphasizes as a common feature of somatoform disorders the existence of physical symptoms, which indicate an internal medicine disorder, but which cannot be fully explained by a general medicine illness, another mental disorder, or the direct effects of a substance. In contrast to simulation, somatic symptoms are not under voluntary control. The difference between somatoform disorders and mental symptoms from a medical pathology is the lack of a medical condition responsible for the patient's symptoms. The common denominator of this condition is considered to be undue bodily discomfort that is produced by psychological, psychiatric or social problems. In a bizarre way the functional symptoms of somatization are a considerable public health problem because they are among the leading causes of work and social disability. Equally problematic is that these patients with relapsing symptoms and no medical explanation are thoroughly investigated, hospitalized and exposed to invasive diagnostic procedures, costly treatments that can lead to iatrogenic illnesses possibly more serious than the illnesses they previously suffered from [2].

In the general population, the frequency of somatization is estimated to be in the range of 0.1-0.5%, with a female to male ratio of 5 to 20, with the possibility that the male sex is under-diagnosed by physicians, resulting in an indicative ratio [3].

Some studies report more frequent reports of somatoform symptoms in isolated rural individuals working in modest or unsupportive institutions [2].

While the ethology of somatization disorders remains unclear, several possible risk factors have been uncovered, including female gender, low socioeconomic status, financial problems, substance use, neuroticism, and a link to other mental illnesses (especially depression) [4]. Often a patient with somatization will refuse to accept the possibility that they are depressed or anxious or that their emotional distress is based in physical distress or disability. The patient's accusations should not be considered sufficient for a diagnosis and therefore evidence should be sought to support the diagnosis of depression and associated symptoms such as: loss of interest and pleasure in daily activities, poor eating and libido, insomnia, lack of energy, initiative and ambition, difficulty concentrating and memory, underestimation, pessimism and feelings of guilt and failure. Anxiety disorders present as marked and unfounded worry in varying degrees and can occur at any time or only in specific situations that the patient avoids. Common physical symptoms accompanying anxiety may include: retrosternal pain, dizziness, shortness of breath, palpitations, fatigue, tingling sensations, trembling. Some symptoms may be the result of hyperventilation, a common symptom in both acute and chronic forms of anxiety [5].

Somatization can amplify any of the symptoms outlined above, leading to fear or belief that the patient has a condition such as heart disease. This belief may be so strong that it remains even after thorough investigations have ruled out the diagnosis of heart disease [5].

Typically, patients with somatization disorders tend to change doctors frequently due to lack of diagnosis and lack of credibility. In the case of a single doctor, this may also be the family doctor. The doctor should empathize with the patient and give the patient the opportunity to present their symptoms, but in short pre-scheduled and regular visits with the examination focused on the newly emerging symptoms. In principle, paraclinical investigations should be avoided due to lack of relevant findings [3].

Adjuvant modalities include individual psychotherapy, psychodynamic or cognitive-behavioral therapy, or group therapy. In addition to risk factors including psychological strain and stressful life events, not only a high frequency of somatization, but also a link between somatization and academic stress, as well as an intensification of somatization and academic stress in the pre-exam period, was observed among medical students. The main factors mentioned by students include: fear of failure, inability to catch up if they fall behind, the amount of information they have to retain, competition between students, academic overload, financial problems, performance pressure and lack of time for learning. In addition to these, a high frequency of depression, anxiety and burnout has been found among medical students in many countries around the world [4].

To test whether somatization has an impact on general medical students or affects other categories of students, we also studied dental students. Studies have found a higher prevalence of anxiety, depression, burnout, depersonalization, exhaustion and high alcohol consumption in dental students than in general medical students [4].

Often a patient with somatization will refuse to accept the possibility that he or she is depressed or anxious, or that the emotional distress is based on physical distress or disability [5,6]. Anxiety disorders present as marked and unfounded worry in varying degrees and can occur at any time or only in specific situations that the patient avoids. Common physical symptoms accompanying anxiety may include: retrosternal pain, dizziness, shortness of breath, palpitations, fatigue, tingling sensations, trembling. Some symptoms may be the result of hyperventilation, a common symptom in both acute and chronic forms of anxiety [7].

Typically, patients with somatization disorders tend to change doctors frequently due to lack of diagnosis and lack of credibility. In the case of a single doctor, this may also be the family doctor [8].

Adjuvant modalities include individual psychotherapy, psychodynamic or cognitive-behavioral therapy, or group therapy. In some cases, psychotropic drug therapy may be particularly helpful in the presence of a concurrent anxiety or depressive disorder [9].

Stress-related somatization among medical students may be exacerbated by the large amount of clinical knowledge they accumulate during their undergraduate studies [10,11]. To test whether somatization has an impact on general medical students or affects other categories of students, we also studied dental students. Studies have found a higher prevalence of anxiety, depression, burnout, depersonalization, exhaustion and high alcohol consumption in dental students than in general medical students [4].

Research conducted in China, at the height of COVID-19, showed an increased prevalence of psychological distress in society. Levels of indicators of somatization, anxiety and distress showed moderate increases after the onset of COVID-19-specific clinical symptoms, suggesting the experience of severe illness [12]. The study revealed that even young COVID-19 patients with attenuated symptoms and a modest course could experience side effects such as anxiety, discomfort, somatization and other complaints [13].

Management of somatization has been difficult due to the impact that the pandemic has brought with increased psychological stress, which has been maintained by factors such as isolation at home, social distancing, financial problems, reduced physical activity, etc. The approach to this situation is cognitive-behavioral therapy which has proven helpful in eliminating harmful habits, an evolution of self-care and self-compassion [14,15]. Pharmacological therapy involves the use of antidepressants, hypnotics and sedatives, with benzodiazepines proving effective. In addition to those mentioned above, meditation, mindfulness-based cognitive therapy sessions, positive emotions and relaxation training are also indicated [16,17].

MATERIAL AND METHODS

To conduct the study, we disseminated an online questionnaire with a total of 22 single and multiple choice questions. The interval in which it could be completed was from March 13, 2024 to May 17, 2024.

The study included a total of 91 people, the selection criterion being the affiliation to the Faculty of Medicine of the "George Emil Palade" University of Medicine, Pharmacy, Science and Technology "George Emil Palade" in Târgu Mureş.

RESULTS

The predominant age of those who filled in the questionnaire is 24 years of age, 29.7% of them. The second highest percentage is 19.8% for 25 year olds, followed by 23 year olds (18.7%), then those over 25.

The response variants were structured into individual years in order to differentiate individuals according to their possible age in college due to the inclusion criterion of student status.

The final results reveal the female gender as predominant in a percentage of 59.3%, while men are only 40.7%.

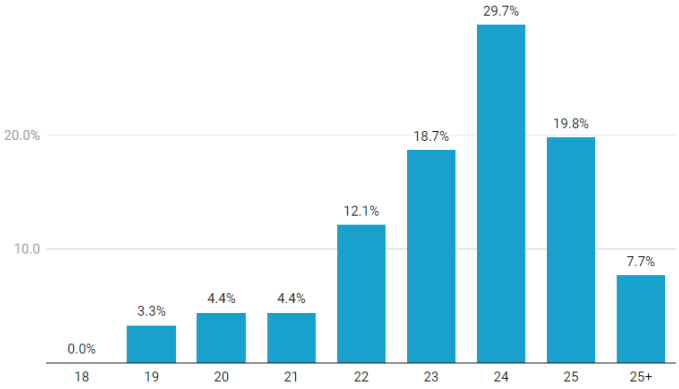


Figure 1. Distribution of responses by age

The prevalence of somatization is known to be higher among women than men.

Most of those who took part in the study are in the sixth year of university (41.8%), followed by the fifth year (35.2%), and the fourth year (8.8%), the first year (5.5%), and finally the third and second years are equal (4.4%).

Figure 2. Distribution of responses by academic year

80.2% of the participants reported the presence of symptoms of a disease, while 19.8% denied the presence of symptoms of a pathology.

The predominance of algic symptoms in a percentage of 54.9% are followed by gastrointestinal symptoms which are in a proportion of 45.1%. These two groups were the most representative symptom groups in the study being followed by the other groups that

had a much lower prevalence: sexual symptoms (25.3%), pseudoneurological symptoms (14.3%) and other symptom groups (18.7%).

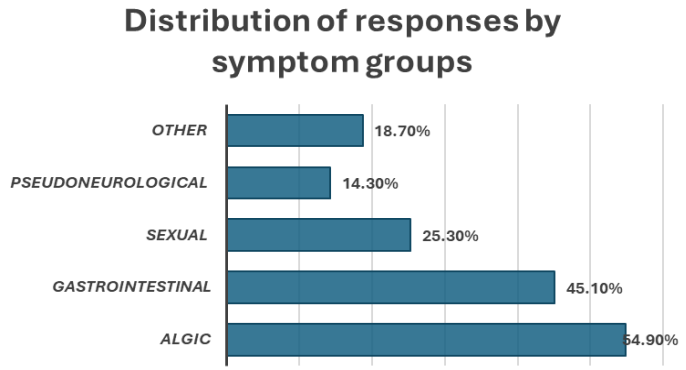


Figure 3. Distribution of responses by symptom groups

Of those with symptoms 72.5% used the internet to search for the symptoms they were experiencing in order to define a pathology they considered they were suffering from, and the other 27.5% did not use external sources for self-diagnosis. Due to the discomfort and stress induced by the symptoms almost three quarters of the study participants self-examined their body while 26.4% did not do so. Taking into account that the participants are medical students we assumed that having contact with various pathologies may be a cause of turning information into physical symptoms. 52.7% of them stated as the cause of the symptoms the disease studied in the faculty and the remaining 47.3% said no. In the end, the two answers are in similar proportions which cannot substantially confirm, but neither substantially disprove the hypothesis of the cause of symptoms in medical students, however, the balance is tipped more towards an endorsement of the hypothesis. Almost two thirds (62.6%) denied a dissatisfaction/ lack of confidence in the medical act for a diagnosis that encompasses the symptoms manifested, and 37.4% were not reconciled with the medical evaluation that was performed. Among those who disagreed with the medical act in view of their symptoms 43.6% had performed tests and investigations more than once, 41% had asked for the expertise of several doctors for their allegations, 15.4% had performed a prolonged treatment beyond the period prescribed by the attending physician, and 5.1% had used other medication without prescription in the hope of a different outcome. Dissatisfaction with the medical evaluation caused various negative feelings in patients. The feeling with the highest prevalence was insecurity with a percentage of 58.7%, followed by frustration with 41.3%, anxiety with 39.1%, fear with 23.9%, anger with 13%, injustice with 10.9% and disappointment with 2.2%.

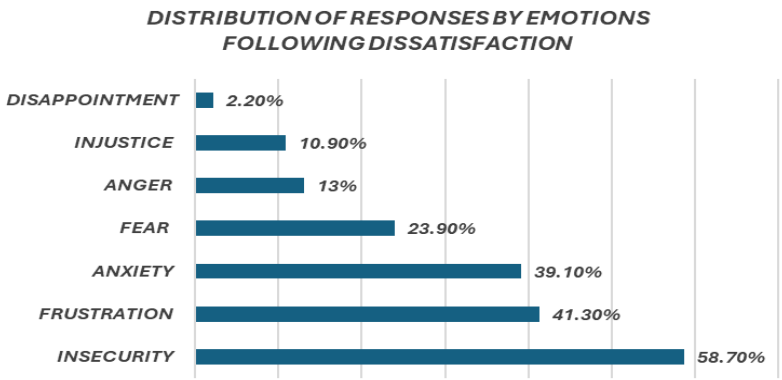


Figure 4. Distribution of responses by emotions following dissatisfaction

36.3% of those who filled in the questionnaire felt misunderstood by others around them, while 63.7% did not experience this problem.47.3% of those who filled in the questionnaire had difficulties in exposing their emotions to others, while the other 52.7% denied this. One third of the participants (36.3%) refused to believe that the symptoms they have are psychologically created, while the other two thirds, 64.7%, accepted that the symptoms are psychologically caused. Nearly three quarters (73.6%) of those surveyed had been stressed recently due to personal problems, while the remaining 26.4% had not experienced any significant stress recently. The main cause of stress among the people in the study was exams for 83.8% of them, followed by family problems with 30.9%, problems in intimate life with 29.4% and illness/ death in the family. To a lesser extent we have friendships, career orientation, degree and high number of responsibilities as causes of stress, all of them with 1.5% each.

Stress is known to be a precipitating factor in the onset of somatization because the person will turn their negative feelings and emotions into physical symptoms in the absence of a present pathology.

In order to estimate the stress level at that time, we proposed five variants for stress staging.

The level of stress during that period that had the highest prevalence was level 3 which had 37.4% of people, then level 4 had 30.8%, followed by level 2 with 18.7%, level 5 with 9.9% and level 1 with only 3.3%.

During the pandemic, 30.8% of participants experienced COVID19 specific symptoms19 in the absence of a positive test for the virus, and 69.2% did not. The main source of symptoms during the pandemic was considered to be isolation at home with 40.7%, followed in descending order by the internet (34.1%), family/friends/acquaintances (26.4%), social networking (18.7%), other respiratory pathology (2.2%), and finally college stress, sedentary lifestyle and congenital pathology each with 1.1%.

DISCUSSIONS

Somatization is the presence of physical symptoms that many patients report to the doctor who, following a clinical examination, laboratory tests and other investigations cannot find a pathological cause to explain their origin. This situation increases the patient's feelings of anxiety, frustration and insecurity, resulting in frequent changes of doctor, frequent tests and investigations and investigations, which turn out to be useless because of a negative unsatisfactory outcome and additional resources and costs.

Psychological stress has a noticeable effect on people and in some individuals it can translate into physical symptoms. Students are prone to significant stress due to exams, the sheer volume information, fear of failure, academic overload, competition between pressure to perform and lack of time allocated to learning.

The pandemic had a marked impact on the population through the stress caused by information about the COVID-19 virus, a newly emerging virus that highly infectious with person-to-person transmission and which untreated. The specific symptoms of this virus were emphasized so that all people showing symptoms would be tested as soon as possible and self-isolate. Isolation at home, social distancing, lifestyle, limitation of physical, recreational and social activities and fear of the virus or passing it on to loved ones have been at the root of anxiety, personal discomfort and somatization.

A total of 91 people participated in the study by completing an online questionnaire. The objective was to follow the frequency of somatization disorders in the students in the period following the COVID-19 pandemic. Following the results 80.2% of the participants presented symptoms of which algic symptoms were predominant, followed by those

gastrointestinal and sexual symptoms. About three quarters used the internet to self-diagnose themselves on the basis of symptoms and self-examined their bodies. The 37.4% who were dissatisfied with their medical care chose to change doctors frequently and have repeated tests and investigations. Feelings predominant feelings developed were insecurity, frustration, anxiety and fear. Of those involved in the study 73.6% reported stress due to exams, family problems, couple problems and people sick/deceased family members. During the pandemic the potential sources leading to somatization symptoms were isolation at home, the internet, social networking and family and friends.

The presence of somatic symptoms among students which are a result of the transformation of psychological stress gathered both from both the academic sphere and the pandemic experience.

CONCLUSIONS

Somatization disorders still remain under-diagnosed due to the lack of clinically relevant evidence for a diagnosis following clinical examination and investigations based on self-reported symptoms. An appropriate response is for the clinician to empathize with the patient, to understand the patient's problem, and to explain the real situation in a friendly manner. If the patient does not accept that his or her symptoms have a psychological source, regular short appointments can be made to give the patient a chance to express his or her newly-emerging symptoms without further investigation. This method can reduce these patients' habit of going from one doctor to another and of having unnecessary tests and investigations, while cutting costs.

The study found that students are susceptible to mainly moderate stress, which may underlie the onset and maintenance of somatic symptoms. Exams, family and marital problems are the predominant causes of stress encountered during their studies, together with the information that medical students have acquired about various pathologies, but which they have not yet mastered sufficiently to distinguish accurately.

The COVID-19 pandemic has had a considerable impact on the entire population by inducing high psychological stress and heightened everyone's attention to the specific symptoms of the coronavirus and the fear of becoming ill for oneself or one's loved ones. The main causes of the onset of somatic symptoms during the pandemic period were isolation at home, the internet, social networks and those around (family, friends, acquaintances) disseminating information about the symptoms, effects, spread and number of people infected with the new virus.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Malterud K. [Somatization--a bad diagnosis]. Tidsskr Nor Laegeforen. 2002 Apr 30;122(11):1092.

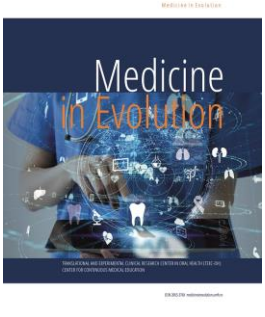
[2] Tudose F, Tudose C, Dobranici L. Psihopatologie și psihiatrie pentru psihologi. București: Infomedica; 2002. 335 p.

[3] Lazarescu M., Ladea M., Bajenaru O., Prelipceanu D., Psihiatrie clinică. Bucureşti Editura Medicală 2021; 1091 p.

[4] Feussner O, Rehnisch C, Rabkow N, Watzke S. Somatization symptoms—prevalence and risk, stress and resilience factors among medical and dental students at a mid-sized German university. PeerJ [Internet]. 2022 Aug 19 [cited 2024 Dec 1];10:e13803. Available from: https://peerj.com/articles/13803

[5] Lica MM, Papai A, Salcudean A, Crainic M, Covaciu CG, Mihai A, Assessment of Psychopathology in Adolescents with Insulin-Dependent Diabetes (IDD) and the Impact on Treatment Management. Children (Basel), 2021 May 19; 8(5): 414.
[6] Tilinca MC, Antal C, Sălcudean A, Abălaşei BL, Fărcaş RM, Groşan A, New directions in pharmacological treatment with SGLT-2 inhibitor molecules in the light of current guidelines for diabetes mellitus, heart failure and kidney disease. Farmacia, 2023; 71(4): 686–696.
[7] Lipowski ZJ. Somatization: a borderland between medicine and psychiatry. CMAJ. 1986 Sep 15;135(6):609–14.
[8] Salcudean A, Lica MM, The Role of Systemic Family Psychotherapy in Glycemic Control for Children with Type 1 Diabetes. Children (Basel), 2024 Jan 15;11(1): 104.
[9] Kalinovic R, Pascariu A, Vlad G, Nitusca D, Sălcudean A, Sirbu IO, Marian C, Enatescu VR, Involvement of the Expression of G Protein-Coupled Receptors in Schizophrenia. Pharmaceuticals (Basel), 2024 Jan 9; 17(1): 85.
[10] Sălcudean A, Nan AG, Bodo CR, Cosma MC, Strete EG, Lica MM, Association between Childhood Onset Inflammatory Bowel Disease and Psychiatric Comorbidities in Adulthood. Diagnostics, 2023 May 26; 13(11): 1868.
[11] Răchită AIC, Strete GE, Sălcudean A, Ghiga DV, Huțanu A, Muntean LM, Suciu LM, Mărginean C, The Relationship between Psychological Suffering, Value of Maternal Cortisol during Third Trimester of Pregnancy and Breastfeeding Initiation. Medicina (Kaunas), 2023 Feb 10; 59(2): 339.
[12] Sălcudean A, Ősz BE, Nan AG, Sasu AB, Cozma MM, Tilinca MC, Bocsak-Pop AR, Strete EG, The efficacy of antidepresive treatment on COVID-19 pandemic-related depressive symptoms - a prospective, single-center, questionnaire-based study. Farmacia, 2023; 71(3): 631-637.
[13] Răchită A, Strete GE, Suciu LM, Ghiga DV, Sălcudean A, Mărginean C, Psychological Stress Perceived by Pregnant Women in the Last Trimester of Pregnancy. Int J Environ Res Public Health, 2022 Jul 7;19(14):8315.
[14] Ősz BE, Jîtcă G, Sălcudean A, Rusz CM, Vari CE. Benzydamine-An Affordable Over-the-Counter Drug with Psychoactive Properties-From Chemical Structure to Possible Pharmacological Properties. Pharmaceuticals (Basel), 2023 Apr 10;16(4):566.
[15] Sălcudean A, Strete G, Enatescu VR, Tilinca MC, Sasu AB, Ceana DE, Dumache R, Kiss M, Ősz BE, Teodorescu DR, Sbrudan D, Bodo C, Cosma M, Radu C, Comsulea E, Pilot Study To Evaluate Adherence To Treatment Using The Mars Scale On A Sample Of Romanian Patients With Cardiovascular Diseases. Farmacia, 2024; 72(1).
[16] Wankhade D, Anjankar AP. Management of Somatization in COVID-19: A Narrative Review. Cureus [Internet]. 2022 Oct 13 [cited 2024 Dec 1]; Available from: https://www.cureus.com/articles/109227-management-of-somatization-in-covid-19-a-narrative-review
[17] Song X, Zhou Y, Rao W, Zhang X. Comparison of prevalence and risk factors of somatization between Chinese health care workers and non-health care workers during COVID-19 outbreak. BMC Psychiatry [Internet]. 2021 [cited 2024 Dec 1];21(1):276. Available from: https://bmcpsychiatry.biomedcentral.com/articles/10.1186/s12888-021-03294-z.

Exploring Salivary Biomarkers and Health Parameters in Type 2 Diabetic and Non-diabetic Patients



Berivan Buzatu[1,2], Ramona Dumitrescu[1,2], Lucian Floare[1], Ioan Alexandru Simerea[1], Delia Abrudan-Luca[1], Iulia Alexa[3], Octavia Balean[1,2], Atena Galuscan[1,2], Ioana Veja (Ilyes)[4]

[1]*Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health, University of Medicine and Pharmacy "Victor Babes", 300040 Timisoara.*
[2]*Clinic of Preventive, Community Dentistry and Oral Health, Department I, University of Medicine and Pharmacy "Victor Babes", Eftimie Murgu Sq. no 2, 300040 Timisoara.*
[3]*Department of Dentistry, Faculty of Dental Medicine, "Vasile Goldis" Western University of Arad, 310045 Arad, Romania.*
[4]*Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania, Arad, Str. Liviu Rebreanu, nr. 86.*

Correspondence to:
Name: Ramona Dumitrescu
E-mail address: dumitrescu.ramona@umft.ro

Received: 04 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

1.Background/Objectives: Diabetes mellitus (DM) is a chronic, non-communicable disease with significant systemic and oral health complications. Early, non-invasive diagnostic approaches, such as salivary biomarker analysis, could improve management and reduce associated complications. Salivary alpha-amylase has emerged as a promising biomarker due to its role in glycemic control and stress-related sympathetic activation. This study aims to evaluate salivary alpha-amylase levels as potential biomarkers for type 2 diabetes mellitus (T2DM) and explore their correlation with clinical parameters.2. Methods: A cross-sectional study was conducted involving 40 participants (20 T2DM patients and 20 controls). Saliva samples were collected and analyzed for alpha-amylase using ELISA. Data on oral health, body mass index (BMI), glycated hemoglobin (HbA1c), and total cholesterol were also collected.3. Results: Salivary alpha-amylase levels were significantly higher in T2DM patients (mean: 177.86 µ/L) compared to controls (mean: 90.98 µ/L, $p = 0.001$). Poorer oral health, higher BMI, and increased cholesterol levels were observed in diabetic participants. HbA1c levels revealed suboptimal glycemic control in a subset of patients.4. Conclusions: Salivary alpha-amylase shows potential as a non-invasive biomarker for T2DM diagnosis and monitoring. The findings emphasize the need for integrated medical and dental management to address systemic and oral health challenges in diabetes. Further research is needed to validate and standardize salivary diagnostic tools.

Keywords: diabetes, salivary amylase, oral health, saliva, biomarker

INTRODUCTION

Diabetes mellitus is a chronic, non-communicable disease that is progressing at an accelerated rate worldwide. The morbidity and mortality associated with diabetes are due to the persistent increase in hyperglycemia and the manifestation of associated complications, such as cardiovascular disorders, nephropathy, retinopathy, neuropathy, and lower limb amputations. Regular testing for prevention, early diagnosis, and decisive management of diabetes have become critical to reducing the global incidence of the disease. Additionally, people with diabetes are at a significantly higher risk of developing infections, which greatly reduces life expectancy. In the oral cavity, complications such as xerostomia, gingivitis, periodontitis, dental caries, and delayed healing of all oral lesions are commonly observed. According to recent data from the International Diabetes Federation (IDF), 463 million adults are living with diabetes. This represents 9.3% of the global adult population. The total number is projected to reach 578 million by 2030 and 700 million by 2045 [1].

The intricate connections between oral health and systemic diseases, including diabetes mellitus, emphasize the critical role of maintaining periodontal health for overall well-being. Diabetes, as a chronic and rapidly escalating global condition, exacerbates the risk of periodontal disease by altering the oral environment through mechanisms such as impaired immune response, increased inflammation, and delayed healing. Factors such as age, systemic conditions, and tobacco use further compound this vulnerability, intensifying both periodontal and systemic disease manifestations. These shared risk factors also create common pathways linking periodontal disease with major noncommunicable diseases, including cardiovascular disease, cancer, chronic respiratory disease, and diabetes itself. Recognizing the oral cavity as a "window to general health" underscores the undeniable relationship between oral and systemic health. Improving oral health literacy and promoting preventive behaviors are essential for mitigating oral diseases and their systemic implications. Given the shared risk factors between oral and systemic diseases, studying salivary biomarkers offers valuable insights into health parameters, particularly in populations affected by Type 2 diabetes [2].

Blood analysis is considered the only conventional method for evaluating biological control. However, blood sampling is invasive, which can lead to complications such as psychological stress and anxiety for most patients. Currently, research is focusing on non-invasive techniques, such as diagnosing type II diabetes mellitus using saliva. Saliva collection is a safe and low-risk method that reduces the potential for virus transmission. As a result, saliva stands out as an innovative, non-invasive, and simple tool for disease diagnosis. It holds the promise of becoming a practical alternative to conventional diagnostic methods, such as serum or urine tests, in the future [3]. Saliva analysis offers several advantages: it is cost-effective, easy to collect, transport, and store. Saliva is a heterogeneous oral fluid composed of numerous constituents that play a crucial role in maintaining oral health homeostasis. Studies show that both the composition and function of saliva are influenced by local and systemic changes. Therefore, salivary molecules could serve as strong indicators for predicting, monitoring, and diagnosing systemic and local disorders. Early diagnosis can prevent or delay long-term health complications in individuals with type II diabetes. If undiagnosed and/or untreated, diabetes significantly impacts quality of life. Consequently, various biochemical parameters of saliva can be investigated, such as glucose, salivary amylase, and immunoglobulin A [4].

The validation of salivary biomarkers in terms of accuracy, sensitivity, specificity, and reliability is essential for advancing personalized approaches to the prevention and treatment of systemic comorbidities, such as type 2 diabetes mellitus (T2DM). This validation could also

impact oral health and host response parameters. T2DM is a chronic metabolic disorder associated with various oral manifestations, including poor periodontal health and changes in salivary composition. Altered protein concentrations detected in the saliva of individuals with diabetes have been proposed as useful tools for identifying T2DM. However, it remains unclear whether salivary protein biomarkers can reliably differentiate between a periodontally healthy T2DM individual and one with periodontitis as part of routine clinical diagnosis [5].

Traditional methods for monitoring glycemic levels, such as measuring blood glucose and glycated hemoglobin (HbA1c), rely on invasive techniques like venous puncture and capillary blood sampling. While accurate, these methods are time-consuming, potentially stressful, and less practical for frequent or immediate use. Point-of-care (POC) testing offers a faster alternative by enabling specimen analysis directly at or near the site of patient care, reducing delays in clinical decision-making. However, invasive procedures may still induce stress, particularly in younger populations or those with neuropsychiatric disorders, which can exacerbate hyperglycemia. Non-invasive approaches, such as salivary diagnostics, provide a promising solution for overcoming these limitations. Salivary glucose levels, typically ranging from 0.5 to 1 mg/dL, increase after food intake and correlate well with blood glucose and HbA1c levels under both stimulated and unstimulated conditions. Other salivary markers, such as fructosamine glycated proteins and salivary amylase, also show strong associations with glycemic control. Salivary amylase, a key enzyme in starch digestion, plays an important role in postprandial glucose regulation. Higher salivary amylase activity is linked to lower blood glucose levels following starch intake, likely due to increased insulin secretion. Furthermore, salivary amylase is sensitive to stress, serving as a marker of sympathetic nervous system activation, and may reflect stress-related glycemic changes in diabetes patients. Despite these advantages, salivary glucose testing can be influenced by factors such as oral bacterial flora, hydration, and certain medications, potentially affecting accuracy. This underscores the need for further exploration of alternative salivary biomarkers for diabetes management. Advances in salivary diagnostics hold significant potential for non-invasive, accessible, and efficient monitoring of glycemic control, but additional research is required to validate these methods and address their current limitations [6].

Aim and objectives

This study aims to explore the potential of salivary alterations as a diagnostic tool for type 2 diabetes mellitus by analyzing the composition and characteristics of saliva in individuals with diabetes and comparing these findings to a control group. The primary objective is to assess salivary amylase levels to evaluate their potential as biomarkers for type 2 diabetes diagnosis, while secondary objectives include correlating salivary markers with clinical and laboratory parameters such as glycated hemoglobin, body mass index (BMI), and total cholesterol. By integrating demographic and clinical data collected through questionnaires, the study also investigates the influence of lifestyle factors and medical history on salivary changes. This research aspires to propose a non-invasive, efficient alternative to traditional blood glucose testing, advancing accessible diagnostic methods and improving clinical management to reduce complications associated with diabetes.

MATERIAL AND METHODS

The investigation of salivary amylase alterations in patients with type 2 diabetes was conducted as part of a comprehensive research project at the Oral Health Clinic, Faculty of Dentistry, Timişoara, between 2023 and 2024. To ensure the scientific integrity and ethical compliance of the study, the research protocol underwent a thorough review by the

University's Ethics Committee. This cross-sectional study was carried out at the Translational and Experimental Clinical Research Center for Oral Health, within the Clinic of Preventive, Community Dentistry and Oral Health at the "Victor Babeş" University of Medicine and Pharmacy, Timişoara, Romania. The study involved the collection of saliva samples from 40 participants under standardized conditions.

The study adhered to the ethical guidelines set forth in the Declaration of Helsinki (1964) by the World Medical Association. Ethical approval was granted by the Ethics Committee of the "Victor Babeş" University of Medicine and Pharmacy, Timişoara, Romania (approval number 34/2018). Participation in the study was entirely voluntary, and informed consent was obtained from all participants. As the study involved the completion of a questionnaire containing personal data and the collection of biological samples, written consent was obtained from all participants before their inclusion in the research.

Initially, a group of 53 patients was selected for inclusion in the study. Subsequently, after applying the appropriate exclusion criteria, the number of participants was reduced to 40, who served as the source of data for the present study. Careful consideration was given to selecting subjects within the same age group and from the same geographical area to ensure the consistency of the data analyzed (Figure 1).

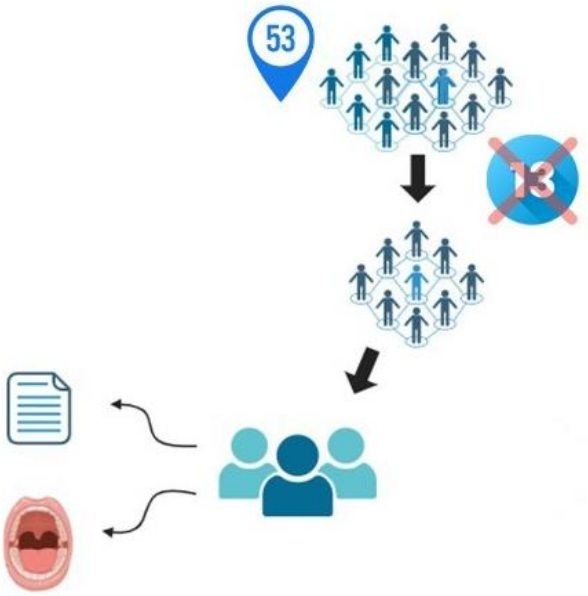


Figure 1. Schematic diagram of the workflow

The inclusion and exclusion criteria were established in accordance with the objectives and purpose of the research. To be eligible for inclusion in the study, participants had to meet the following inclusion criteria: they needed to be within a predefined age range, diagnosed with type 2 diabetes mellitus according to relevant international criteria, and willing to provide informed consent for participation in the study.

The exclusion criteria included the presence of other metabolic or endocrine disorders that could affect salivary composition, the use of medications that might influence salivary secretion, or any other conditions that could interfere with the collection and interpretation of salivary data.

By applying these criteria, it was ensured that the participants selected for the study represented a homogeneous group, suitable for the evaluation of salivary changes associated with type 2 diabetes.

To collect general information about the subjects, such as age, sex, type of diabetes diagnosis, and disease duration, a questionnaire was used in the first stage of the study. Additionally, the presence of other systemic conditions, ongoing treatments, and the subjects' smoking history was investigated, thus supplementing the obtained data with relevant information regarding their lifestyle and general oral health status. Furthermore, body mass index (BMI) was determined and blood analyses were performed to assess glycated hemoglobin, blood glucose levels, and total cholesterol. These additional data allow for a more comprehensive understanding of the participants' health status and the potential correlations between the various variables investigated.

In the second stage, the experimental phase, saliva samples were collected to determine salivary amylase levels. The collection took place between 06:00 and 08:00 in the morning, before performing oral hygiene and without prior consumption of food or liquids. Special containers, called Salivettes, were used for saliva collection, with a minimum sample volume of 1 ml required for each sample. The collection process involved opening the Salivette container to expose the internal absorbent pad, which was not touched by hand (Figure 2). The pad was then placed directly in the oral cavity by gently tilting the container and chewed lightly for 2 minutes to allow it to become saturated with saliva. Afterward, the pad was placed back into the container without being touched and the container was securely sealed. Subsequently, the samples are stored in a cryogenic environment at low temperatures before being transported to a specialized laboratory for analysis. Saliva was then analyzed using the ELISA method, a biochemical test that employs a solid-phase enzyme immunoassay to detect a ligand in a liquid sample, utilizing antibodies specific to the protein to be measured. ELISA is widely used as a diagnostic tool in medicine.

Figure 2. Salivette – containers for saliva sample collection

The data were entered into a computer (MS Office 2010, Excel spreadsheet) and subjected to statistical analysis using the SPSS statistical software package (version 23). To measure statistically significant differences between the two groups, the independent samples t-test and the Chi-square test were used.

RESULTS

The study cohort consisted of 40 participants, divided equally into two groups: 20 individuals with type 2 diabetes and 20 non-diabetic controls. Within the diabetic group, 12

participants were women, with an average age of 45.3 years, and 8 were men, with an average age of 41.7 years. In comparison, the non-diabetic group included 11 women, with an average age of 44.4 years, and 9 men, with an average age of 45.1 years. The age distribution between the two groups was relatively similar, with no significant differences in average age, ensuring comparability for further analyses. The balanced gender distribution and similar age ranges across both groups helped minimize demographic variability, allowing for a more focused assessment of the specific parameters being studied. This alignment strengthens the validity of the comparisons drawn between diabetic and non-diabetic individuals, particularly when examining salivary biomarkers, clinical metrics, and other related health parameters. The demographic characteristics of the diabetic and control groups, based on responses collected from questionnaires, are presented in Table 1.

The duration since diagnosis of diabetes was 11 ± 8 years. Blood glucose levels were 261 ± 131 mg/dL. Data obtained from the diabetic patients were compared with a control (non-diabetic) group consisting of 20 subjects, including 11 women and 9 men. The mean (±SD) blood glucose levels in this group were 92 ± 9 mg/dL.

Table 1 shows the distribution of study subjects, indicating that 20 subjects with diabetes and 20 subjects in the normal group were included.

Table 1. Distribution of study subjects in the Diabetes and Non-Diabetes group

No.	Study Group	Type 2 Diabetes	Average Age	Non-diabetes	Average Age
1.	Women	12	45.3	11	44.4
2.	Men	8	41.7	9	45.1
Total		20		20	

In the studied sample, two distinct groups were analyzed: one consisting of individuals with diabetes and the other of individuals without diabetes. The average age of the diabetic group is 43.5 years, with a standard deviation of 1.8 years, indicating moderate variability in ages within this group. In contrast, the non-diabetic group recorded a slightly higher average age of 44.7 years, but with a significantly smaller standard deviation of only 0.35 years. This suggests greater homogeneity in terms of age within the non-diabetic group. These data indicate that, although the average age is similar between the two groups, the age variability is considerably lower among individuals without diabetes (Table 2).

Table 2. Descriptive table with age and standard deviation for the studied sample

No.	Sample	Average Age	Standard deviation
1.	DIABETIC	43,5	1,8
2.	NON DIABETIC	44,7	0,35

Table 3 presents the comparison of salivary alpha-amylase levels between diabetic patients and healthy subjects, showing a statistically significant difference between the two groups ($p < 0.05$).

Table 3. Comparison of salivary alpha-amylase levels between diabetic patients and healthy subjects using the independent samples t-test

No.	Sample	Mean	Standard Deviation	*p* Value
1.	DIABETIC	177.86	72.17	0.001*
2.	NON-DIABETIC	90.98	44.17	0.001*

Another important factor that was analyzed based on the questionnaire was the oral health. The results show that diabetic patients mostly visit the dentist 2-3 times, or even 4 times a year, while healthy subjects typically visit the dentist 1-2 times a year. This suggests

that oral health is poorer among diabetic patients. One reason for this is the reduced salivary flow, which consequently increases the incidence of dental caries. Regarding the frequency of dental hygiene, the majority of diabetic patients brush their teeth once a day; 4 out of 20 reports brushing twice a day. In contrast, among the healthy subjects, 10 brush once a day, and 10 brush twice a day. All diabetic patients, as well as healthy subjects, use fluoride toothpaste and auxiliary hygiene tools, either a water flosser or dental floss.

As is well known, type 2 diabetes is associated with certain oral manifestations, such as dry mouth, halitosis, dental mobility, spontaneous or brushing-induced gum bleeding, fungal infections, and taste alterations. Based on the responses from diabetic patients, we find that 11 of them report experiencing dry mouth and bad breath, 6 have dental mobility, and 16 patients complained of gum bleeding, with the majority occurring during brushing, and only a few spontaneously (Figure 3). When comparing these responses with those of healthy subjects, we find that only 7 out of 20 healthy subjects report minor gum bleeding, which is exclusively caused by tooth brushing. Among healthy subjects, xerostomia (dry mouth) is present in 2 individuals, while dental mobility is absent (Figure 4).

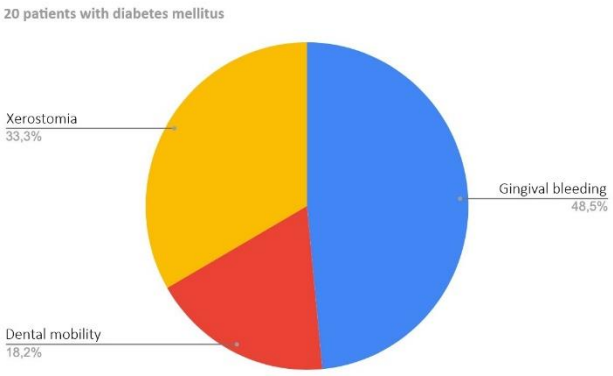


Figure 3. Description of the diabetic patient sample based on oral manifestations

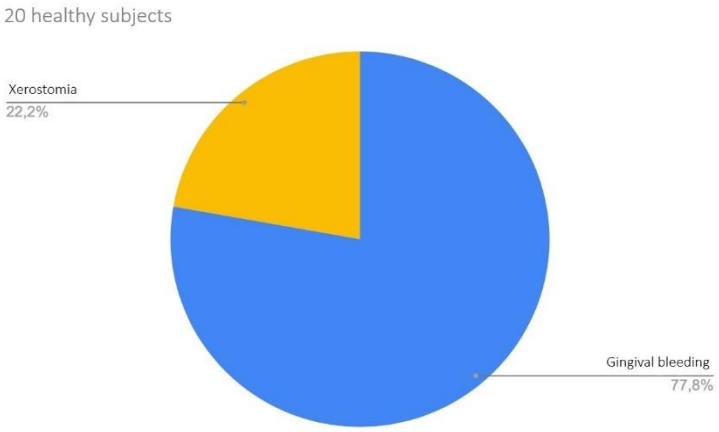


Figure 4. Description of the non-diabetic patient sample based on oral manifestations

The age, weight, and height of both diabetic patients and healthy subjects were recorded, allowing for the calculation of Body Mass Index (BMI) for each participant. A graph was generated to facilitate a comparative analysis of the results. The data revealed a significant difference in BMI values between the groups. Notably, none of the diabetic patients had a BMI below 25, which is considered within the normal range. Within the BMI range of 25-30, six individuals were identified, comprising four women and two men. The 30-35 BMI range showed the highest prevalence, with 13 individuals classified as overweight,

including eight women and five men. Only one individual was observed with a BMI exceeding 35 (Figure 5).

Among the healthy subjects, a distinct distribution of BMI values was observed, highlighting notable lifestyle differences compared to diabetic patients. In the BMI category below 25, 50% of the healthy subjects, totaling 10 individuals, were classified. Within the BMI range of 25-30, nine individuals were identified, while one subject fell within the 30-35 BMI range. No individuals in the healthy group had a BMI exceeding 35 (Figure 5).

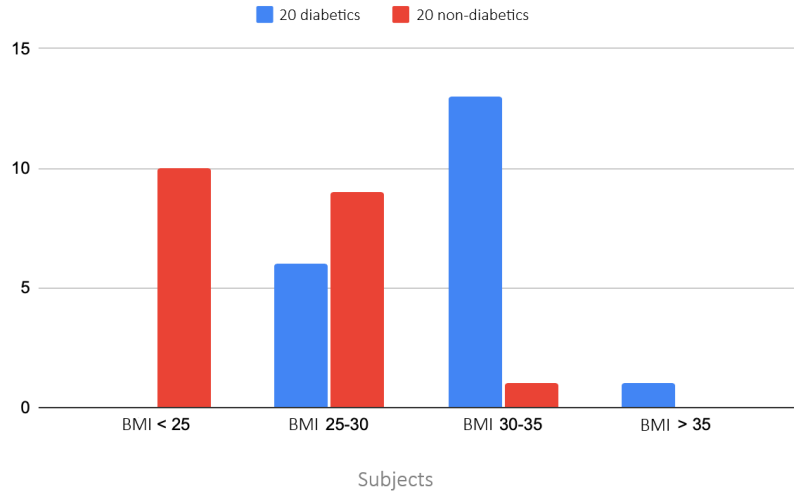


Figure 5. Description of the diabetic and non-diabetic patient sample based on body mass index

Glycated hemoglobin was analyzed in diabetic patients, as this test is routinely conducted as part of their clinical management. Glycated hemoglobin serves as a critical marker for assessing long-term glycemic control in individuals with diabetes. Normal values, indicative of well-controlled diabetes, range between 6-7%. Values exceeding 7% suggest inadequate glycemic control, potentially due to factors such as non-adherence to prescribed antidiabetic medication or dietary recommendations. A comparative graph was generated based on the results obtained from the diabetic patients. The analysis revealed that the majority of patients (17 individuals) had glycated hemoglobin levels within the target range of 6-7%. Conversely, three patients were found to have glycated hemoglobin levels exceeding 7%, reflecting suboptimal glycemic control (Figure 6).

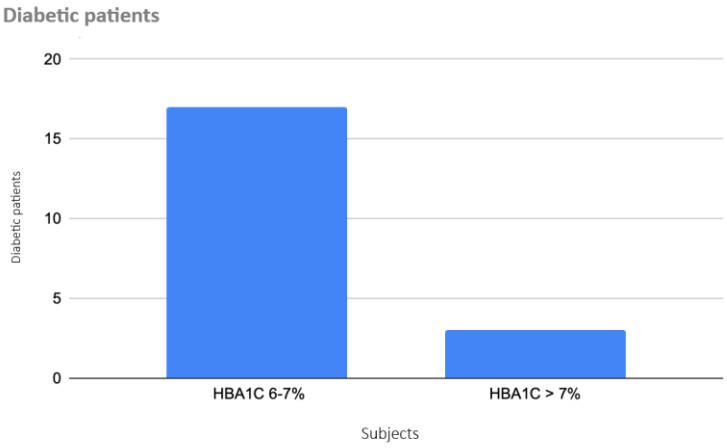


Figure 6. Description of the diabetic patient sample based on glycated hemoglobin levels

Total cholesterol levels were analyzed in both diabetic patients and healthy controls to compare values between the groups and explore the potential influence of type 2 diabetes on this parameter. The aim was to assess whether diabetes impacts cholesterol levels and to correlate these findings with health status. Among the diabetic patients, six individuals were found to have total cholesterol levels within the range of 200-240 mg/dL, which is considered borderline normal. However, 14 patients exhibited cholesterol levels exceeding 240 mg/dL, indicating hypercholesterolemia. In contrast, the healthy control group presented markedly different results: five individuals had cholesterol levels in the range of 200-240 mg/dL, while the majority, 15 individuals, had cholesterol levels below 200 mg/dL, considered optimal. These findings highlight a significant disparity in cholesterol levels between diabetic and healthy individuals.

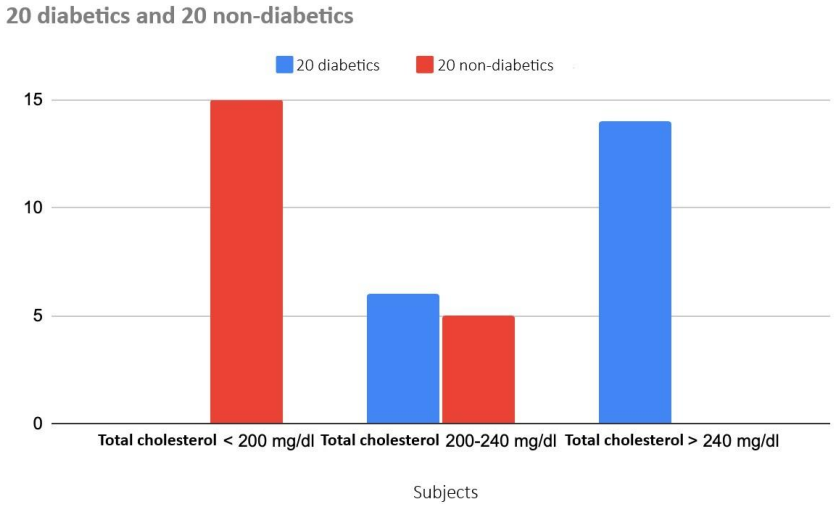


Figure 7. Description of the diabetic and non-diabetic patient sample based on total cholesterol levels

DISCUSSIONS

This study highlights the potential of salivary diagnostics as a non-invasive, cost-effective, and practical approach to evaluating type 2 diabetes mellitus (T2DM) and associated complications. The analysis of salivary alpha-amylase levels revealed significantly higher concentrations in diabetic patients compared to healthy controls, supporting the hypothesis that salivary biomarkers can serve as reliable indicators of glycaemic status. These findings align with previous research, demonstrating that salivary amylase levels correlate with blood glucose and glycated haemoglobin (HbA1c) levels, thereby offering a non-invasive alternative to traditional blood-based diagnostic methods [7,8]. Importantly, the observed increase in salivary amylase levels among diabetics underscores its potential utility in routine clinical monitoring and early detection of diabetes.

Salivary amylase begins the hydrolysis of starch in the mouth, accounting for no more than 30% of the total hydrolysis of starch. Since salivary amylase is inactivated by an acidic pH, no significant carbohydrate hydrolysis occurs in the stomach. Acinar cells, which produce salivary amylase, are innervated by both sympathetic and parasympathetic pathways. Activation of the sympathetic nervous system increases amylase synthesis, thereby increasing the concentration of amylase in saliva, while parasympathetic activity increases the rate of salivary flow with little or no effect on amylase synthesis. Salivary amylase is associated with the autonomic system and is involved in glycemic digestion, making it a promising biomarker for evaluating and monitoring diabetes mellitus [9]. Blood glucose

levels after starch consumption are influenced by genetic differences in salivary amylase, an enzyme that breaks down dietary starch. Higher salivary amylase activity is associated with lower blood glucose levels. In fact, individuals with high salivary amylase concentrations have had significantly lower blood glucose responses after starch ingestion compared to individuals with low enzyme concentrations, with this difference being mediated by increased plasma insulin concentrations in individuals with high enzyme levels [9].

Salivary alpha-amylase has been identified as a marker of sympathetic nervous system activity and stress. Its activity increases under sympathetic autonomic stimulation, making it a potential indicator for evaluating glycemic control in pathological conditions like diabetes mellitus (DM), where stress plays a role in glycemic fluctuations. Measuring salivary amylase provides a non-invasive method for monitoring stress-mediated changes in diabetic patients [10,11]. Key techniques for measuring salivary amylase include enzyme-linked immunosorbent assays (ELISA) and colorimetric methods, with the Phadebas® method being particularly accurate and user-friendly. Saliva collection methods can significantly influence the results, as factors like diurnal variations, saliva collection schedules, and techniques (e.g., cotton swabs vs. flow collection) affect amylase measurements. Studies have reported conflicting results regarding salivary amylase levels in diabetic patients, with some showing reduced levels due to autonomic neuropathy and microvascular complications, while others found increased levels linked to altered glucose regulation mechanisms. These discrepancies may stem from variations in sample collection, disease duration, comorbidities, and medication use. Hyperglycemia impacts salivary gland function, reducing salivary flow and altering composition, leading to oral health issues such as dry mouth, infections, caries, and mucosal changes. Saliva's biochemical profile, including glucose, proteins, electrolytes, and enzymes like amylase, reflects systemic changes in diabetes and can be used for disease diagnosis and management [12-16].

The present study observed higher salivary alpha-amylase levels in diabetic patients compared to healthy controls, supporting its potential as a biomarker. The increase is likely due to glucose regulation mechanisms involving the pancreas and salivary glands, highlighting the interconnectedness of systemic and oral health in diabetes. Further research is needed to standardize methodologies and validate salivary biomarkers for clinical use. In this study, the mean total salivary alpha-amylase level in diabetic subjects was 177.86 µ/L, while in normal subjects it was 90.98 µ/L, a difference that was statistically significant ($p=0.001$). These results are consistent with the study conducted by Panchabhai AS and colleagues, who measured salivary glucose, salivary alpha-amylase, total salivary proteins, and salivary flow rate in diabetic patients in India. The results of that study showed a decrease in salivary alpha-amylase levels in patients with controlled diabetes who were under treatment, compared to normal subjects [17]. In the present study, an increase in salivary alpha-amylase levels was found in patients newly diagnosed with diabetes mellitus. This finding could explain why an increase in salivary alpha-amylase levels was observed in our study. The results are in line with those of the study by Pal and colleagues, who demonstrated a significant positive correlation between salivary alpha-amylase levels and total proteins in diabetic patients. Furthermore, the present study aligns with the research conducted by Malathi and colleagues, who investigated salivary alpha-amylase as a diagnostic tool for early-stage diabetic patients. In that study, the average salivary alpha-amylase level in diabetic patients was 2739.48 µ/L, compared to 1740.38 µ/L in the normal group. In our study, newly diagnosed diabetic patients were evaluated for salivary alpha-amylase levels, and the results showed that the level of salivary alpha-amylase was higher in men than in women [16].

Salivary alpha-amylase is a component of saliva whose level does not change with age. Ben-Aryeh and colleagues found lower levels of alpha-amylase in older individuals,

while others observed no significant differences or even reported elevated levels of this enzyme. Salivary alpha-amylase is primarily produced by the parotid glands and is considered a marker of parotid saliva. It has been reported that these glands can maintain their secretory function throughout human life, which may explain the results obtained in our study, where no significant differences in alpha-amylase levels were found between younger and older individuals. Differences in results may be attributed to varying methodologies, different age groups, and/or whether saliva was collected in a stimulated or unstimulated state. Another factor that may influence results is stress, which is inherently present in dental practice and can be induced in patients by routine dental procedures or even by regular check-ups. It is known that stress increases salivary alpha-amylase levels [18].

The replacement of blood tests with other non-invasive samples, such as saliva, is increasingly being proposed for a variety of pathologies and is especially useful for patients with neurocognitive disorders or children, for whom blood collection is very stressful. This is primarily due to the fact that saliva tests are cheaper than blood tests, they are non-invasive and easy to store. Additionally, saliva is less infectious than blood, easier to handle in diagnostic procedures, and does not coagulate [19].

The study also explored the broader implications of T2DM on oral health. Diabetic participants reported significantly higher rates of oral manifestations, such as xerostomia, gum bleeding, halitosis, and dental mobility, compared to their non-diabetic counterparts. These symptoms are consistent with the well-documented impact of hyperglycemia on salivary gland function and periodontal health, which predispose individuals with diabetes to oral infections and delayed wound healing [20,21]. The reduced salivary flow observed in diabetic patients contributes to an increased risk of dental caries and periodontal disease, further emphasizing the interconnectedness of systemic and oral health. Notably, the frequent dental visits among diabetic patients, as opposed to the healthy controls, highlight the heightened need for oral healthcare interventions in this population.

BMI and cholesterol levels provided additional insights into the systemic health disparities between diabetic and non-diabetic individuals. None of the diabetic participants had a BMI below 25, with the majority falling within the overweight or obese categories. This contrasts sharply with the non-diabetic group, where a substantial proportion maintained a normal BMI. These results underscore the strong association between obesity and diabetes, with obesity acting as a significant risk factor for insulin resistance and glycemic dysregulation [22]. The cholesterol analysis revealed a similar trend, with a high prevalence of hypercholesterolemia among diabetic patients, further corroborating the increased cardiovascular risk associated with diabetes. This highlights the need for comprehensive management strategies that address not only glycemic control but also lipid profile optimization and weight management [23].

Glycated hemoglobin analysis provided a valuable measure of long-term glycemic control among diabetic participants. While most individuals achieved HbA1c levels within the target range of 6-7%, a subset exhibited levels exceeding 7%, indicative of suboptimal glycemic control. This finding points to potential challenges in treatment adherence, dietary regulation, or medication efficacy, necessitating a personalized approach to diabetes management. The significant variability in glycemic control observed in the study population underscores the importance of early detection and continuous monitoring of diabetes to mitigate long-term complications [24].

Oral manifestations of type 2 diabetes can be prevented through several approaches, including ensuring proper brushing and flossing behaviors, encouraging patients to visit the dentist for routine check-ups, and controlling blood glucose levels. Many patients with diabetes are unaware of the relationship between diabetes and oral health. There is a lack of awareness about the importance of maintaining among diabetic patients. Furthermore, only a

small percentage of patients diagnosed with diabetes visit the dentist for regular periodontal checks. It is assumed that every diabetic patient is at risk for periodontal disease and should be referred for periodontal screening and educated about the importance of oral health and regular dental visits. It has been reported that more than 90% of patients with diabetes mellitus (DM) experience oral manifestations due to the lack of regular dental check-ups. It has been suggested that individuals with higher educational levels are more concerned about the prevention and control of the disease. Therefore, providing education will increase awareness, which will help prevent oral complications of diabetes [25,26]. Involvement of oral health professionals in the strategies for identifying individuals at risk of diabetes mellitus will strengthen the preventive and screening efforts needed to prevent oral diseases. Treatment outcomes can be improved if dental practitioners are aware of the dental implications and risk factors of diabetes mellitus. Diabetic patients should be encouraged to visit the dentist to reinforce and educate them on oral health information through diabetes and dental care centers. Systemic health is closely linked to oral health, especially in diabetic individuals, which increases the need for collaborative dental and medical management of the patient. To improve the general and oral health of diabetic patients, a collaborative relationship should be developed between patients, physicians, and dentists [27,28].

Finally, the study demonstrated the utility of integrating demographic, clinical, and lifestyle data to provide a holistic understanding of the interplay between systemic and oral health in diabetes. The use of questionnaires to collect data on oral hygiene practices, medical history, and systemic health parameters further enriched the analysis, providing a comprehensive picture of the multifaceted impact of T2DM. The promising results obtained from salivary diagnostics suggest a shift toward non-invasive diagnostic modalities, which could improve patient compliance and accessibility, particularly in resource-limited settings [29].

Further research is warranted to validate these findings across larger populations and diverse settings, as well as to address potential limitations, such as the influence of oral bacterial flora and hydration status on salivary marker accuracy.

CONCLUSIONS

In conclusion, this study supports the viability of salivary biomarkers as diagnostic and monitoring tools for T2DM while highlighting the broader systemic and oral health challenges faced by individuals with diabetes. The findings underscore the importance of a multidisciplinary approach to diabetes management, integrating medical, dental, and lifestyle interventions to improve patient outcomes.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Chen C, Shao Y. Elevated Interleukin-17 Levels in Patients with Newly Diagnosed Type 2 Diabetes Mellitus. Biochemistry & Physiology: Open Access. 2016 Jan 1;5.

[2] Schwarz C, Hajdu AI, Dumitrescu R, Sava-Rosianu R, Bolchis V, Anusca D, et al. Link between Oral Health, Periodontal Disease, Smoking, and Systemic Diseases in Romanian Patients. Healthcare [Internet]. 2023 Aug 21 [cited 2024 Dec 15];11(16):2354. Available from: https://www.mdpi.com/2227-9032/11/16/2354

[3] Schwarz C, Balean O, Dumitrescu R, Ciordas PD, Marian C, Georgescu M, et al. Total Antioxidant Capacity of Saliva and Its Correlation with pH Levels among Dental Students under

Different Stressful Conditions. Diagnostics [Internet]. 2023 Dec 12 [cited 2024 Dec 15];13(24):3648. Available from: https://www.mdpi.com/2075-4418/13/24/3648

[4] Shrestha S, Pokhrel S, Poudel A, Bhandari Bc S, Shakya M, Timilsina A, et al. Implication of Salivary Biochemical Parameters for Diagnosis and Prognosis of Type 2 Diabetes Mellitus. Int J Anal Chem. 2022;2022:1781613.

[5] Miller CS, Ding X, Dawson DR, Ebersole JL. Salivary biomarkers for discriminating periodontitis in the presence of diabetes. J Clinic Periodontology [Internet]. 2021 Feb [cited 2024 Jun 30];48(2):216–25. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jcpe.13393

[6] Pérez-Ros P, Navarro-Flores E, Julián-Rochina I, Martínez-Arnau FM, Cauli O. Changes in Salivary Amylase and Glucose in Diabetes: A Scoping Review. Diagnostics [Internet]. 2021 Mar 6 [cited 2024 Nov 28];11(3):453. Available from: https://www.mdpi.com/2075-4418/11/3/453

[7] Yoshizawa JM, Schafer CA, Schafer JJ, Farrell JJ, Paster BJ, Wong DTW. Salivary biomarkers: toward future clinical and diagnostic utilities. Clin Microbiol Rev. 2013 Oct;26(4):781–91.

[8] Satish B, Kumar P, Avanti SM, Singh S. Salivary Amylase as Potential Biochemical Marker in Diabetes Mellitus. Int J Recent Surg Med Sci [Internet]. -- [cited 2024 Dec 1];2(1):19–22. Available from: https://ijrsms.com/salivary-amylase-as-potential-biochemical-marker-in-diabetes-mellitus/

[9] Patel BJ, Dave B, Dave D, Karmakar P, Shah M, Sarvaiya B. Comparison and Correlation of Glucose Levels in Serum and Saliva of Both Diabetic and Non-diabetic Patients. J Int Oral Health [Internet]. 2015 Aug [cited 2024 Dec 1];7(8):70–6. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4588794/

[10] Rao PV, Laurie A, Bean ES, Roberts CT, Nagalla SR. Salivary Protein Glycosylation as a Noninvasive Biomarker for Assessment of Glycemia. J Diabetes Sci Technol [Internet]. 2015 Jan 1 [cited 2024 Jun 2];9(1):97–104. Available from: http://journals.sagepub.com/doi/10.1177/1932296814554414

[11] Ali N, Nater UM. Salivary Alpha-Amylase as a Biomarker of Stress in Behavioral Medicine. IntJ Behav Med [Internet]. 2020 Jun [cited 2024 Jun 2];27(3):337–42. Available from: https://link.springer.com/10.1007/s12529-019-09843-x

[12] Chojnowska S, Ptaszyńska-Sarosiek I, Kępka A, Knaś M, Waszkiewicz N. Salivary Biomarkers of Stress, Anxiety and Depression. JCM [Internet]. 2021 Feb 1 [cited 2024 Jun 2];10(3):517. Available from: https://www.mdpi.com/2077-0383/10/3/517

[13] Abd-Elraheem SE, El Saeed AM, Mansour HH. Salivary changes in type 2 diabetic patients. Diabetes & Metabolic Syndrome: Clinical Research & Reviews [Internet]. 2017 Dec [cited 2024 May 12];11:S637–41. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1871402117300978

[14] Lima-Aragão MVV, De Oliveira-Junior JDJ, Maciel MCG, Silva LA, Do Nascimento FRF, Guerra RNM. Salivary profile in diabetic patients: biochemical and immunological evaluation. BMC Res Notes [Internet]. 2016 Dec [cited 2024 Jun 2];9(1):103. Available from: http://www.biomedcentral.com/1756-0500/9/103

[15] Naseri R, Mozaffari H, Ramezani M, Sadeghi M. Effect of diabetes mellitus type 2 on salivary glucose, immunoglobulin A, total protein, and amylase levels in adults: A systematic review and meta-analysis of case–control studies. J Res Med Sci [Internet]. 2018 [cited 2024 May 12];23(1):89. Available from: https://journals.lww.com/10.4103/jrms.JRMS_135_18

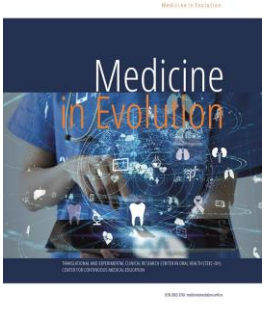
[16] Sardari F, Tahmasbi A, Ghanbarzadegan A. Salivary IgA concentration in diabetic patients compared to healthy controls. Dental Hypotheses [Internet]. 2015 Jun [cited 2024 Jun 2];6(2):60. Available from: https://journals.lww.com/dhyp/fulltext/2015/06020/salivary_iga_concentration_in_diabetic_patients.6.aspx

[17] Panchbhai AS. Correlation of Salivary Glucose Level with Blood Glucose Level in Diabetes Mellitus. JOMR [Internet]. 2012 Jul 4 [cited 2024 Jun 2];3(3). Available from: http://www.ejomr.org/JOMR/archives/2012/3/e3/v3n3e3ht.htm

[18] J C, Bb P, Hassan S. '"Assessment of Salivary Alpha Amylase level in subjects with Diabetes mellitus -A Cross Sectional Study."' IP Annals of Prosthodontics and Restorative Dentistry [Internet]. [cited 2024 Jun 2];2(3):79–82. Available from: https://www.aprd.in/article-details/2824

[19] Martínez PMS. LA SALIVA COMO FLUIDO DIAGNÓSTICO.
[20] Lalla E, Papapanou PN. Diabetes mellitus and periodontitis: a tale of two common interrelated diseases. Nat Rev Endocrinol. 2011 Jun 28;7(12):738–48.
[21] Preshaw PM, Alba AL, Herrera D, Jepsen S, Konstantinidis A, Makrilakis K, et al. Periodontitis and diabetes: a two-way relationship. Diabetologia. 2012 Jan;55(1):21–31.
[22] Magliano DJ, Islam RM, Barr ELM, Gregg EW, Pavkov ME, Harding JL, et al. Trends in incidence of total or type 2 diabetes: systematic review. BMJ [Internet]. 2019 Sep 11 [cited 2024 Dec 1];366:l5003. Available from: https://www.bmj.com/content/366/bmj.l5003
[23] Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. Nat Clin Pract Endocrinol Metab. 2009 Mar;5(3):150–9.
[24] Sherwani SI, Khan HA, Ekhzaimy A, Masood A, Sakharkar MK. Significance of HbA1c Test in Diagnosis and Prognosis of Diabetic Patients. Biomark Insights. 2016;11:95–104.
[25] Nassar M, Hiraishi N, Islam MdS, Otsuki M, Tagami J. Age-related changes in salivary biomarkers. Journal of Dental Sciences [Internet]. 2014 Mar [cited 2024 Jun 2];9(1):85–90. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1991790213001724
[26] Herman WH, Taylor GW, Jacobson JJ, Burke R, Brown MB. Screening for prediabetes and type 2 diabetes in dental offices. J Public Health Dent [Internet]. 2015 Aug [cited 2024 Jun 2];75(3):175–82. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jphd.12082
[27] Mazzini Torres F, Ubilla Mazzini W, Moreira Campuzano T, Mazzini Torres F, Ubilla Mazzini W, Moreira Campuzano T. Predisposing factors affecting oral health in diabetes mellitus patients. Revista odontológica mexicana [Internet]. 2017 Jun [cited 2024 Jun 2];21(2):103–8. Available from: http://www.scielo.org.mx/scielo.php?script=sci_abstract&pid=S1870-199X2017000200103&lng=es&nrm=iso&tlng=en
[28] Bossart M, Calley K, Gurenlian J, Mason B, Ferguson R, Peterson T. A pilot study of an HbA1c chairside screening protocol for diabetes in patients with chronic periodontitis: the dental hygienist's role. Int J Dental Hygiene [Internet]. 2016 May [cited 2024 Jun 2];14(2):98–107. Available from: https://onlinelibrary.wiley.com/doi/10.1111/idh.12140
[29] Shang YF, Shen YY, Zhang MC, Lv MC, Wang TY, Chen XQ, et al. Progress in salivary glands: Endocrine glands with immune functions. Front Endocrinol [Internet]. 2023 Feb 3 [cited 2024 Dec 1];14. Available from: https://www.frontiersin.org/journals/endocrinology/articles/10.3389/fendo.2023.1061235/full

The Influence of Different Whitening Toothpastes on Tooth Colour



Ruxandra Sava-Rosianu[1,2], Ramona Dumitrescu[1,2], Berivan Buzatu[1,2], Lucian Floare[2], Ana Vukovic[3], Vanessa Bolchis[1,2], Delia Abrudan-Luca[2], Ioana Veja (Ilyes)[4], Octavia Balean[1,2]

[1]*"Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania, Faculty of Dentistry, Clinic of Preventive, Community Dentistry and Oral Health;*
[2]*"Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania, Faculty of Dentistry, Clinic of Preventive, Community Dentistry and Oral Health; Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health, Victor Babes University of Medicine and Pharmacy, 300040 Timisoara, Romania*
[3]*Department of Pediatric and Preventive Dentistry, School of Dental Medicine, University of Belgrade, Belgrade, Serbia*
[4]*Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania, Arad, Str. Liviu Rebreanu, nr. 86*

Correspondence to:
Name: Ioana Veja (Ilyes)
E-mail address: ilyes.ioana@uvvg.ro

Received: 4 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

1.Background/Objectives: Nowadays, when aesthetic appeal holds unprecedented significance, a paramount aspect is a radiant, healthy smile. The purpose of the study was to demonstrate the influence of different whitening toothpastes on tooth-colour. *2.Methods*: 25 caries-free premolars, extracted for periodontal reasons, after signing informed consent, were randomly divided in 5 groups after soaking them into. Using a spectrophotometer the cervical tooth colour was measured. Each group was soaked into espresso coffee, for 72 hours. Each group was underwent a cleaning procedure using 3 different kinds of whitening toothpastes, professional airflow and sodium bicarbonate powder. *3.Results*: All sample teeth lightened up by at least one nuance. Group 1 has stained from the initial color 2 shades up. After brushing with Colgate Advanced white the color has improved one shade down. Group 2 was brushed with Colgate Max. improving the initial color by 1 shade. Group 3 has gained approximately its initial color with the Splat extreme white toothpaste. Groups 4 and 5 were not treated with conventional toothpaste but with sodium bicarbonate and airflow. Group 4 stained up 2 shades and improved one shade after brushing with sodium bicarbonate. *4.Conclusion:* All whitening substances had a direct whitening effect on the tooth color.

Keywords: tooth-whitening, airbrushing, airflow, enamel, spectrophotometer

INTRODUCTION

Nowadays, in an era where aesthetic appeal holds unprecedented significance, a paramount aspect is a radiant, healthy smile. It frequently stands out as the initial point of attention during conversations. A luminous smile plays a pivotal role in crafting a favourable first impression, thereby exerting a profound influence on one's social interactions. The outward appearance serves as a symbolic introduction to society. Numerous methods can be employed to fulfil this desire. Among the most prevalent options are whitening toothpastes, which aid in brightening the shade of teeth and eliminating discolouration. Their popularity stems from their widespread availability, user-friendly nature, easy accessibility, and affordability. [1] Most of the whitening toothpastes make use of mild abrasive particles that help to polish the enamel surface. [2] They remove surface stains caused by highly pigmented food and drinks like red wine or tea. Habits such as smoking or chewing tobacco can tarnish teeth with frequent use. The fine particles in whitening toothpaste are more delicate compared to those in regular toothpaste, allowing for a gentle removal of surface stains without causing harm to the tooth enamel.

Enamel being the outermost layer of the tooth, serves as a barrier and is a protective component. It is the strongest tissue in the human body, but it is incapable of regenerating. So once it's lost, it cannot rebuild.

Whitening toothpastes have several ways of reacting. As already mentioned, one of the most used processes is the use of abrasives (mechanical mechanism). [2] These small particles work by physically polishing the tooth surface to remove extrinsic stains that make it appear in a brighter shade. [1;2]

Another technique makes use of chemical agents or enzymes that help to break down and dissolve surface stains. Also, some pastes help to prevent stain build-up. The ingredients work by creating a protective barrier on the tooth surface which makes it more difficult for new stains to adhere to the enamel [3].

Tooth whitening through toothpaste is not compatible with everybody and can even worsen the situation. The appearance of the tooth color has multiple factors. It depends on the thickness and the translucency of the enamel, in the case of having thin enamel and then brushing your teeth with abrasive whitening toothpastes, the enamel thinners even more through abrasion [3]. The teeth can get even more yellowish and teeth can start to develop sensitivity. Other important factors that influence the color of teeth are genetics, age, lifestyle and general dental health.

Aim and objectives

People from all over the world consider white healthy teeth are desirable and beautiful, making it an important international topic. White teeth are a sign of health and youthfulness and reflect attractiveness. In this study different whitening tooth paste are compared as well as the professional air flow system and the home remedy sodium bicarbonate to see which method has the greatest impact on the tooth appearance.

The purpose of the study is to demonstrate the influence of different whitening toothpastes on the color of extracted teeth.

MATERIAL AND METHODS

The experimental study shows a comparison between the effectiveness of different whitening tooth pastes and between professional dental hygiene performed by airflow versus the popular home remedy baking powder. The results were evaluated using a

spectrophotometer under natural light. For this study 25 extracted premolars were randomly divided in 5 groups. These caries free teeth were extracted from patients who had to undergo dental extraction due to severe periodontitis and previously gave the informed consent to use the teeth for research purposes. With the help of the spectrophotometer the tooth color was measured on the cervical part of the tooth. The teeth were cut along the long axis with a diamond-coated conical bur, from coronal to apical between the cusps. Both halves of each tooth were placed in espresso coffee (Julius Meinl) for a time of 72 hours. After being stained in coffee, the color was measured again with the spectrophotometer. One half of each stained tooth was selected to conduct the brushing experiment. The contra-angle hand-piece was used for brushing the samples for 30 seconds with the respective whitening medium. Finally, a new measurement was taken with the spectrophotometer under natural light.The teeth have been treated with 3 different kinds of whitening toothpastes (Colgate, splat), professional airflow and sodium bicarbonate powder. Each product was tested on 4 extracted teeth that were previously soaked in espresso coffee, for 72 hours, followed by brushing for 30 seconds. The following products were used for whitening:

1. Colgate Advanced White. Promises whiter teeth in 10 days, (fluoride content 1450ppm). Ingredients: Aqua, hydrated silica, sorbitol, PEG-12, Aroma, Sodium Lauryl sulfate, xanthan gum, potassium hydroxide, cellulose gum, tetrasodium pyrophosphate, phosphoric acid, sodium fluoride, benzyl alcohol, sodium saccharin, sodium bicarbonate, volcanic ash, charcoal powder, limonene, Cl 74160

2. Colgate Max White purple reveal (fluoride content 1450ppm). Promises to instantly correct yellow tones effect is temporary. Ingredients: Aqua, Sorbitol, Hydrated Silica, PEG-12, Sodium Lauryl Sulfate, Aroma, Cellulose Gum, Potassium Hydroxide, Tetrasodium, Pyrophosphate, Phosphoric acid, cocamidopropyl betaine, Sodium fluoride, Sodium Saccharin, Xanthan Gum, Hydroxypropyl Methylcellulose, Eugenol, Cl 17200, Cl 42090, Cl 73360, Cl 74160.

3. Splat special – extreme white. Promises intensive teeth whitening, protection against tooth decay and effective cleaning and polishing (fluoride content 600ppm). Ingredients: Aqua, Hydrogenated starch hydrolysate, Hydrated silica, Dicalium Phosphate Dihydrate, PEG-8, Sodium Lauryl sulfate, Hydrogenated palm oil, aroma, xanthan gum, zinc citrate, PEG – 200, Sodium methyparaben, Sodium Saccharin, Tetrasodium Glutamate Diacetate, Urea peroxide, Lecithin, PVP, Cl 77891, sodium fluoride, Cl 73360, Sodium hydroxide, Ananas Sativus Fruit extract, Maltodextrin, Limonene, Cl 16255.

4. Sodium Bicarbonate (baking powder). Sodium Bicarbonate (NaHCO3) is commonly known as baking powder. It has a high solubility, which means an easy penetration through the dental biofilm and can neutralize acids. Additionally, it is known for its abrasiveness which makes it not recommendable.

5. Airflow - the KaVo PROPHYfelx 4. The Kavo Prophyflex is known for its balanced and ergonomically designed handle and its efficiency. The product evenly distributes the airflow powder on the tooth surface, which makes it effective but at the same time is gentle to the enamel, being non-aggressive and protective. Different heads are available on the market for different treatment purposes.

The “before and after” color measurements were compared with a spectrophotometer under natural light. A spectrophotometer is a digital device that establishes colours and shades. In this study the VITA Easyshade V by the German company VITA Zahnfabrik is used. It can be used on natural teeth but also on ceramic restorations. The producer claims that the determination of the tooth shade is precise, reliable and reproducible due to the LED technology. It has an OLED color touch display and offers wireless communication via Bluetooth and using VITA Assist PC software. It is an efficient and easy-to-use device with an

ergonomic design which makes working with this spectrophotometer very enjoyable. (4) The color shade was established with VITA Easyshade V on the dry cervical surface of the tooth.

RESULTS

After taking into consideration the initial, before and after brushing color results (Table 1), the results can be seen in table 1. All sample teeth lightened up by at least one nuance.

Table 1. Comparison of shades between the procedures

GROUP	INITIAL	STAINED COLOR	BRUSHED
1	A1; A2; A1; B2; B1	A3,5; A4; A3,5; B4; A3,5	A2; A3; A2; B2; B2
2	A3; A2; A4; A3; A3	A3,5; A3; A3,5; A4; A3,5	A2; A1; A3; A2; A1
3	A1; A2; B1; A2; A2; A3	B3; B2; B3; A3; A3,5	A1; A1; A2; A2; A2
4	B2; B1; B2; A2; A3	B3; C4; C4; B3; A3,5	C3; B2; C3; B2; C3
5	B1; A2; B1; B2; A1	B2; A3; B2; C3; A3	A1; A1; A2; B1; A1

Group 1 has stained from the initial color 2 shades up. After brushing with Colgate Advanced white the color has improved one shade down. The toothpaste was not able to regain the initial color. Group 2 was brushed with Colgate Max. white. This toothpaste was able to whiten the initial color by 1 shade. Group 3 has gained approximately its initial color with the Splat extreme white toothpaste.

Groups 4 and 5 were not treated with conventional toothpaste but with sodium bicarbonate and airflow. Group 4 stained up 2 shades and improved one shade after brushing with sodium bicarbonate. This shows how big the impact of coloured food and beverages is, that it is possible to affect the base tooth color in just as little time in which the teeth were kept in coffee. Sodium bicarbonate has been known for many years to be a useful home remedy to whiten teeth, but at the same time, it has a significant impact on tooth health, specifically on its enamel surface. It can lead to tooth hypersensitivity induced by the abrasive particles, which scratch the enamel and open dentinal tubules, making the tooth sensitive. New stains will stick more easily to the surface and make the tooth appear darker. Group 5 was treated with the professional airflow that is used in the dental office. After airbrushing the shades improved one number.

DISCUSSIONS

A more aesthetically pleasing smile has long been a common aspiration for many patients seeking dental procedures. The color of the teeth is widely regarded as a key determinant of dental attractiveness, especially in the front portion of the upper set of teeth. Tooth discolouration can stem from either extrinsic or intrinsic sources. Intrinsic discolourations arise from endogenous chromogens present within the enamel and dentin, whereas extrinsic discolourations are the result of exogenous chromogens binding to the enamel surfaces [5].

Different techniques have been proposed for the removal of discolourations, including micro-abrasion, macro-abrasion, and bleaching. An optimal whitening solution should effectively eliminate surface deposits and stains while minimizing any adverse effects on the integrity of tooth enamel and restorations. However, studies have shown that toothpastes containing whitening agents and abrasives may lead to elevated levels of calcium release rates and morphological lesions on enamel [6,7]. Furthermore, dental hypersensitivity and enamel demineralization resulting from the low pH of certain bleaching agents have been documented as prevalent side effects of tooth whitening procedures [8-12].

The present study refers only to the tooth color and does not give any information on the abrasiveness. The impact and how much the tooth surface is affected cannot be determined by visual appearance. The Vita Easyshade spectrophotometer utilized in this investigation proves to be a dependable, consistent, and quantitative instrument for evaluating modifications in tooth discolouration under both controlled laboratory settings and real-life scenarios [13]. The magnitude of ΔE signifies the comprehensive alteration in color, with thresholds of at least 3.3 being acknowledged as visually discernible and clinically identifiable by the human eye [13].

It is essential to note that the tooth shade does not definitively reflect its actual health and condition. A brighter color does not necessarily equate to better health. Moreover, this study only focuses on specific teeth selected for analysis, making it challenging to evaluate certain parameters due to variations in their initial tooth color, thus presenting a limitation.

Sodium bicarbonate (NaHCO3) or baking soda is commonly incorporated in toothpaste due to its abrasive properties, which aid in removing stains. Sodium bicarbonate, in the form of a white powder with a pH value of approximately 8, has been found to be effective in whitening teeth. Some researchers suggest that abrasives like silica and sodium bicarbonate can eliminate surface stains but may not penetrate deeper intrinsic stains [14] and other studies noted a visible reduction of inherent discolourations following the utilization of sodium bicarbonate-infused toothpastes during mechanical brushing [5]. It is postulated that the utilization of CPP-ACP toothpastes mitigates the deleterious effects of whitening agents on tooth structure [15-20]. Some investigations posit that mineral compounds containing calcium and phosphate ions are more preferable than fluoride-containing compounds for use in bleaching products. This is due to the fact that fluoride ions tend to precipitate on the enamel surface, thereby obstructing further ion penetration into the subsurface lesion, consequently restricting deeper remineralization [15,21,22]. Interestingly, de Vasconcelos et al. [17] suggested that the gel containing "CPP-ACP" alone demonstrated efficacy in eliminating tooth discolouration. They posited that the remineralizing properties of CPP-ACP result in enhanced lustre and translucency of enamel, thereby contributing to a subtle enhancement in tooth color [17].

CONCLUSIONS

Within the limitations of the present study, the conclusion that can be drawn is that all whitening substances that have been used have a direct whitening effect on the tooth color. Summarizing, the whitening effect of the toothpastes is only a change in the superficial outer layer of the tooth, which is achieved by mechanical abrasion of stains.

Acknowledgments

The authors would like to acknowledge the patients who signed the informed consent and the students of the Faculty of Dentistry within the University of Medicine and Pharmacy „Victor Babes" Timisoara for their collaboration.

Conflicts of Interest

The authors declare no conflict of interest.

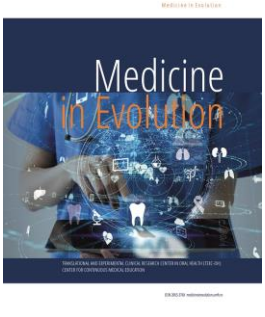
REFERENCES

[1] Ritter AV, Sturdevant CM, Herausgeber. Sturdevant's art and science of operative dentistry. Seventh edition. St. Louis: Mosby; 2018. 1 S.

[2] Rode SDM, Sato TDP, Matos FDS, Correia AMDO, Camargo SEA. Toxicity and effect of whitening toothpastes on enamel surface. Braz oral res. 2021;35:e025.

[3] Yildirim E, Koc Vural U, Yalcin Cakir F, Gurgan S. Effects of Different Over – the - Counter Whitening Products on the Microhardness, Surface Roughness, Color and Shear Bond Strength of Enamel. Acta Stomatol Croat. 15. Juni 2022;56(2):120–31.
[4] Hajdu AI, Dumitrescu R, Balean O, Lalescu DV, Buzatu BLR, Bolchis V, u. a. Enhancing Esthetics in Direct Dental Resin Composite: Investigating Surface Roughness and Color Stability. JFB. 25. Juli 2024;15(8):208.
[5] Kleber CJ, Moore MH, Nelson BJ. Laboratory assessment of tooth whitening by sodium bicarbonate dentifrices. J Clin Dent. 1998;9(3):72–5.
[6] De Araújo D, Campos EJ, Silva L, Correia De Araújo R. In vitro study on tooth enamel lesions related to whitening dentifrice. Indian J Dent Res. 2011;22(6):770.
[7] Araujo DB, Silva LR, de Araujo RPC. Calcium release rates from tooth enamel treated with dentifrices containing whitening agents and abrasives. Gen Dent. 2010;58(6):e240-245.
[8] Al-Salehi SK, Wood DJ, Hatton PV. The effect of 24h non-stop hydrogen peroxide concentration on bovine enamel and dentine mineral content and microhardness. Journal of Dentistry. November 2007;35(11):845–50.
[9] Berger SB, Cavalli V, Ambrosano GMB, Giannini M. Changes in surface morphology and mineralization level of human enamel following in-office bleaching with 35% hydrogen peroxide and light irradiation. Gen Dent. 2010;58(2):e74-79.
[10] Kossatz S, Martins G, Loguercio AD, Reis A. Tooth sensitivity and bleaching effectiveness associated with use of a calcium-containing in-office bleaching gel. The Journal of the American Dental Association. Dezember 2012;143(12):e81–7.
[11] Moosavi H, Arjmand N, Ahrari F, Zakeri M, Maleknejad F. Effect of low-level laser therapy on tooth sensitivity induced by in-office bleaching. Lasers Med Sci. Mai 2016;31(4):713–9.
[12] Ghanbarzade M, Ahrari F, Akbari M, Hamzei H. Microhardness of demineralized enamel following home bleaching and laser-assisted in office bleaching. J Clin Exp Dent. 2015;e405–9.
[13] Eslami N, Ahrari F, Rajabi O, Zamani R. The staining effect of different mouthwashes containing nanoparticles on dental enamel. J Clin Exp Dent. 2015;e457–61.
[14] Kleber CJ, Putt MS, Nelson BJ. In vitro tooth whitening by a sodium bicarbonate/peroxide dentifrice. J Clin Dent. 1998;9(1):16–21.
[15] Borges B, Borges J, De Melo C, Pinheiro I, Santos AD, Braz R, u. a. Efficacy of a Novel At-home Bleaching Technique with Carbamide Peroxides Modified by CPP-ACP and Its Effect on the Microhardness of Bleached Enamel. Operative Dentistry. 1. Oktober 2011;36(5):521–8.
[16] Borges BCD, Pinheiro MHM, De Sousa Feitosa DA, Correia TC, Braz R, Montes MAJR, u. a. Preliminary study of a novel in-office bleaching therapy modified with a casein phosphopeptide-amorphous calcium phosphate. Microscopy Res & Technique. November 2012;75(11):1571–5.
[17] Vasconcelos AAMD, Cunha AGG, Borges BCD, Vitoriano JDO, Alves-Júnior C, Machado CT, u. a. Enamel properties after tooth bleaching with hydrogen/carbamide peroxides in association with a CPP-ACP paste. Acta Odontologica Scandinavica. Juli 2012;70(4):337–43.
[18] Manton D, Bhide R, Hopcraft M, Reynolds E. Effect of ozone and Tooth MousseTM on the efficacy of peroxide bleaching. Australian Dental Journal. Juni 2008;53(2):128–32.
[19] Bayrak S, Tunc ES, Sonmez IS, Egilmez T, Ozmen B. Effects of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) application on enamel microhardness after bleaching. Am J Dent. Dezember 2009;22(6):393–6.
[20] Gama Cunha AG, Meira De Vasconcelos AA, Dutra Borges BC, De Oliveira Vitoriano J, Alves-Junior C, Machado CT, u. a. Efficacy of in-office bleaching techniques combined with the application of a casein phosphopeptide-amorphous calcium phosphate paste at different moments and its influence on enamel surface properties. Microscopy Res & Technique. August 2012;75(8):1019–25.
[21] Poosti M, Ahrari F, Moosavi H, Najjaran H. The effect of fractional CO2 laser irradiation on remineralization of enamel white spot lesions. Lasers Med Sci. Juli 2014;29(4):1349–55.
[22] Shahabi M, Ahrari F, Mohamadipour H, Moosavi H. Microleakage and shear bond strength of orthodontc brackets bonded to hypomineralized enamel following different surface preparations. J Clin Exp Dent. 2014;e110-5.

Relationship between Screen Time and Sugar Consumption - a Predictor for Children´s Oral Health



Cristina Simon[1], Malina Popa[1], Nicoleta Nikolajevic-Stoican[1], Magda Luca[1]

[1]*Department II, Pediatric Dentistry Research Center, Pedodontics University Clinic, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, 300041 Timisoara, Romania*

Correspondence to:
Name: Mălina Popa
E-mail address: popa.malina@umft.ro

Received: 4 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

The impact of screen time on children's health is a growing concern, particularly with regard to its association with dietary habits and oral health. This cross-sectional study investigates the relationship between daily recreational screen time and the consumption of cariogenic foods, including sweets, soft drinks, fast food, and snacks, among Romanian children aged 1 to 6 years. A total of 121 children were enrolled, but after applying inclusion and exclusion criteria, 74 participants (39 boys and 35 girls) were included in the final analysis. Parents provided data on their children's screen time and dietary habits through a structured questionnaire. Results indicated a significant correlation between increased screen time and higher consumption of sugary snacks and beverages, contributing to the risk of dental caries. This study highlights the need for early interventions to promote healthy screen time and eating behaviors to improve children's oral health outcomes.

Keywords: Toddler, Oral Health, Screen-time, Food Habits, Added sugar

INTRODUCTION

The triple burden of malnutrition, comprising undernutrition, hidden hunger, and overweight, poses a serious threat to children's growth and development. While the prevalence of infant undernutrition has notably decreased, there has been a rapid increase in cases of overweight and obesity [1]. This suggests that malnutrition has emerged as the primary nutritional concern for children worldwide. The toddler stage (1-3 years) is crucial for shaping eating habits and food preferences [2]. The nutritional well-being of infants and toddlers can profoundly influence long-term health outcomes [3]. Following a nutritious diet can significantly mitigate the risk of malnutrition [4].

Childhood overweight and obesity represent significant global public health concerns at present. In 2019, approximately 38 million children under the age of 5, and in 2016, over 340 million children and adolescents aged 5–19 years were affected by overweight or obesity worldwide [5]. In Europe, during the period spanning 2016 to 2017, the statistics remained equally concerning. The prevalence of overweight and obesity among children aged 6 to 9 years ranged from 10% to 21%, with the highest rates observed in Southern European nations [6]. It is crucial to note that obese children are at a higher risk of experiencing health complications both during their childhood and later in adulthood [7-9].

Childhood overweight and obesity stem from a blend of genetic, behavioral, and environmental influences [9]. These factors lead to an energy imbalance where calorie intake exceeds calorie expenditure [10]. The nutritional quality of children's diets is influenced by various factors, including gender, geographical location, parental education levels, socioeconomic status (SES), levels of physical activity, and duration of sleep [11,12]. Furthermore, children's screen time has experienced a significant surge during the COVID-19 pandemic [13]. In recent decades, the widespread availability of various electronic media devices worldwide has brought attention to the complexity of recreational screen time. While television (TV) viewing remains prevalent among schoolchildren, activities such as video gaming, computer (PC) use, and ownership of devices like tablets and smartphones have become ingrained in daily life from an increasingly young age.

Nonetheless, there is a growing concern regarding the impact of screen time on the health of children and adolescents [14]. The screen time observed in children and adolescents is linked to negative health outcomes and physiological effects, such as diminished physical fitness and adverse impacts on both psychosocial and physical well-being [15]. The American Academy of Pediatrics advises that children and adolescents should limit their screen time to no more than 2 hours per day [16].

Excessive screen time often correlates with poor dietary choices, including the consumption of high-fat, high-sugar foods and beverages, while decreasing intake of fruits and vegetables. These dietary patterns, coupled with metabolic disorders, can contribute to a higher incidence of dental caries and increased plaque accumulation. Moreover, the sedentary lifestyle associated with excessive screen viewing may impact oral health behaviors such as frequency of tooth brushing, regular dental check-ups, and overall oral hygiene practices [17].

The duration spent on screens could influence snacking behavior through various channels, including increased parental working hours leading to reduced supervision time, overlooking the negative impacts of poor dietary choices, and resorting to convenient options like mobile devices for entertainment and junk food for quick feeding [18,19].

Oral health issues represent substantial concerns that not only affect the dental well-being of children but also influence their psychosocial welfare, encompassing dental discomfort, anxiety, and absenteeism from school. These consequences extend beyond impacting individuals and families, potentially leading to increased stress and strain on

healthcare resources required for treatment provision [20]. Dental caries, classified by the World Health Organization as a significant global public health issue and the most prevalent non-communicable ailment, shares common risk factors like diet with other conditions such as obesity [21].

Aim and objectives

Hence, the aim of this study is to examine the association between daily recreational screen time and the consumption frequency of sweets, soft drinks, fast food, and snacks among a group of Romanian children aged 1 to 6 years.

MATERIAL AND METHODS

1.1. Ethic Approvals

The research procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki, following the guidelines established in 2008 and the most recent amendment in 2013. Parental consent was obtained prior to the participation of the children in the study. Ethical approval was granted by the Research Ethics Committee of the Faculty of Medicine and Pharmacy at the University of Victor Babeş, Timişoara (IRB No. CEFMF/10, dated 30 May 2024).

1.2. Study Design and Participants

This study was conducted at the Pedodontics Dentistry Clinic, Faculty of Dentistry, University of Medicine and Pharmacy Victor Babeş, Timişoara, and involved a sample of children aged 1–6 years. Data were collected using a questionnaire administered to the parents, which assessed various aspects of their children's diets and screen time habits. The questionnaire gathered information on the duration of screen exposure—including television, computers, and phones—and the frequency of consumption of potentially cariogenic foods such as sweets, soft drinks, fast food, and snacks. This methodology aimed to explore the association between screen time and dietary habits within the specified age group, with a focus on potential implications for oral health.

Inclusion criteria required parents to have the ability to read and fully comprehend the questionnaire, while children had to fall within the specified age range. Children with developmental disorders or medical conditions affecting dietary habits were excluded. Initially, 121 children aged 1–6 years were enrolled in the study; however, 47 were excluded due to non-compliance with inclusion criteria (e.g., developmental disorders or incomplete questionnaires) or missing data. This resulted in a final sample size of 74 children (39 boys and 35 girls). The study utilized a cross-sectional design, collecting data on screen time and cariogenic food consumption through a structured parental questionnaire.

1.3. Data Collection

Data were collected using a questionnaire divided into three sections: demographic and anthropometric data, screen time, and eating behavior. The questionnaire was distributed to parents for completion after obtaining their informed consent. It collected information on general demographic details, children's screen time, eating behaviors, and specific characteristics of the children.

1.3.1. Demographics and Anthropometrics

General demographic information, including gender, age, the respondent's relationship to the child, and their level of education, was collected through the questionnaire.

1.3.2. Screen Time Assessment:

The time children spent on various screen-based activities, including television watching, playing video games, and using a computer, tablet, or smartphone, was reported

by parents. Screen time was categorized into levels based on the World Health Organization's recommendations for preschool-aged children, which suggest limiting screen time to less than one hour per day.

The frequency of cariogenic food consumption, including sweets, sugary drinks, and fast food, was assessed through the questionnaire using a 5-point Likert scale. Responses ranged from 1 ("never") to 5 ("always").

1.3.3. Cariogenic Food Consumption Assessment:

Cariogenic food consumption was assessed using a series of questions that asked about the frequency of consuming various cariogenic foods and drinks, including:

- Sugary snacks (e.g., candy, cookies, chips)
- Sweetened beverages (e.g., soda, juice, sports drinks)
- Refined carbohydrates (e.g., white bread, pasta, rice)
- Processed meats (e.g., hot dogs, sausages, bacon)

Parents were asked to report the frequency of consuming each food item, using a 5-point scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always).

1.3.4. Data Analysis:

Descriptive statistics summarized demographic data, screen time, and food consumption habits. Pearson's correlation was applied to explore the relationship between screen time and cariogenic food intake. Children were divided into two age groups (<4 years, >4 years) to examine age-related differences. All analyses were conducted using R 4.3.1 software.

1.3.5. Age-Related Analysis:

To examine age-related differences in the relationship between screen time and cariogenic food consumption, the study population was divided into two age groups: children younger than 4 years (n = 35) and children older than 4 years (n = 39). Separate correlation analyses were conducted for each age group to examine the relationship between screen time and cariogenic food consumption.

1.3.6. Statistical Software:

All data analyses were conducted using R 4.3.1 software.

RESULTS

The final study sample consisted of 74 children, of which 39 (52.7%) were boys and 35 (47.3%) were girls. Among these, 65% of children exceeded the recommended screen time limits of less than one hour per day. Table 1 provides a summary of demographic characteristics, screen time habits, and dietary behavior patterns across the study population. Children aged 4 years and older exhibited higher screen time and a greater frequency of consuming sugary snacks and drinks compared to younger children.

Table 1. Summary of demographic characteristics and behaviors

Variable	Total (N=74)	Age ≤ 4 Years (n=35)	Age > 4 Years (n=39)
Boys (%)	52.7%	48.6%	56.4%
Girls (%)	47.3%	51.4%	43.6%
Exceeding Screen Time (%)	65%	58%	71%
High Sugary Snack Intake (%)	43%	32%	51%

The first figure (Figure 1) explores the frequency of sugary drink consumption among children aged ≤4 years in relation to whether they are allowed to eat during screen time.

Among children not allowed to eat during screen time, 6 children consume sugary drinks once a week, another 6 children never consume sugary drinks, 4 children consume them less than once a week, and 1 child consumes them several times a week. In contrast, among children allowed to eat during screen time, 7 children consume sugary drinks less than once a week, 2 children never consume sugary drinks, 2 children consume them several times a week, and 1 child consumes them once a week. These findings suggest a slightly higher frequency of sugary drink consumption among children permitted to eat during screen time.

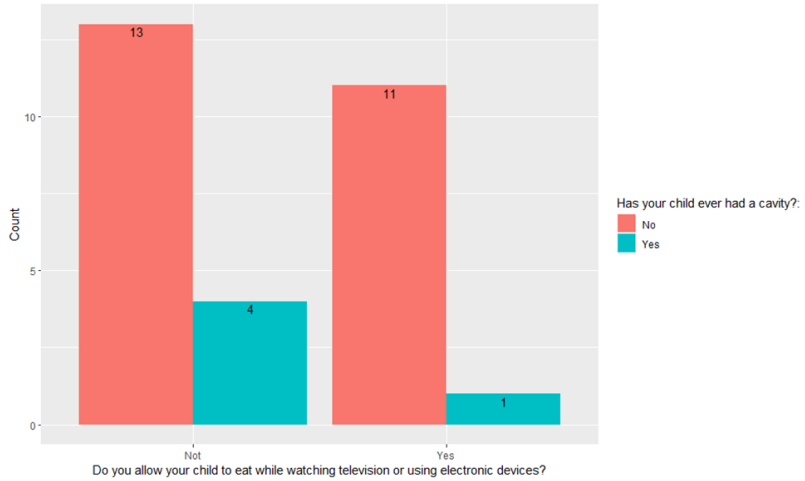


Figure 1. Association Between Eating Habits During Electronic Device Use and the Presence of Dental Caries in Children Aged ≤4 Years

The second figure (Figure 2) illustrates the frequency of sweet snack consumption among the same groups of children. Among those not allowed to eat during screen time, 8 children never consume sweet snacks, 6 children consume them less than once a week, 2 children consume them once a week, and 1 child consumes sweet snacks several times a week. Among children allowed to eat during screen time, 9 children never consume sweet snacks, 1 child consumes them less than once a week, 1 child consumes them once a week, and 1 child consumes sweet snacks several times a week. Overall, the majority of children, regardless of whether they are allowed to eat during screen time, do not consume sweet snacks.

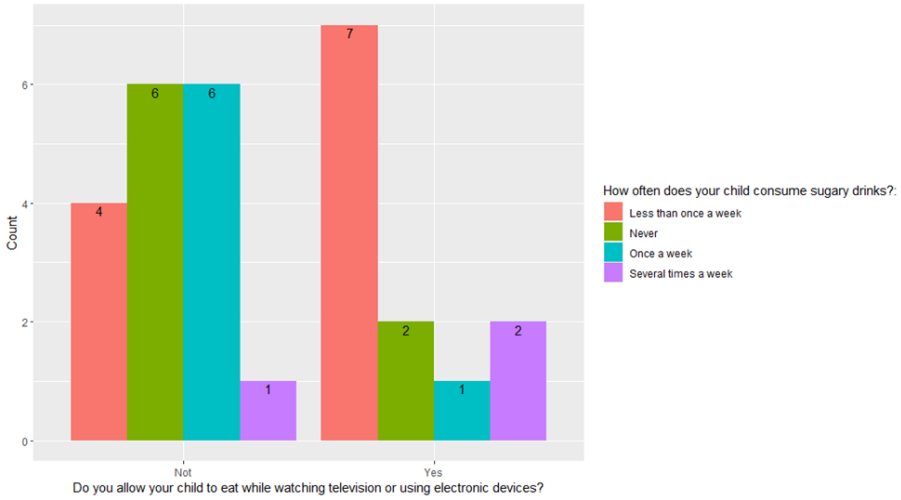


Figure 2. Association Between Screen-Time Eating Habits and Sugary Drink Consumption in Children Aged ≤4 Years

The third figure (Figure 3) examines the relationship between screen-time eating habits and the occurrence of cavities. Among children not allowed to eat during screen time, 13 children have never had a cavity, while 4 children have had at least one cavity. Among children allowed to eat during screen time, 11 children have never had a cavity, and 1 child has had at least one cavity. These results reveal a notable difference in cavity occurrence, with a higher prevalence of cavities observed in children who are allowed to eat during screen time.

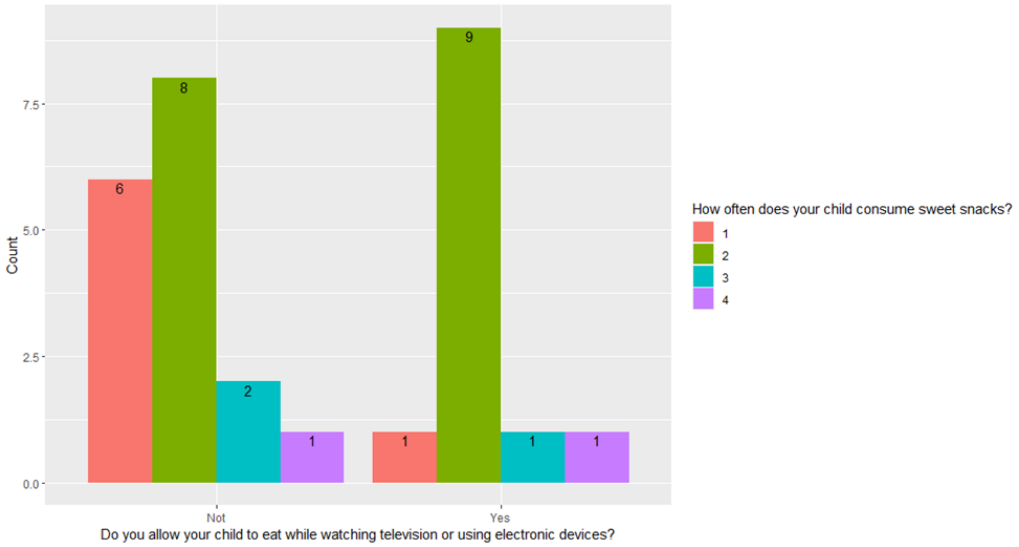


Figure 3. Relationship Between Screen-Time Eating Habits and Sweet Snack Consumption in Children Aged ≤4 Years

For children aged > 4 years, the figures analyze the potential impact of using electronic devices during meals on dental health and dietary habits: Children not allowed to eat with devices show an equal distribution of cavity cases, with 11 having cavities and 11 not. In contrast, among those permitted to eat with devices, 6 have cavities, while only 3 do not. This indicates a potential association between eating with electronic devices and a slightly higher prevalence of cavities (Figure 4).

Figure 5 highlights that children not eating with devices most often consume sugary drinks "less than once a week" (8) or "never" (8). On the other hand, children allowed to eat with devices show a higher frequency of sugary drink consumption, with 5 drinking them "once a week" and 3 "several times a week," suggesting a possible link between device use and increased sugary drink intake. Figure 6 illustrates that children not eating with devices tend to consume sweet snacks at moderate frequencies (6 at level 1, 8 at level 2). In comparison, children eating with devices are more likely to consume sweet snacks at higher frequencies, with fewer at the lowest level (3 at level 1) and more at the highest level (4 at level 4).

Overall, these findings suggest that eating while using electronic devices among children aged > 4 years may be linked to unhealthier dietary habits, including increased sugary drink and snack consumption, as well as a heightened risk of cavities. Further research is needed to confirm these associations and establish causation.

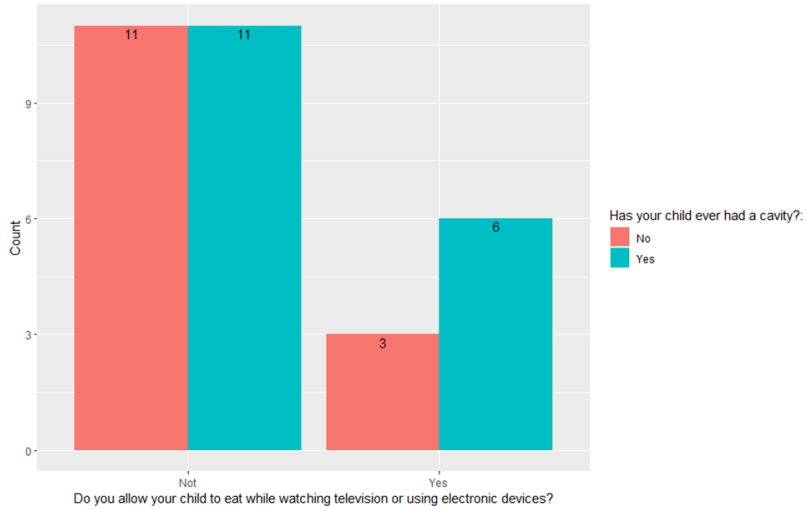


Figure 4. Association Between Eating Habits During Electronic Device Use and the Presence of Dental Caries in Children Aged > 4 Years

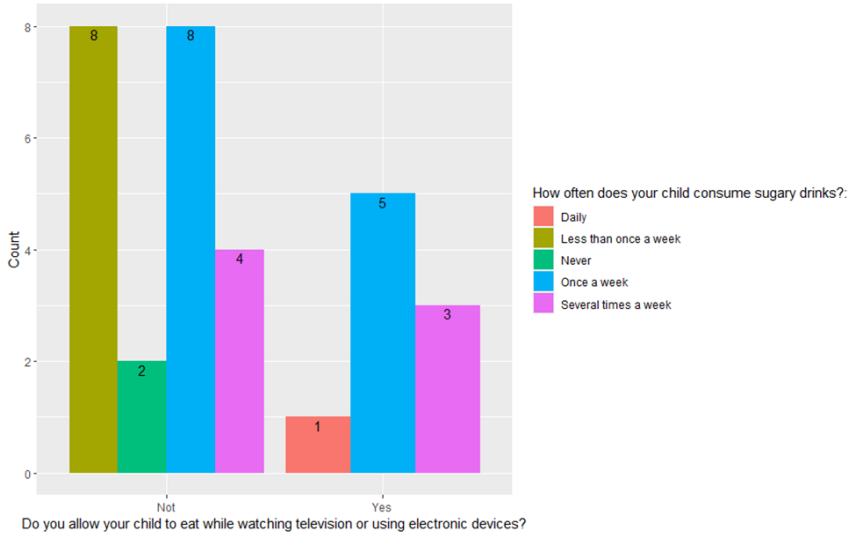


Figure 5. Association Between Screen-Time Eating Habits and Sugary Drink Consumption in Children Aged >4 Years

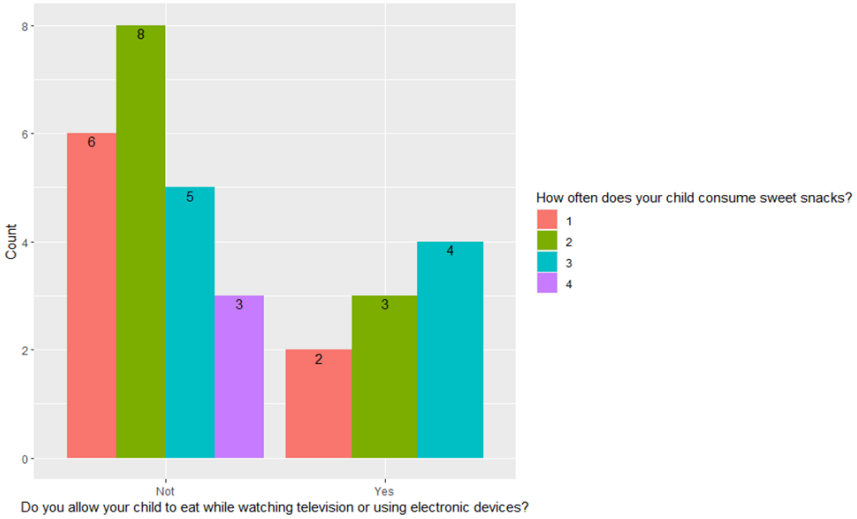


Figure 6. Relationship Between Screen-Time Eating Habits and Sweet Snack Consumption in Children Aged >4 Years

A significant positive correlation was identified between screen time and the frequency of sugary snack consumption ($r = 0.56$, $p < 0.05$). This relationship was particularly pronounced among children older than 4 years, who were more likely to engage in unhealthy eating habits as screen time increased. The correlation analysis underscores that prolonged screen exposure is associated with higher consumption of cariogenic foods, such as sugary snacks and drinks.

DISCUSSIONS

The results of this study are consistent with prior research indicating that screen time is linked to unhealthy eating behaviors, including the preference for sugary snacks and beverages. These behaviors contribute to a higher risk of developing dental caries, which is one of the most prevalent chronic conditions in children. Given the increasing screen time among young children, especially following the COVID-19 pandemic, there is an urgent need for public health interventions aimed at reducing screen time and promoting healthier eating habits. Moreover, the role of parents in monitoring both screen time and dietary habits is crucial. Parental education on the impact of screen time on children's overall health, including oral health, should be emphasized in health promotion campaigns. Furthermore, this study suggests the importance of implementing national guidelines on screen time and nutrition in early childhood to prevent long-term health issues.

According to the American Academy of Pediatrics (AAP), the guidelines for screen time are well-defined: no screen exposure for children under 18 months, a maximum of one hour per day for children aged 2-5 years, and for children aged 6 and older, restrictions should be imposed on both the duration of screen use and the type of media accessed. Similarly, the WHO recommends that preschoolers should spend less than one hour per day in front of electronic screens [22].This study reveals that 65% of children exceed the American Academy of Pediatrics (AAP) and WHO recommendation by spending more than 1 hour per day on screens, aligning with findings from a UK survey, where 79.4% of 5-year-old preschoolers reported using electronic screens for more than 1 hour daily [23]. Preschoolers in various regions around the world exhibit differing amounts of screen time, likely due to variations in economic levels. This suggests that particular attention should be given to children's screen time in economically developed regions [24].

Our study identified a significant positive correlation between screen time and the consumption of snacks and sugar-sweetened beverages (SSBs), which is consistent with findings from earlier research [25]. One potential explanation for this phenomenon is that preschool children may inadvertently consume energy-dense, nutrient-poor foods, such as snacks and SSBs, while interacting with electronic screens [26]. Numerous studies have indicated that extended exposure to screen time is associated with a reduced intake of fruits and vegetables, along with an increased consumption of snacks and sugar-sweetened beverages (SSBs) [25]. Additionally, research conducted on Canadian children demonstrated a positive correlation between television viewing and the consumption of energy-dense foods and beverages, as well as fast food, while showing a negative correlation with fruit and vegetable intake [27]. Therefore, the risk of developing dental caries is significantly higher due to the increased consumption of sugar-sweetened foods and beverages, as indicated by various studies [28]. Dental caries are not the only negative effects associated with sugar consumption; weight gain, type 2 diabetes, and certain cancers have also been linked to excessive sugar intake [29]. However, the majority of these studies have concentrated on school-aged children and adolescents [30], or have aimed to investigate the dangers associated with excessive screen time [31], Only a limited number of studies have attempted to examine the relationship between screen time and food consumption in preschoolers [32].

The preschool years are a critical stage for developing healthy eating behaviors and habits that play a key role in promoting long-term health into adulthood [25]. Therefore, it is essential to understand the current patterns of screen time in preschool children and how it relates to their food consumption. In Romania, there are few studies investigating the relationship between the use of electronic devices and eating behavior. In the future, further research on this topic is needed within the national context.

CONCLUSIONS

This study highlights a significant association between increased screen time and the consumption of cariogenic foods, which elevates the risk of dental caries in young children. As the prevalence of excessive screen time continues to rise, targeted interventions focusing on reducing screen time and promoting healthier dietary choices are essential. Dental health professionals should incorporate advice on screen time management and nutritional counseling into routine pediatric care to help mitigate the risk of dental caries and other related health conditions in children. Further research is needed to explore the long-term effects of early screen exposure on dietary habits and oral health outcomes.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Gonçalves H, Barros FC, Buffarini R, Horta BL, Menezes AMB, Barros AJD, et al. Infant nutrition and growth: trends and inequalities in four population-based birth cohorts in Pelotas, Brazil, 1982–2015. International Journal of Epidemiology [Internet]. 2019 Apr 1 [cited 2024 Mar 3];48(Supplement_1):i80–8. Available from: https://academic.oup.com/ije/article/48/Supplement_1/i80/5382482

[2] Penha SDC, Norde MM, Carioca AAF. Childhood eating practices are relevant to ultra-processed food consumption in adulthood: results from the Nutritionists' Health Study. J Dev Orig Health Dis [Internet]. 2022 Oct [cited 2024 Mar 3];13(5):583–92. Available from: https://www.cambridge.org/core/product/identifier/S2040174421000696/type/journal_article

[3] Ley D, Desseyn JL, Gouyer V, Plet S, Tims S, Renes I, et al. Early life nutrition influences susceptibility to chronic inflammatory colitis in later life. Sci Rep [Internet]. 2019 Dec 2 [cited 2024 Mar 3];9(1):18111. Available from: https://www.nature.com/articles/s41598-019-54308-6

[4] Snetselaar LG, De Jesus JM, DeSilva DM, Stoody EE. Dietary Guidelines for Americans, 2020–2025: Understanding the Scientific Process, Guidelines, and Key Recommendations. Nutr Today [Internet]. 2021 Nov [cited 2024 Mar 3];56(6):287–95. Available from: https://journals.lww.com/10.1097/NT.0000000000000512

[5] Cartanyà-Hueso À, González-Marrón A, Lidón-Moyano C, Garcia-Palomo E, Martín-Sánchez JC, Martínez-Sánchez JM. Association between Leisure Screen Time and Junk Food Intake in a Nationwide Representative Sample of Spanish Children (1–14 Years): A Cross-Sectional Study. Healthcare [Internet]. 2021 Feb 18 [cited 2024 Mar 3];9(2):228. Available from: https://www.mdpi.com/2227-9032/9/2/228

[6] Childhood Obesity Surveillance Initiative (COSI) Factsheet. Highlights 2015-17 [Internet]. [cited 2024 Mar 3]. Available from: https://www.who.int/andorra/publications/m/item/childhood-obesity-surveillance-initiative-(cosi)-factsheet.-highlights-2015-17

[7] Umer A, Kelley GA, Cottrell LE, Giacobbi P, Innes KE, Lilly CL. Childhood obesity and adult cardiovascular disease risk factors: a systematic review with meta-analysis. BMC Public Health [Internet]. 2017 Dec [cited 2024 Mar 3];17(1):683. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-017-4691-z

[8] Chung ST, Onuzuruike AU, Magge SN. Cardiometabolic risk in obese children. Annals of the New York Academy of Sciences [Internet]. 2018 Jan [cited 2024 Mar 3];1411(1):166–83. Available from: https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/nyas.13602

[9] Spinelli A, Buoncristiano M, Kovacs VA, Yngve A, Spiroski I, Obreja G, et al. Prevalence of Severe Obesity among Primary School Children in 21 European Countries. Obes Facts [Internet]. 2019 [cited 2024 Mar 3];12(2):244–58. Available from: https://www.karger.com/Article/FullText/500436

[10] Obesity and overweight [Internet]. [cited 2024 Mar 3]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

[11] Özkul Sağlam N. The factors that affect the breastfeeding and complementary feeding choices of children between 24-48 months. Sisli Etfal [Internet]. 2018 [cited 2024 Mar 3]; Available from: http://www.sislietfaltip.org/jvi.aspx?un=SETB-91328

[12] Janmohamed A, Luvsanjamba M, Norov B, Batsaikhan E, Jamiyan B, Blankenship JL. Complementary feeding practices and associated factors among Mongolian children 6–23 months of age. Maternal & Child Nutrition [Internet]. 2020 Oct [cited 2024 Mar 3];16(S2):e12838. Available from: https://onlinelibrary.wiley.com/doi/10.1111/mcn.12838

[13] Kołota A, Głąbska D. COVID-19 Pandemic and Remote Education Contributes to Improved Nutritional Behaviors and Increased Screen Time in a Polish Population-Based Sample of Primary School Adolescents: Diet and Activity of Youth during COVID-19 (DAY-19) Study. Nutrients [Internet]. 2021 May 11 [cited 2024 Mar 3];13(5):1596. Available from: https://www.mdpi.com/2072-6643/13/5/1596

[14] Domingues-Montanari S. Clinical and psychological effects of excessive screen time on children. J Paediatrics Child Health [Internet]. 2017 Apr [cited 2024 Mar 3];53(4):333–8. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jpc.13462

[15] Tambalis KD, Panagiotakos DB, Psarra G, Sidossis LS. Screen time and its effect on dietary habits and lifestyle among schoolchildren. Cent Eur J Public Health [Internet]. 2020 Dec 18 [cited 2024 Mar 3];28(4):260–6. Available from: http://cejph.szu.cz/doi/10.21101/cejph.a6097.html

[16] Bomfim RA, Frias AC, Cascaes AM, Mazzilli LEN, Souza LBD, Carrer FCDA, et al. Sedentary behavior, unhealthy food consumption and dental caries in 12-year-old schoolchildren: a population-based study. Braz oral res [Internet]. 2021 [cited 2024 Mar 3];35:e041. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1806-83242021000100240&tlng=en

[17] Olczak-Kowalczyk D, Tomczyk J, Gozdowski D, Kaczmarek U. Excessive computer use as an oral health risk behaviour in 18-year-old youths from Poland: A cross-sectional study. Clinical & Exp Dental Res [Internet]. 2019 Jun [cited 2024 Mar 3];5(3):284–93. Available from: https://onlinelibrary.wiley.com/doi/10.1002/cre2.183

[18] Mollborn S, Limburg A, Pace J, Fomby P. Family socioeconomic status and children's screen time. J of Marriage and Family [Internet]. 2022 Aug [cited 2024 Mar 3];84(4):1129–51. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jomf.12834

[19] Pérez-Farinós N, Villar-Villalba C, López Sobaler AM, Dal Re Saavedra MÁ, Aparicio A, Santos Sanz S, et al. The relationship between hours of sleep, screen time and frequency of food and drink consumption in Spain in the 2011 and 2013 ALADINO: a cross-sectional study. BMC Public Health [Internet]. 2017 Dec [cited 2024 Mar 3];17(1):33. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3962-4

[20] Al-Mazyad M, Flannigan N, Burnside G, Higham S, Boyland E. Food advertisements on UK television popular with children: a content analysis in relation to dental health. Br Dent J [Internet]. 2017 Feb [cited 2024 Mar 3];222(3):171–6. Available from: https://www.nature.com/articles/sj.bdj.2017.120

[21] Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990–2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res [Internet]. 2017 Apr [cited 2024 Mar 3];96(4):380–7. Available from: http://journals.sagepub.com/doi/10.1177/0022034517693566

[22] Sukhpreet K. TamanaID1, Victor Ezeugwu1,Joyce Chikuma1,Diana L.Lefebvre 2,Meghan B. Azad3,Theo J.Moraes 4,Padmaja Subbarao4,Allan B. Becker3,Stuart E. Turvey5, Malcolm R. Sears2,Bruce D. Dick6,Valerie Carson7,Carmen Rasmussen1,CHILD study

Investigators¶,Jacqueline Pei8,Piush J.Mandhane 1*. Screen-time is associated with inattention problems in preschoolers: Results from the CHILD birth cohort study [Internet]. 2019. Available from: https://doi.org/10.1371/journal.pone.0213995

[23] Alison Parkes, Helen Sweeting, Daniel Wight, Marion Henderson Correspondence to Dr Alison Parkes, MRC/CSO Social and Public Health Sciences Unit, University of Glasgow, 4 Lilybank Gardens, Glasgow G12 8RZ, UK; Alison-p@sphsu.mrc.ac.uk. Do television and electronic games predict children's psychosocial adjustment? Longitudinal research using the UK Millennium Cohort Study. Alison Parkes, Helen Sweeting, Daniel Wight, Marion Henderson;

[24] Juliana Nogueira Pontes Nobre (https://orcid.org/0000-0002-9876-1136) 1, Juliana Nunes Santos (https://orcid.org/0000-0002-1101-5270) 2, Lívia Rodrigues Santos (https://orcid.org/0000-0003-3318-1592) 3, Sabrina da Conceição Guedes (https://orcid.org/0000-0002-9738-2302) 2, Leiziane Pereira (https://orcid.org/0000-0002-8290-960X) 2, Josiane Martins Costa (https://orcid.org/0000-0002-4266-4070) 2, et al. Determining factors in children's screen time in early childhood [Internet]. Available from: DOI: 10.1590/1413-81232021263.00602019

[25] Claudia Börnhorst 1, , Trudy MA Wijnhoven 2* , Marie Kunešová 3, , Agneta Yngve 4, , Ana I Rito 5, , Lauren Lissner 6, , et al. WHO European Childhood Obesity Surveillance Initiative: associations between sleep duration, screen time and food consumption frequencies [Internet]. Available from: DOI 10.1186/s12889-015-1793-3

[26] Jiaqi Huo 1,†, Xiaoni Kuang 2,†, Yue Xi 3, Caihong Xiang 1, Cuiting Yong 1, Jiajing Liang 1, Hanshuang Zou 1 and Qian Lin 1,*. Screen Time and Its Association with Vegetables, Fruits, Snacks and Sugary Sweetened Beverages Intake among Chinese Preschool Children in Changsha, Hunan Province: A Cross-Sectional Study [Internet]. Nutrients 2022; Available from: https://doi.org/10.3390/nu14194086

[27] Michael M. Borghese, Mark S. Tremblay, Genevieve Leduc, Charles Boyer, Priscilla Bélanger, Allana G. LeBlanc, Claire Francis, and Jean-Philippe Chaput. Independent and combined associations of total sedentary time and television viewing time with food intake patterns of 9- to 11-year-old Canadian children [Internet]. Available from: dx.doi.org/10.1139/apnm-2013-0551

[28] Qiping Yang †, Yue Xi † , Hanmei Liu, Jing Luo, Yufeng Ouyang, Minghui Sun, Cuiting Yong, Caihong Xiang and Qian Lin *. Free Sugars Intake among Chinese Adolescents and Its Association with Dental Caries: A Cross-Sectional Study [Internet]. Available from: https://doi.org/10.3390/ nu13030765

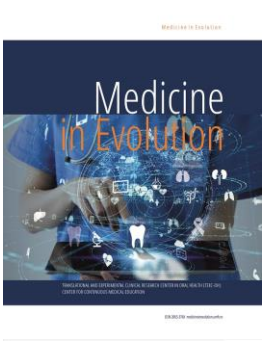
[29] Vasanti S. Malik 1,2,* and Frank B. Hu 2,3,4. Sugar-Sweetened Beverages and Cardiometabolic Health: An Update of the Evidence. 2019.

[30] Konstantinos D. Tambalis1, Demosthenes B. Panagiotakos1, Glykeria Psarra1, Labros S. Sidossis1, 2 1Department of Nutrition and Dietetics, Harokopio University, Athens, Greece 2Department of Kinesiology and Health, Rutgers University, New Brunswick, New Jersey, USA. SCREEN TIME AND ITS EFFECT ON DIETARY HABITS AND LIFESTYLE AMONG SCHOOLCHILDREN [Internet]. Cent Eur J Public Health 2020; Available from: https://doi.org/10.21101/cejph.a6097

[31] Rafael Aiello BOMFIM(a) Antonio Carlos FRIAS(b) Andreia Morales CASCAES(c) Luiz Eugênio Nigro MAZZILLI(b) Luciana Bronzi de SOUZA(d) Fernanda Campos de Almeida CARRER(b) Maria Ercília de ARAÚJO(b). Sedentary behavior, unhealthy food consumption and dental caries in 12-year-old schoolchildren: a population-based study [Internet]. Available from: https://doi.org/10.1590/1807-3107bor-2021.vol35.0041

[32] Rachael Cox, Helen Skouteris, Leonie Rutherford, Matthew Fuller-Tyszkiewicz, Daniela Dell' Aquila and Louise L. Hardy. Television viewing, television content, food intake, physical activity and body mass index: a cross-sectional study of preschool children aged 2-6 years.

Relationship between Fixed Orthodontic Treatment and Oral Hygiene. Patients Self-Reported Attitudes and Habits



Malina Popa[1], Ioana Veja (Ilyes)[2], Carolina Cojocariu[2], Iustin Olariu[2], Tiberiu Hosszu[2], Ioana Elena Lile[2], Diana Marian[2], Isabela Toser[2,3], Roxana Radu[4], Serban Talpos[5]

[1]Pediatric Dentistry Research Center (Pedo-Research), Department of Pediatric Dentistry, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy Timisoara, Eftimie Murgu Square 2, 300041 Timisoara, Romania
[2]Department of Dentistry, Faculty of Dental Medicine, "Vasile Goldis" Western University of Arad, Romania
[3]PhD, Doctoral School UMFTVB, Department I, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara, Romania
[4]Private practice, Timisoara, Romania
[5]Discipline of Oral and Maxillo-Facial Surgery, Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy Timisoara, 300041 Timisoara, Romania

Correspondence to:
Name: Ioana Veja (Ilyes)
E-mail address: ilyes.ioana@uvvg.ro

Received: 4 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

1.Aim and objectives: The objective of this evaluation was to assess data regarding the frequency, guidelines, and products associated with oral hygiene (OH) in orthodontic patients. 2.Material and methods: This study was a analysis conducted among orthodontic patients. Thirty patients, comprising twenty-five in the fixed orthodontic appliance and five in the removable orthodontic cohort, satisfied the inclusion criteria. A paired t-test was performed on all tested variables to evaluate intra-group and inter-group differences at each observation. p value of < 0.05 was considered statistically significant. 3.Results: All of the patients in the control and study groups were comparable regarding age, gender and initial plaque and gingival indices values ($p > 0.05$). The eighth week plaque and gingival indices of the test group were also significantly lower than those of the control group ($p < 0.001$). 4.Conclusions: Our findings indicate that conventional verbal and written instructional treatments are more effectively complemented by hands-on assisted training programs, contingent upon the orthodontist's limitations. A longer educational intervention correlates with improved preservation of plaque and gingival indices.

Keywords: oral hygiene, biofilm, prevention, orthodontic patients

INTRODUCTION

Malocclusion is frequently regarded as detrimental to an individual's physical, social, and mental health, as well as their self-esteem [1-3]. Consequently, patients seek orthodontic treatment to improve their aesthetics, oral functionality, psychological health, and overall quality of life. The primary motivation for adult patients pursuing orthodontic treatment is aesthetic enhancement [4].

Reports indicate that 40–62.4% of the population requires orthodontic treatment [5]. The heightened awareness of the advantages of orthodontic treatment has led to a rise in individuals pursuing such treatment during the past two decades [5]. The increasing demand for orthodontic treatment, coupled with the government's restricted capacity to provide such services, has facilitated the establishment of private orthodontic practices in Romania [6].

Orthodontic patients may necessitate either detachable or fixed appliance therapy depending on the diagnosis and severity of their issue. The elements of fixed orthodontic appliances, like as brackets, may provide an aesthetically displeasing appearance, impose functional limitations, and cause discomfort and agony during treatment, thereby impacting patients' oral health-related quality of life [7]. Previous research has delineated the distinctions between removable and fixed orthodontic treatment devices in terms of aesthetics, cost, technical and dental health considerations, and patient experiences [8]. The pain and discomfort levels experienced by patients receiving removable and fixed dental appliance therapy differed among the groups [9] Furthermore, certain studies indicated a greater prevalence of eating disturbances in patients undergoing treatment with conventional fixed braces compared to those receiving detachable appliance therapy [10].

Orthodontic appliances will likely adversely affect oral hygiene indices due to the configuration and placement of both detachable and fixed devices. Nonetheless, prior studies yielded incongruous findings on the effects of removable and fixed braces modalities on dental health-related quality of life [10] The conflicting results may be linked to the limited sample size, necessitating studies with bigger samples. Moreover, it remains uncertain if patients undergoing detachable appliance therapy experience less oral health implications compared to those receiving fixed appliance orthodontic therapy [11].

Dental caries and periodontal disease, the most prevalent oral disorders, are classified as behavioural diseases due to the essential role of adopting healthy oral habits in their management [12]. Literature indicates that orthodontic appliances affect the maintenance of oral hygiene [13]. The uneven surfaces of brackets, bands, wires, ligatures, and other orthodontic appliances have been demonstrated to enhance plaque accumulation and impede the teeth's natural cleansing processes, including the movement of the cheek muscles and salivary flow [14]. It is essential to acknowledge the heightened plaque accumulation induced by orthodontic appliances, as microbial plaque is the principal etiological factor in tooth caries and periodontal disorders, notwithstanding the varying pathogenic mechanisms implicated [15]. The literature indicates a correlation between fixed orthodontic treatment and various adverse conditions, including white spot lesions (WSL) resulting from dental plaque, carious lesions exhibiting cavitation alongside the advancement of WSL, and periodontal issues such as gingivitis, bleeding, and alveolar bone loss [16]. Such difficulties may extend or even conclude the orthodontic treatment process. The inability to mitigate the detrimental consequences of inadequate oral hygiene during orthodontic treatment may pose a considerable public health issue. Consequently, individuals receiving orthodontic treatment must maintain excellent oral hygiene practices and be cognizant of potential complications that may arise during the process.

Reports indicate that issues arising from plaque accumulation during orthodontic treatment can be mitigated with the application of appropriate dental hygiene education, patient awareness, and motivation tactics [15]. It is essential to assess the patient's perspective, disposition, and degree of compliance during the treatment process when evaluating the management system and the efficacy of orthodontic therapy. Patients have varying degrees of understanding and viewpoints concerning oral hygiene practices and the accompanying treatment risks. These disparities may stem from cultural shifts, accessibility of oral health care, and varying demographics [17]. To formulate effective oral hygiene programs in orthodontic treatment, it is crucial to assess the oral hygiene practices and the perceptions of treatment risks and attitudes towards orthodontic care among the target demographic.

Aim and objectives

This study aims to assess patients' opinions and perspectives regarding the correlation between orthodontic treatment and oral hygiene, as well as their oral hygiene practices. The comparison of oral health effects between removable and fixed orthodontic treatments remains a problem and requires additional evidence to inform the selection of orthodontic component therapy in clinical practice. This study posited that restrictions in daily activities, dietary intake, and mouth discomfort varied between patients undergoing detachable versus fixed orthodontic treatment. The study's aims can be summarized as follows: to evaluate patients' understanding of oral hygiene practices and potential oral health issues related to orthodontic treatment, to examine patients' perceptions regarding oral hygiene and orthodontic treatment, and to identify the factors that affect patients' attitudes and behaviours regarding oral hygiene throughout fixed orthodontic treatment.

The first null hypothesis was that none of the oral hygiene education methods would affect oral hygiene.

MATERIAL AND METHODS

The study design conforms to the requirements of the Declaration of Helsinki as adopted by the 18th World Medical Assembly in 1964 and subsequently revised. All subjects were informed about the nature and purpose of the study, and each subject signed an Informed Consent. The study was carried out between October 2020 and October 2023.

The subjects of this study were patients with fixed orthodontic appliances, and each had a minimum of 20 permanent teeth present in the oral cavity. The study group comprised 30 orthodontic patients recruited consecutively over a period of 6 months. The participants were randomly allocated to a test group (n = 15) and a control group (n = 15).

Inclusion criteria:

(1) physically healthy with no relevant allergies or systemic diseases;

(2) more than 12 years;

(3) capable of maintaining adequate oral hygiene;

(4) optimal dental health without immediate necessity for any associated dental procedures.

Exclusion criteria:

(1) skeletal anteroposterior discrepancies between the maxilla and mandible;

(2) differences between centric relation and centric occlusion over 3 mm;

(3) active periodontal disease.

The oral hygiene condition was evaluated for each patient by plaque and gingival indices. The plaque index technique established by Heintze et al. [18] was employed to document the plaque condition of these orthodontic patients. Initially, all buccal and lingual

surfaces of the bonded teeth were marked with a revealing agent (Figure 1-3). Three sites were documented on the buccal surface of each tooth and three on the oral surface. The existence or nonexistence of plaque at each location was documented.

Figure 1. Clinical image before staining

Figure 2. Application of the disclosing agent buccal view

Figure 3. Application of the disclosing agent lateral view

To determine the percentage of plaque presence, the quantity of sites impacted by plaque was multiplied by the weighting factor and subsequently divided by the total number of teeth present. Banded teeth and third molars in the full dentition were excluded from the count, as the latter were infrequently banded. The buccal and lingual surfaces were utilized to compute the buccal plaque index and the lingual plaque index, respectively. The average plaque index was calculated by summing the buccal and lingual plaque indices. The gingival index system was adapted from Löe's methodology: healthy gingiva was assigned a score of 0, redness a score of 1, redness with probing-induced bleeding a score of 2, and spontaneous bleeding a score of 3 [19].

Each tooth was partitioned into buccal and lingual surfaces, which were subsequently subdivided into mesial, central, and distal sections. The gingival index for each tooth was recorded for six segments. The average buccal gingival index was calculated by summing the gingival indices from all buccal sites and dividing by the total number of teeth. The lingual gingival index was computed in a same fashion as the buccal gingival index. The mean gingival index was the aggregate of the buccal and lingual gingival indices.

Oral hygiene instruction

Control group **-** the patients in the control group received standard printed educational material and were assisted with verbal information.

Test group **-** the patients in this study group received hands-on training.

The significance of removing dental plaque for oral health was underscored, and oral hygiene instructions were reiterated by the same author at each appointment. All patient groups utilized identical toothbrushes and toothpaste during the trial and were instructed to

clean their teeth a minimum of three times daily for three minutes each session. The patients' brushing habits were assessed at each consultation, and the orthodontic archwires were secured using stainless steel wires.

The questionnaire was used in order to evaluate the sociodemographic attributes, baseline oral hygiene behaviors including toothbrushing techniques, frequency, and the utilization of oral hygiene adjuncts such as interdental brushes, dental floss, and mouth rinses by the participants. Eight questions were made to evaluate the patient's dental hygiene practices, focusing on the usage of dental floss, the daily frequency of tooth brushing, and the application of mouth rinse. The inquiries encompassed both closed and open-ended formats.

Data analysis

A paired *t*-test was performed on all tested variables to evaluate intra-group and inter-group differences at each observation. p value of < 0.05 was considered statistically significant.

RESULTS

The mean age of participants was 15.93 ± 1.39 years, with females predominant (63.33%). All the subjects used toothbrushes and toothpaste to clean their teeth daily, regarding the daily use of adjuncts, 66.66% of the study population made use of mouthwashes, 40% used dental floss, 36.6% interdental brush, 26.6% used toothpick, while only 23.33% used oral irrigator.

All of the patients in the control and test groups were comparable regarding age, gender and initial plaque and gingival indices values ($p > 0.05$). The test group show significant intra-group deterioration regarding plaque and gingival indices at the initial examinations ($p < 0.001$). However, the eighth week plaque and gingival indices in the control group patients significantly lower when compared with the initial index values ($p < 0.001$). The eighth week plaque and gingival indices of the test group were also significantly lower than those of the control group ($p < 0.001$).

DISCUSSIONS

This study examined the plaque and gingival indices of individuals undergoing various instructional approaches at the eighth week of therapy. The plaque index values of the two groups were significantly influenced by varying instructional approaches ($p < 0.05$). Consequently, the initial null hypothesis was accepted.

This study examined the effectiveness and therapeutic impact of several educational interventions on oral hygiene motivation in patients receiving fixed orthodontic treatment. Fixed appliance treatment is associated with adverse consequences, including gingivitis, white spots, decalcification, and cavity formation, unless patients maintain proper oral hygiene [20].

The establishment of oral hygiene prior to the initiation of orthodontic treatment is advised as an effective measure to prevent the aforementioned issues. As maintaining dental hygiene becomes increasingly challenging after the deployment of therapeutic appliances, the educational intervention for oral hygiene practices and orthodontic treatment materials is prioritized at the onset of treatment [21]. The sole recognized and effective method for attaining optimal oral hygiene involves educating the patient before treatment and fostering rapport between the physician and patient throughout the prolonged treatment process [22].

Previous researches have examined the efficacy of various techniques in enhancing oral hygiene compliance among patients receiving fixed orthodontic treatment to mitigate adverse consequences. Orthodontists are concerned that patient compliance may diminish

during the 4-6 week intervals between appointments; therefore, patients received various reminder messages or applications (text, WhatsApp, WeChat) highlighting the significance of proper oral hygiene, and the efficacy of these reminders was examined. All research indicated that reminders in dentistry enhanced patients' out-clinical management, consistent appointment attendance, favourable behavioural modifications, and educational outcomes [23-25].

Despite the aforementioned oral hygiene incentives requiring less time for each patient, we implemented educational activities that are more broadly embraced by orthodontic patients and have evolved into a long-term practice. Patient education regarding oral hygiene practices was deemed effective by vocal, written, or visual instructional methods [10]. These strategies have demonstrated greater efficacy when employed in conjunction rather than in isolation. It is recognized that practical training, in conjunction with verbal and written teaching methods, enhances success rates in the preservation of plaque and gingival indices during orthodontic treatment [23].

The primary objective of this study was to examine the duration of educational sessions across three distinct modes of information delivery and to assess its correlation with favourable outcomes in plaque and gingival indices. The efficacy of standard, and hands-on educational methods was also examined. The research indicated that both study cohorts effectively maintained oral hygiene, with no significant difference in the preservation rates of plaque and gingival indices ($p > 0.05$). While both standard and hands-on training required substantial time from the orthodontist, the period of hands-on education was significantly less than that of standard-assisted instruction ($p < 0.001$). This may present the orthodontist with two alternatives: a time-intensive choice (standard) or a labor-intensive way (hands-on assisted), contingent upon their limitations. Conversely, the control group, which underwent regular educational intervention, did not maintain oral hygiene, at least until the eighth week of therapy.

Despite being time and labor-intensive, hands-on assisted teaching methods appear to be more effective in maintaining plaque and gingival indices ($p < 0.001$), hence mitigating potential treatment consequences. The dental hygiene instruction encompassed the nomenclature of therapeutic equipment, their upkeep, and the proficient utilization of oral hygiene instruments. Patients were required to fully recall and accurately implement this information following the educational intervention. Furthermore, they needed to surmount their formidable and detrimental impulses and implicit withdrawal from dental hygiene practices. The orthodontist's motivation to administer oral hygiene through educational intervention is crucial for patients to comprehend and adhere to oral hygiene practices. It is advisable to reiterate subjects pertaining to dental hygiene at subsequent appointments [26].

Plaque accumulation is commonly seen and challenging to remove in regions where space maintainers are positioned. Due to their direct interaction with oral microorganisms, space maintainers serve as optimal sites for biofilm production. The composition of space maintainers is conducive to microbe adherence and biofilm development [27]. Moreover, the bands affixed to the supporting teeth of permanent space maintainers and the retention clasps of removable space maintainers can facilitate plaque formation and periodontal disease [28]. Nonetheless, the resemblance in color between the tooth surface and dental plaque can render it difficult to identify dental plaque, especially on polished surfaces [29]. Consequently, rendering plaque visible through the use of plaque-disclosing tablets or liquids is deemed the most effective method for maintaining dental hygiene [30].

The primary weakness of the study was the Hawthorne effect, which stemmed from the inability to blind participants. The elimination was unfeasible due to the agreement form acquired from patients and their guardians for study participation. The second limitation was the restricted follow-up time of eight weeks, with no long-term follow-up conducted. This

deficiency may be deemed typical since our study prioritizes training periods over the efficacy of oral hygiene motivation.

CONCLUSIONS

Our findings indicate that conventional verbal and written instructional treatments are more effectively complemented by hands-on assisted training programs, contingent upon the orthodontist's limitations. A longer educational intervention correlates with improved preservation of plaque and gingival indices. Orthodontists could potentially enhance patient safety by extending educational opportunities, such as showing video recordings in the waiting area or facilitating hands-on training in proper orthodontic oral hygiene and fixed appliance care, supervised by a dental hygienist. Oral hygiene education repeated at frequent intervals will be more effective for controlling dental plaque in patients with orthodontic treatment.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Feu D, de Oliveira BH, de Oliveira Almeida MA, Kiyak HA, Miguel JAM. Oral health-related quality of life and orthodontic treatment seeking. Am J Orthod Dentofacial Orthop. 2010;138(2):152–159.

[2] Anthony SN, Zimba K, Subramanian B. Impact of malocclusions on the oral health-related quality of life of early adolescents in Ndola, Zambia. Int J Dent. 2018;2018:7920973.

[3] Naseri N, Baherimoghadam T, Kavianirad F, Haem M, Nikmehr S. Associations between malocclusion and self-esteem among Persian adolescent population. J Orthod Sci. 2020;9:6.

[4] Yassir YA, McIntyre GT, Bearn DR. The impact of labial fixed appliance orthodontic treatment on patient expectation, experience, and satisfaction: an overview of systematic reviews. Eur J Orthod. 2020;42(3):223–230.

[5] Haralur SB, Addas MK, Othman HI, Shah FK, El-Malki AI, AlQahtani MA. Prevalence of malocclusion, its association with occlusal interferences and temporomandibular disorders among the Saudi sub-population. Oral Health Dent Manag. 2014;13(2):164–169.

[6] Alharbi F. The prevalence of malocclusion traits in Saudi Arabia 2015–2019: an epidemiological cross sectional study. J Int Oral Health. 2020;12:129–134.

[7] Jawaid M, Qadeer TA. Assessment of the changes in the oral health related quality of life 24 hours following insertion of fixed orthodontic appliance components - An observational cross-sectional study conducted at Bahria University Medical and Dental College Karachi. J Pak Med Assoc. 2019;69(5):677–683.

[8] Schaefer I, Braumann B. Halitosis, oral health and quality of life during treatment with Invisalign(®) and the effect of a low-dose chlorhexidine solution. J Orofac Orthop. 2010;71(6):430–441.

[9] Miller KB, McGorray SP, Womack R, et al. A comparison of treatment impacts between Invisalign aligner and fixed appliance therapy during the first week of treatment. Am J Orthod Dentofacial Orthop. 2007;131(3):302.e1–9.

[10] Shalish M, Cooper-Kazaz R, Ivgi I, et al. Adult patients' adjustability to orthodontic appliances. Part I: a comparison between Labial, Lingual, and InvisalignTM. Eur J Orthod. 2012;34(6):724–730.

[11] Gao M, Yan X, Zhao R, et al. Comparison of pain perception, anxiety, and impacts on oral health-related quality of life between patients receiving clear aligners and fixed appliances during the initial stage of orthodontic treatment. Eur J Orthod. 2021;43 (3):353–359.

[12] Okoroafor CC, Okobi OE, Owodeha-Ashaka M, et al.: Dental health knowledge attitude and practice among University of Calabar students. Cureus. 2023, 15:e40055.
[13] Guo J, Li L, Guan G, Bennani F, Mei L: Oral health knowledge and practice among orthodontic clients in China and New Zealand. Can J Dent Hyg. 202, 54:124-32.
[14] Erbe C, Klukowska M, Tsaknaki I, Timm H, Grender J, Wehrbein H: Efficacy of 3 toothbrush treatments on plaque removal in orthodontic patients assessed with digital plaque imaging: a randomized controlled trial. Am J Orthod Dentofacial Orthop. 2013, 143:760-6.
[15] Gomes AP, Gonçalves SH, Hutala MF, Martinho FC, Gonçalve SE, Torres CR: Relationship between patient's education level and knowledge on oral health preventive measures. Int Dent Med J Adv Res. 2017, 1:1-7.
[16] Kudirkaite I, Lopatiene K, Zubiene J, Saldunaite K: Age and gender influence on oral hygiene among adolescents with fixed orthodontic appliances. Stomatologija. 2016, 18:61-5.
[17] Alhaija ES, Al-Saif EM, Taani DQ: Periodontal health knowledge and awareness among subjects with fixed orthodontic appliance. Dental Press J Orthod. 2018, 23:40.e1-9.
[18] Heintze SD, Jost-Brinkmann PG, Finke C, Miethke RR. Oral health for the orthodontic patient. Quintessence Publishing Co, Inc, Illinois, pp. 1-23, 1999.
[19] Löe H. The Gingival Index, The Plaque Index and the Retention Index systems. J Periodontol, 38: 610-616, 1967.
[20] Mitchell L. Decalcification during orthodontic treatment with fixed appliances-an overview. Br J Orthod. 1992;19(3):199-205.
[21] Lees A, Rock W. A comparison between written, verbal, and videotape oral hygiene instruction for patients with fixed appliances. Br J Orthod. 2000;27(4):323-8.
[22] Thomson AM, Cunningham SJ, Hunt NP. A comparison of information retention at an initial orthodontic consultation. Eur J Orthod. 2001;23(2):169-78.
[23] Zotti F, Dalessandri D, Salgarello S, Piancino M, Bonetti S, Visconti L, et al. Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. Angle Orthod. 2015;86(1):101-7.
[24] Brent Bowen T, Rinchuse DJ, Zullo T, DeMaria ME. The influence of text messaging on oral hygiene effectiveness. Angle Orthod. 2014;85(4):543-8.
[25] Li X, Xu ZR, Tang N, Ye C, Zhu XL, Zhou T, et al. Effect of intervention using a messaging app on compliance and duration of treatment in orthodontic patients. Clin Oral Investig. 2016;20(8):1849-59.
[26] Clark Jr. Oral hygiene in the orthodontic practice: Motivation, responsibilities, and concepts. Am J Orthod Dentofacial Orthop. 1976;69(1):72-82.
[27] Gok B, Kirzioglu Z, Kivanc M. Green tea extract solutions can control bacterial biofilms formed on space maintainers. Niger J Clin Pract. 2020 Jun;23(6):783-791.
[28] Hosseinipour ZS, Poorzandpoush K, Heidari A, Ahmadi M. Assessment of Periodontal Parameters Following the Use of Fixed and Removable Space Maintainers in 6-12-year Olds. Int J Clin Pediatr Dent. 2019 Sep-Oct;12(5):405-409.
[29] You W, Hao A, Li S, Wang Y, Xia B. Deep learning-based dental plaque detection on primary teeth: a comparison with clinical assessments. BMC Oral Health. 2020 May 13;20(1):141.
[30] Peng Y, Wu R, Qu W, Wu W, Chen J, Fang J, Chen Y, Farella M, Mei L. Effect of visual method vs plaque disclosure in enhancing oral hygiene in adolescents and young adults: a single-blind randomized controlled trial. Am J Orthod Dentofacial Orthop. 2014 Mar;145(3):280-6.

Legal Considerations Regarding the Responsibility of the Mass Media on the Veracity of Medical Information Disseminated to the Public

Emanuela-Lidia Petrescu[1,2], Meda-Lavinia Negruțiu[1,2], Cătălina Giurgi-Oncu[3], Andreea-Codruța Novac[1,2], Daliana Emanuela Bojoga[4,5], Kristian Miok[6], Mioara-Raluca Cosoroabă[7], Alina-Doina Tănase[2,7]

[1]Department of Prostheses Technology and Dental Materials, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[2]Research Centre in Dental Medicine Using Conventional and Alternative Technologies, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[3]University Clinic of Psychiatry, Faculty of Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[4]Department of Oral Rehabilitation and Emergencies in Dentistry, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[5]Interdisciplinary Research Center for Dental Medical Research, Lasers and Innovative Technologies, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania
[6]The Institute for Advanced Environmental Research-ICAM, West University of Timisoara, Timişoara, Romania
[7]Department of Professional Legislation in Dental Medicine, Faculty of Dental Medicine, "Victor Babeș" University of Medicine and Pharmacy, Timişoara, Romania

Correspondence to:
Name: Cătălina Giurgi-Oncu
E-mail address: catalina.giurgi@umft.ro

Received: 6 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

The responsibility of mass media is a subject of real interest for practitioners from the health system and for media trusts. Backgroung/Objectives: Numerous situations have occurred regarding the damange of professional and public image of the medical staff from Romania as a result of the transmission of false or erroneous information regarding the medical practice. Methods: This observational-prospective study evaluated the patients' opinion regarding the degree of influence over the medical staff's professionalism, as a result of the information transmitted in the mass media. Results: Most of the patients have the opinion that there is a very high risk that the image and professional prestige of the medical staff will be affected when the information transmitted through the mass media is not in agreement with reality. This indicates the need of solid legal levels through which press trusts can be held accountable when commit such slips. Conclusions: The main conclusion focuses on the legal identification and sanctioning of mass media every time there is a violation of the legislation and ethics nature regarding the transmission of false/erroneous information related to the professional activity of the medical staff.

Keywords: mass-media, medical staff, patients, news, professional prestige, right to image

INTRODUCTION

The representation of medical activities in mass media has a long history, being justified by the broad interest of the population [1]. Gradually, this interest of the public became more and more accentuated, reaching a real invasion of medical news in written and audio-visual media, especially in television [2].

The abundance of medical information in the press or on the Internet allows everyone interested to form more or less scientifically based opinions. The interference of medical activities with audio-visual and written media is particularly complex [3]. The effectiveness of medical treatments also significantly depends on the trust that patients have in medical professionals and health institutions. In this regard, nowadays, the role of audio-visual and written media is overwhelming [4]. In many cases, the rights of medical personnel are often violated by written publications, radio or television stations. Televisions seem to be particularly interested in the news through which a series of information with negative impact because massively increase the audience among the public [5]. Even if the media coverage of negative situations occurring in medical practice can contribute to their quick remedy, the tendency to generalize can cause a decrease in patients' trust in the healthcare system [6].

In certain situations, the news broadcast in the mass media related to the professional activity of the medical staff have as starting point, completely invented information which is then taken over and processed to become as credible as possible [7]. Other times, articles published by some personalities who have different theories than those of the majority of the scientific community are taken with the intention of sowing distrust in official healthcare. The incomplete presentation of these opinions without being signalled and the contrary opinions favour the disorientation of the public [8-9]. The efficiency of the dissemination of medical information through the mass media is correlated with a number of factors including: the credibility, accessibility or usefulness of the news [10]. The medical information propagated through the audio-visual media have a favourable impact on the public that receives it and is necessary to follow very strict rules, but those who make these materials seem not to know or not to apply [11]. Non-compliance with these rules in the mass media leads to the birth of a high degree of scepticism among the population, which eventually ends up losing confidence in the medical staff [12-13].

The role of the audio-visual media is a overwhelming source of information these days, but the mass media has the duty to disseminate only those truthful information, which can be demonstrated [14-15].

Aim of the study

This study focuses on evaluating the opinion of patients in Romania regarding the way and degree in which the mass media contribute through the news they promote to influencing their opinion regarding the activity carried out by the medical staff.

MATERIAL AND METHODS

The material and method of this study is an anonymous questionnaire consisting of 10 closed questions with yes or no answers that were focused on analyzing the patients' opinion regarding the way in which the mass media contribute through the news they promote to influence their opinion regarding medical profession.

The questionnaire was distributed in written format to a group of 60 patients in different dental offices in Timiş County, both in urban and rural areas. The questionnaires

completed by the patients were anonymous. The subjects were asked for their consent in order to participate in the conducted study, the purpose of this study being explained to them. Also, before completing the questionnaire, patients were invited to ask any question they considered necessary regarding the study. The patients' participation in the study was voluntary and they had the right to withdraw at any time, without being manipulated or influenced in any way. For all the questions were omly two answers, 0-NO and YES-1.

The first question analyzed to what extent they allowed themselves to be influenced or manipulated in a negative sense by the information transmitted through the media regarding the medical staff and the activity undertaken by them. The purpose was to observe to what extent patients allow themselves to be influenced by the news propagated in the mass media or choose to build their personal opinion regarding the activity carried out by the medical staff, compared to the direct interaction with them.

The second question aims to analyze the degree to which the prestige and image of the medical staff are affected once a series of distorted, untrue news or information is disseminated in the mass media. We wanted to find out the patients' opinion on this subject, considering that they often turn to a certain doctor, who was previously recommended to them, and there are positive references regarding the activity provided by him.

Third question evaluate the opinion of the patients regarding an extremely important topic, namely if they found that recently it is chosen to propagate the news with negative impact on the medical system, and less the positive aspects that contribute to increasing patients' trust in the medical act.

Fourth question aim of analyzse to what extent patients consider it beneficial that those cases in which the medical staff committed certain professional errors due to negligence or imprudence should be publicized in the press, so that on future to become much more responsible in the relationship with patients. We wanted to assess to what extent patients believe that in this way, possible professional errors in medical practice are prevented in the future.

Question number five analyzes to what extent the rights of medical personnel are effectively protected within Romanian legislation when it comes to the relationship with the mass media, so that there are no situations in which the interests of those working in the health system are harmed due to the fact that the legislation does not protect them sufficiently.

As for the sixth question in the questionnaire, it aims to debate the population's accessibility to information related to the medical act. The accessibility of patients with regard to all the information that interests them also depends on the means through which it ends up being communicated to them within a reasonable time. For this reason, we wanted to evaluate the patients' opinion regarding the role of the media in terms of disseminating information to the population as quickly as possible.

Question seven analyzes the degree of knowledge possessed by the patients participating in the study regarding the legislation in Romania that regulates the conditions under which the mass media can and has the right to transmit related news about a specific patient treated in a health facility. We wanted to observe whether patients are informed about the fact that their consent must be requested before information about their health condition is transmitted in written or audio-visual media.

The eighth question in the questionnaire also analyzes the level of knowledge of the patients regarding the conditions stipulated at the legislative level in which the media has the right to transmit certain images of them undergoing treatment in health facilities. We want to assess to what extent patients know their rights stipulated at the legislative level, so that they can protect themselves when they are violated.

The ninth question considers a numerical evaluation of the cases in which the mass media were sanctioned for prejudicing the rights and interests of medical personnel, by transmitting false information in bad faith, with the aim of harming the professional image and prestige of medical specialists.

The last question brings into discussion an important topic these days, namely the use by patients of various online platforms through which they choose to report certain acts committed by the medical staff. The question that arises is to what extent these online platforms would represent a real threat to medical personnel, considering that most of these sites are anonymous, anyone can enter and comment on various aspects related to the professional activity performed by medical personnel.

RESULTS

The data collected from the patients participating in the study were centralized and analyzed statistically by reference to their environment of origin, respectively urban or rural, being rendered in the form of figures.

Question 1: Has your opinion been negatively influenced regarding the work carried out by medical personnel, given certain information that you have become aware of through the media? The results showed that of the total of 60 patients who agreed to participate in this study, 27% of them from the rural environment and 43% from the urban environment believe that their opinion was not negatively influenced in terms of the activity carried out by the medical staff, as a result of the information transmitted through the media in the press. 8% of rural patients and 22% of urban patients stated the opposite, namely that their opinion was negatively influenced after different information was disseminated in the media regarding the activity carried out in different public or private health facilities by the medical staff (Figure 1).

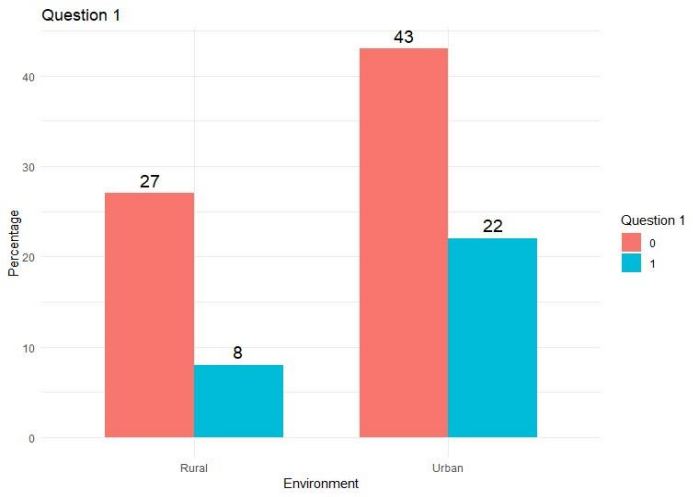


Figure 1. Influencing the opinion of patients regarding the activity carried out by the medical staff as a result of the information transmitted in the mass media

Question 2: Do you consider that at the present time the medical staff suffers because of the information that is transmitted in a distorted way in the press, being affected by their professional image and prestige? Compared to the second figure, as it also appears from its content, of the total of 60 patients included in the study, 10% from the rural environment and 12% from the urban environment do not consider that at the present time the medical staff is affected because of the information that is transmitted in a distorted way in the press (Figure 2). On the contrary, the majority of those who completed the questionnaire had the opposite

opinion, namely 25% of those from rural areas and 53% from urban areas stating that the image and prestige of doctors is affected due to the transmission through the media of erroneous and false information regarding the activity provided by them in the medical field.

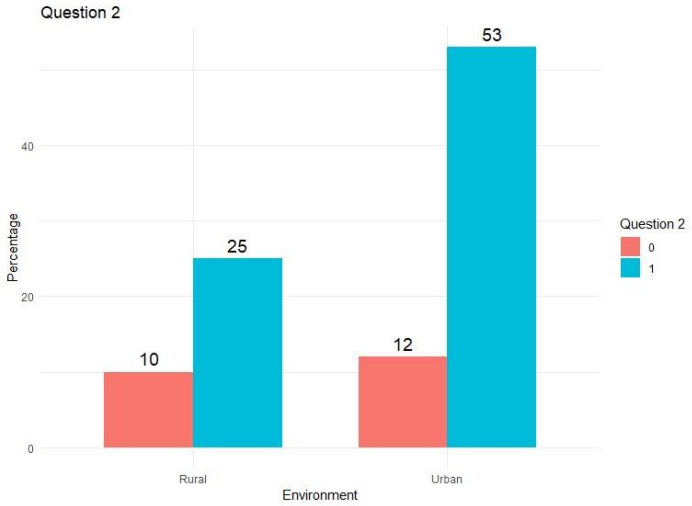


Figure 2. The degree of damage to the professional image and prestige of the medical staff as a result of the information erroneously transmitted through the media

Question 3: Do you think that currently, in most cases, the media promotes information and news with a negative impact on the medical system in Romania, minimizing the positive aspects regarding the activity of the medical staff? The results showed that 5% of the patients from the rural environment and 12% from the urban environment do not believe that currently the mass media mostly promotes information and news with a negative impact regarding the activity of the medical staff carried out within the health system from our country (Figure 3). On the other side were the patients who had an opposite point of view, namely 30% of the patients from the rural environment and 53% of those from the urban environment, being of the opinion that most of the news broadcast in the mass media put the emphasis on information with a negative impact on the activity carried out by the medical staff in Romania, minimizing the positive aspects related to the health system.

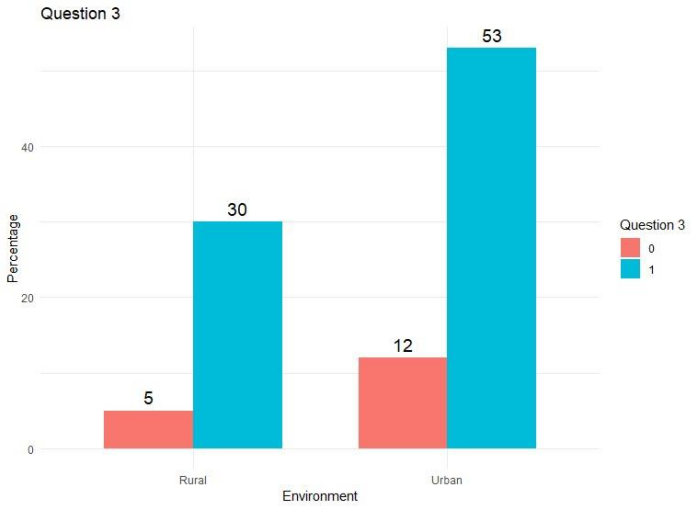


Figure 3. Patients' opinion regarding the promotion of information and news with a negative impact in the mass media regarding the activity of the health system in Romania

Question 4: Do you consider that the media presentation of news related to possible professional errors committed by professionals in the field will have a favorable impact on patient safety, because in this way the medical staff will be aware of the risks they are exposed to if they do not adopt a behavior that prevents future mistakes? From the total number of patients included in the study, 12% of them from the rural environment and 23% from the urban environment do not believe that the presentation in the mass media of news related to possible professional errors committed by professionals in the field will have a favorable impact on patient safety (Figure 4). They do not consider that by disseminating the cases of medical malpractice in the media, doctors will become aware of the risks they are exposed to if they do not adopt a behavior that prevents future mistakes. A higher percentage of patients, namely 23% from rural areas and 42% from urban areas, believe that, on the contrary, the behavior of the medical staff will be influenced as a result of the disclosure of malpractice allegations through the media, this awakens in the doctors' consciousness a greater degree of responsibility regarding the prevention of future mistakes in the medical act.

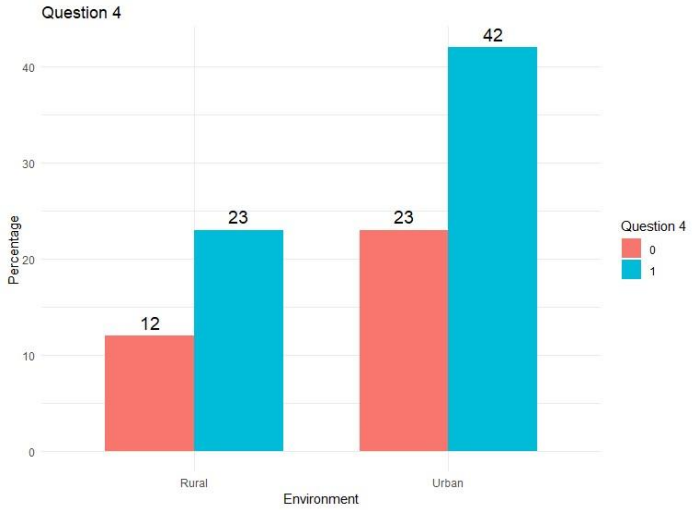


Figure 4. Patients' opinion regarding the degree of influence on the behavior of medical personnel following the presentation in the media of cases of medical malpractice

Question 5: Do you think that the rights of medical personnel should be much better protected within the Romanian legislation in relation to the mass media? The results showed that 10% of patients from rural areas and 10% of those from urban areas (a similar percentage regardless of the area of origin) do not believe that the rights of medical personnel should be better protected in relation to the mass media. On the contrary, the majority of patients, respectively 25% from the rural environment and 55% from the urban environment, stated the opposite, being of the opinion that the rights of medical personnel require increased protection in relation to those who work in the mass media (Figure 5).

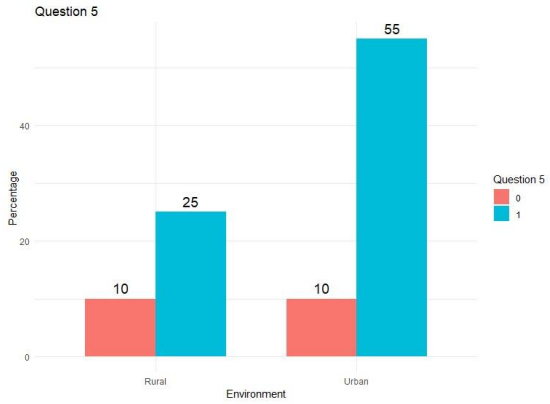


Figure 5. The opinion of patients regarding the increase in the degree of protection of the rights of medical personnel in the relationship with the mass media

Question 6: Do you think that the mass media contribute to the dissemination of information related to the activities carried out by medical personnel in a much shorter time, the population having access to the information they need in this way much easier? According to the results obtained, 10% of urban patients do not consider that the mass media contribute to the dissemination in a much shorter time of information related to the activities carried out by the medical staff. In rural areas, there was no patient who stated this. On the other hand, in rural areas, 35% of patients and 55% of those in urban areas stated that, on the contrary, the information transmitted through the media regarding the activity carried out by medical personnel reaches the entire population much faster, having access to easier this way (Figure 6).

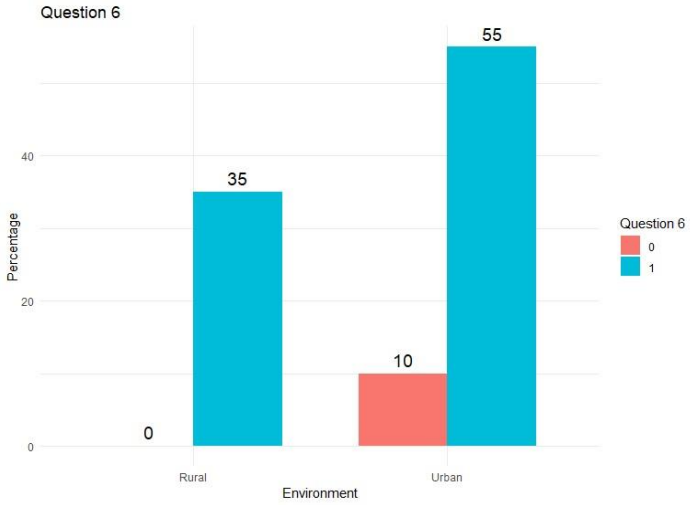


Figure 6. The speed of dissemination of information related to the activity carried out by the medical staff through the media

Question 7: Are you aware that information about the activities carried out within a health facility, public or private, involving both the doctor/medical staff and the patient can only be transmitted to the media with their consent? The results showed that 10% of patients from rural and 22% from urban areas do not know that information related to the activities carried out within a public or private health facility that involves both the doctor/medical staff and the patient is not can be transmitted in the mass media only with their consent (Figure 7). Most of the patients, respectively 25% from rural areas and 43% from urban areas, have knowledge and are informed about this rule.

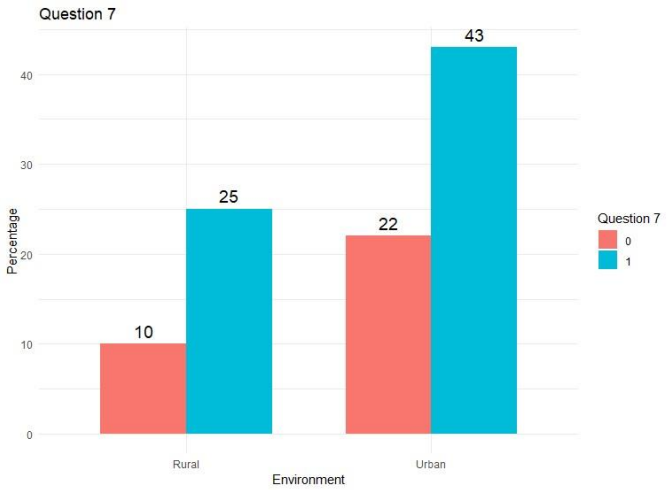


Figure 7. The degree of information of patients regarding the rule of expressing consent by them and the medical staff prior to the transmission by the mass media of information related to the activity carried out in public or private health facilities

Question 8: Do you know what is the legislation currently applicable in Romania that regulates the conditions under which the media has the right to transmit certain images of patients while they are being treated in various health facilities? To this question, 18% of patients from rural and 32% of those from urban areas do not have knowledge and are not informed about the legislation in Romania that regulates the conditions in which the mass media have the right to transmit certain images of patients while they are being treated in various health facilities (Figure 8). The difference compared to rural or urban patients who have knowledge of the content of the legislation that regulates the conditions under which the media has the right to transmit certain images of patients while they are being treated in different health facilities is not a notable one, with a percentage of 17% from the rural environment and 33% from the urban environment.

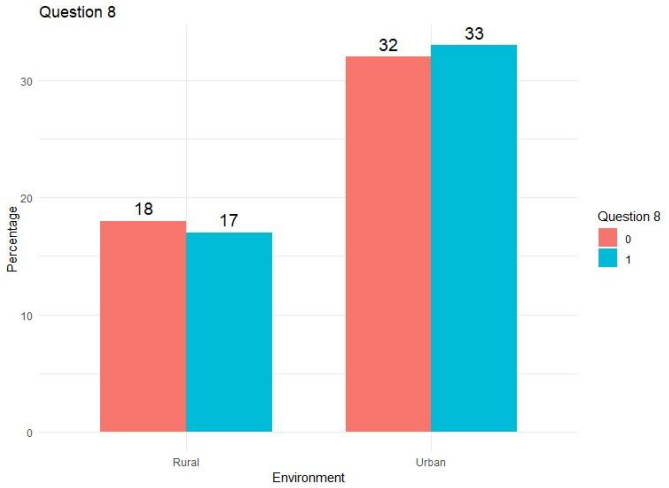


Figure 8. The level of information of patients regarding the legislation in Romania that regulates the conditions under which the media has the right to transmit certain images of patients while they are undergoing treatment in various health facilities

Question 9: Are you aware of situations in which personnel working in the mass media have been sanctioned and held liable for transmitting untrue and undocumented information regarding the work of medical specialists? Regarding the penultimate question in the questionnaire addressed to patients, 23% of those from rural areas and 52% from urban

areas do not have information regarding cases in which personnel working in the media are sanctioned as a result of the transmission of false information regarding the activity carried out by the medical staff, damaging their image (Figure 9). A much smaller percentage, namely 12% of patients from rural areas and 13% of those from urban areas know of cases in which those employed in the mass media were sanctioned for such acts.

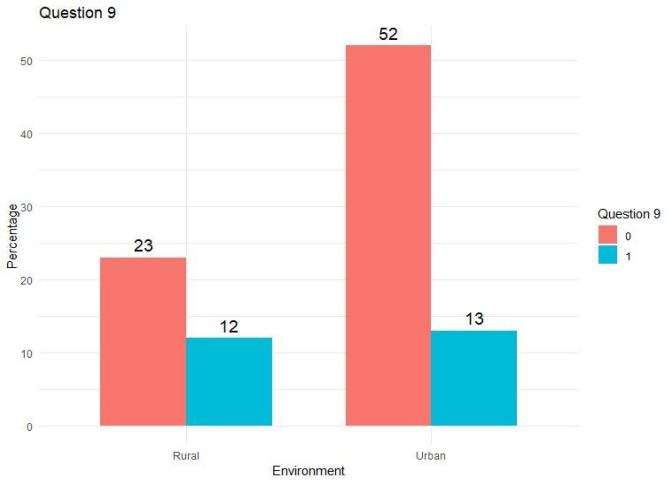


Figure 9. The degree of information of patients regarding the cases of legal liability of those who carry out their activity in the mass media as a result of the dissemination of false/erroneous information regarding the activity carried out by the medical staff

Question 10: Do you consider that currently the online platforms that promote the possibility for patients to complain about a number of aspects related to the activity carried out by the medical staff constitute a real threat to the professional prestige of the latter? The results showed that 13% of patients from rural and 25% of those from urban areas do not consider that currently the online platforms that promote the possibility for them to claim a number of aspects related to the activity carried out by the medical staff constitute a real threat for the professional prestige of the latter (Figure 10). On the contrary, 22% of patients from rural areas and 40% of those from urban areas expressed a completely opposite point of view, stating that there is an increased risk that the image and professional prestige of those working in the health system will be affected as a result of complaints made by patients online through different platforms.

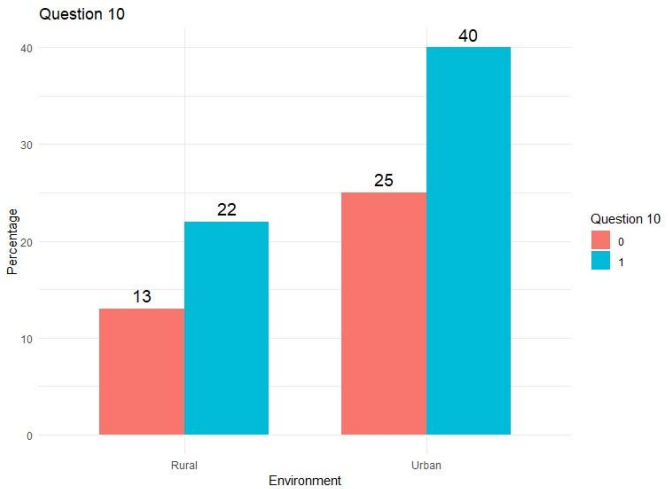


Figure 10. The degree of risk regarding the damage to the image and professional prestige of the medical staff as a result of complaints and reports submitted by patients through online platforms

DISCUSSIONS

We do not want to dispute the multitude of benefits brought to the population as a result of the involvement of the mass media in the transmission of information related to the medical system and the activity carried out by the staff within it, but in many cases it has been shown that doctors have suffered as a result of the transmission of false/erroneous information regarding their activity in the press, their image and professional prestige being affected. The medical system is extremely vulnerable at the present time, and unfortunately many patients form a wrong opinion about the activity carried out by the medical staff, referring only to what is circulated in the press, not passing through their own filter and not verifying the information [16]. In this context, we believe that there must be a series of mechanisms regulated at the legislative level through which the personnel working within the press trusts are aware of the importance of carrying out the activity in a legal, ethical and moral framework, and when they break certain rules to be held accountable.

From our point of view, protecting the rights of medical personnel in the relationship with media trusts will contribute to the reduction of abuses in the health system, to the reduction of cases of damage to the image and prestige of those who work in the medical field in Romania, and to greater safety of them. We do not deny the importance and role of the mass media in the transmission to the population of news that presents a series of aspects that happened in the medical field that violate the legal norms in force, because these slips must be corrected and eliminated if they really exist, but we consider that the dissemination of information false, unproven/unproven, just for the purpose of increasing the audience is not an ethical, moral and legal attitude of those who are part of the media trusts. In this context, we believe that it is imperative that the rights of medical personnel are much more firmly protected by Romanian legislation in relation to press trusts.

CONCLUSIONS

The central conclusion of this study is that according to which, the degree of awareness of those who work in the mass media must be increased regarding the importance of complying with the legislation regarding the transmission of information related to the activity of medical personnel, and where a series of slippages must be acted upon firmly, applying drastic sanctions in order to prevent the occurrence of these cases in the future.

The activity carried out by the medical staff must be presented in a real way, without hiding the truth and without sending false/erroneous information in order to increase the audience among the media trusts in Romania.

Conflicts of Interest

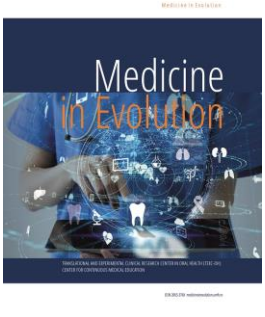
The authors declare no conflict of interest.

REFERENCES

[1] Goobie CG. Social media impacts on the dissemination of health-related information and patientphysician relationships. UBCMJ. 2020; 2(11): 6-8.
[2] Petcu M. Mass media din România după 30 de ani. Editura Tritonic. Bucureşti, 2020: 120-123.
[3] Oprea B. Fake news şi dezinformare online: recunoaşte şi verifică. Manual pentru toţi utilizatorii de internet. Editura Polirom. Bucureşti, 2021: 79.
[4] Rutuja AS. The Role of Mass Media in Health Care Development: A Review Article. Journal of Advanced Research in Journalism & Mass Communication. 2018; 1-2(5): 39-43.

[5] Catalán-Matamoros D. The role of mass media communication in public health. Health Management Different Approaches and Solutions. 2011: 90.
[6] Naveena N. Importance of mass media in communicating health messages: an analysis. IOSR Journal of Humanities and Social Science. 2015; 20: 36-41.
[7] Car J. eHealth in the future of medications management: personalization, monitoring and adherence. BMC Medicine. 2017; 15: 73.
[8] Cavill N, Adrian B. Changing the way people think about health-enhancing physical activity: do mass media campaigns have a role?. Journal of Sports Sciences. 2004; 22: 771-790.
[9] Antheunis ML, Tates K, Nieboer E. Patients' and health professionals' use of social media in health care: Motives, barriers and expectations. Patient Educ Couns. 2013;92(3):426.
[10] Cheston CC, Flickinger TE, Chisolm MS. Social media use in medical education: a systematic review. Academic Medicine. 2013;88(6):893–901.
[11] Moorhead SA, Hazlett DE, Harrison L, Carroll JK, Irwin A, Hoving C. A New dimension of health care: systematic review of the uses, benefits, and limitations of social media for health communication. J Med Internet Res. 2013;15(4):85.
[12] Free C. The effectiveness of M-health technologies for improving health and health services: a systematic review protocol. BMC Research Notes. 2010; 3: 250.
[13] Maftei I, Maftei Golopenţia IM, Maftei Golopenţia TV. Drepturile cadrelor medicale, Ed. Cermaprint, Bucureşti; 2023:76.
[14] Ardelean F, Laza I. Mass-media sub lupa cercetătorilor şi a practicienilor, Editura Tritonic; Bucureşti, 2024:80.
[15] Coman M. Introducere în sistemul mass-media. Editura Polirom, Bucureşti, 2016: 90
[16] Badau HM. Tehnici de comunicare în social media. Editura Polirom, Bucureşti, 2011: 65-70.

Variation in Salivary pH Based on Sugar Consumption



Lucian Floare[1], Delia Abrudan-Luca[1], Ioan-Alexandru Simerea[1], Ramona Dumitrescu[1,2], Octavia Balean[1,2], Vanessa Bolchis[1,2], Jojic Alina Arabela[3]

[1]Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania, Faculty of Dentistry, Clinic of Preventive, Community Dentistry and Oral Health; Translational and Experimental Clinical Research Centre in Oral Health, Department of Preventive, Community Dentistry and Oral Health
[2]"Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania, Faculty of Dentistry, Clinic of Preventive, Community Dentistry and Oral Health
[3]"Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania, Faculty of Pharmacy, Discipline of Pharmacology-Pharmacotherapy

Correspondence to:
Name: Delia Abrudan-Luca
E-mail address: delia.abrudan-luca@umft.ro

Received: 6 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

This research investigates the impact of sugar consumption on salivary pH, highlighting its implications for oral health. 1.Background/Objectives: The study aimed to analyze the effects of excessive sugar intake, a key factor in the development of dental conditions. 2. Methods: The study involved 45 students aged 20–23 years. Saliva samples were collected at four intervals: before sugar intake, immediately after, 30 minutes later, and one hour post-consumption. Samples were obtained via drainage, and pH was measured using indicator strips. 3. Results: The data revealed a significant drop in salivary pH immediately after sugar consumption, decreasing from an initial pH of 7 to 5.5. Partial recovery was observed, with pH reaching 6.5 after one hour. This temporary acidification of the oral environment confirms the link between sugar intake and an increased risk of dental caries. 4. Conclusion: The study emphasizes the importance of maintaining optimal salivary pH to prevent enamel demineralization and support natural remineralization. It also underscores the need for public education to reduce sugar consumption and adopt effective oral hygiene practices. This research contributes to understanding the dietary impact on oral health and suggests preventive measures to lower the incidence of dental issues.

Keywords: pH, saliva, acid, diatery, oral health, sugar consumption, caries, oral enviroment

INTRODUCTION

In recent decades, oral health has increasingly been recognized as a significant public health issue, heavily influenced by dietary behaviors, particularly the excessive consumption of sugar. Sugars have been identified as a primary risk factor for the development of dental caries and periodontal diseases, which are among the most prevalent non-communicable diseases worldwide [1]. These conditions contribute significantly to the global burden of oral health problems, affecting individuals' overall well-being, quality of life, and healthcare systems. As such, addressing sugar consumption is critical in mitigating oral health risks and promoting long-term health outcomes.

A key factor in preserving oral health is the maintenance of an optimal salivary pH. The importance of salivary pH in maintaining oral health lies in its ability to regulate the acid-base balance within the oral cavity. Recognizing the importance of saliva as a diagnostic fluid, the New York Academy of Sciences sponsored a pivotal conference on this topic in 1992. During the event, participants highlighted the critical need for advancing highly sensitive and specific assays to accurately measure and understand salivary variations associated with drug therapy, substance abuse, endocrine function, systemic and oral diseases, genetic abnormalities, nutritional status, and age-related changes. This conference significantly contributed to raising awareness of the potential of saliva-based diagnostics. Since then, ongoing research has led to the development of more refined salivary assays, enhancing our understanding of the intricate relationship between oral health and overall well-being [2]. When salivary pH is within the optimal range (6.2–7.6), saliva exerts a buffering effect that helps neutralize acids produced as a result of consuming foods and beverages, particularly those containing sugars. Saliva plays a crucial role in neutralizing acids in the oral cavity, protecting tooth enamel from demineralization, and supporting the remineralization process [3]. However, frequent and excessive intake of sugar-laden foods and beverages disrupts this balance, leading to a persistent drop in salivary pH. Acidic conditions in the oral environment create a favorable for the environment growth and activity of acidogenic and aciduric bacteria, which metabolize sugars into organic acids. This microbial activity accelerates the demineralization of enamel, increasing the risk of dental caries and other periodontal complications over time. Understanding the dynamic relationship between sugar consumption, salivary pH, and oral health is fundamental for devising effective preventive strategies. Prior research links sugar intake to salivary pH reduction, with studies highlighting the acidifying effects of sugary beverages and foods [2]. Numerous studies have investigated the factors influencing salivary pH, including dietary habits, sugar consumption, and microbial activity within the oral cavity. Recent studies have examined how salivary pH varies among individuals with different caries risk levels following the consumption of organic sugars, such as sucrose, and non-organic sugars, like maltitol. These findings highlight the distinct acidogenic potential of these sugars and their impact on caries risk. Such research provides valuable insights into the complex relationship between dietary sugars and oral health, underscoring the need to understand how different types of sugars influence the oral environment [4]. In addition to research examining salivary pH changes in individuals with varying caries risk after consuming organic and non-organic sugars, other studies further emphasize the complex interplay between dietary sugars, salivary pH, and oral health [5]. For instance, investigations have explored how sugar-rich diets interact with salivary proteins, shedding light on their role in dental plaque formation and its impact on oral health. These findings contribute to a broader understanding of the mechanisms linking sugar consumption to oral disease development [6].

Aim and objectives

This study investigates salivary pH fluctuations in response to sugar consumption, focusing on changes observed before, immediately after, and at specific intervals following exposure. This sugar consumption pattern is strongly associated with oral health challenges, underscoring the vital connection between sugar intake, salivary pH dynamics, and the overall condition of the oral cavity. By examining these physiological changes, the study aims to deepen understanding of the processes linking dietary habits to oral health outcomes.

MATERIAL AND METHODS

This cross-sectional study was conducted between October and November 2023 in Clinic of Preventive, Community Dentistry and Oral Health. The study included volunteers who provided informed consent after disclosing information about their health status, medication use, and smoking habits. The participants were second- and third-year students from the University of Medicine and Pharmacy "Victor Babeş" Timişoara, enrolled in the oral health discipline. The research was conducted during laboratory sessions as part of their academic activities. This study was approved by the Ethics Committee of the "Victor Babeş" University of Medicine and Pharmacy, Timişoara, Romania (No 34/2018). The research was conducted in accordance with the Declaration of Helsinki (1975) and its subsequent amendments, with written informed consent obtained from all participants prior to data collection.

The study was conducted with students enrolled in the "Oral Health" course, a mandatory component of the fifth-year curriculum at the Faculty of Dental Medicine Timisoara. Attendance for this course is compulsory, as it is required for eligibility to sit for the final examination. Out of the 110 students initially enrolled, 80 met the participation criteria. The final study included 45 students, comprising 19 males and 26 females aged between 20 and 23 years, with a mean age of 22. Exclusions were made for one participant with diabetes, two who declined participation by not signing the informed consent form, and one who violated the rules by eating an hour before saliva sample collection. Thus, the final sample consisted of 45 participants who adhered to all inclusion criteria and the study protocol.

Inclusion and exclusion criteria for the study were based on participants' consent to join and their adherence to the established guidelines. Participants were required to sign informed consent forms and comply with specific preparatory conditions, including abstaining from food consumption for at least two hours prior to saliva sample collection, refraining from oral hygiene practices such as toothbrushing, and, for smokers, avoiding smoking for one hour before the procedure. A general health questionnaire, designed by the College of Dental Physicians of Romania and widely used in dental offices across the country, was completed by participants. This questionnaire collected personal information, including age, gender, residence, general health status, and smoking habits (smoker or non-smoker). Additional data recorded during sample collection included medication use, smoking duration for smokers, and the number of cigarettes smoked daily. Individuals who did not comply with these requirements, refused to sign the consent forms, or failed to complete the questionnaire were excluded from the study. These measures ensured that the collected data were both reliable and relevant to the research objectives.

The study utilized the draining method to collect unstimulated whole saliva, a widely accepted approach for such samples due to its simplicity and high acceptability. Saliva was collected until a volume of 2 to 3 mL was reached in sterile tubes, adhering strictly to clinical protocols to ensure reliable results. To minimize the influence of circadian rhythms on salivary biochemical composition, sample collection was standardized between 8:00 and 10:00

AM. Participants were instructed to abstain from consuming food or beverages (except water), performing oral hygiene procedures, or smoking for a minimum of two hours prior to collection, with smokers refraining from smoking within one hour. Additionally, participants avoided medication use for at least eight hours to prevent any drug-related effects on salivary secretion. The collection took place in a relaxed classroom and examination setting, with participants seated, their heads slightly tilted downward, and facial and lip movements minimized after a 5-minute adaptation period. The research consisted of four stages: before the sugar consumtion, immediately after, 30 minutes post-consumtion, and one hour post-consumtion. Saliva samples were promptly analyzed using pH indicator strips (Qualigens, Glaxo India Ltd., Mumbai, India) by immersing them in the saliva and comparing the resulting color change to a standard color chart provided by the manufacturer. While these strips offer convenience and cost-effectiveness, their precision is lower compared to pH electrodes, as they measure pH in increments of 0.5 rather than two decimal points. Materials used in the study included collection cups, salivary pH indicator strips, a color chart, and 100g of Milka milk chocolate (Mondelez International), which served as the stimulus. The chocolate contained sugar, salt, cocoa butter, skimmed milk powder, cocoa mass, whey powder, milk fat, and an emulsifier. This composition was integral to assessing its effects on salivary pH. The normal salivary pH range of 6.5 to 7.4 provided a baseline for comparison, ensuring a consistent framework for evaluating pH changes throughout the study. Strict adherence to collection protocols ensured the accuracy and reliability of the results.

The study was conducted in four distinct stages to evaluate salivary pH fluctuations in response to a sugar stimulus. In the first stage, salivary pH was measured without any external stimulants to establish baseline values. Volunteers recorded salivary pH within the normal physiological range of 6 to 7, serving as a reference point for subsequent stages. In the second stage, participants were given a 4.2g cube of milk chocolate, which they chewed for three minutes to ensure uniform exposure of the oral cavity to the stimulus. Immediately after chewing, saliva samples were collected using sterile collection cups, and the pH was measured. A noticeable decrease in salivary pH was observed at this stage, with values ranging between 5 and 6, reflecting the acidogenic impact of the chocolate. The third stage involved collecting saliva samples 30 minutes after the participants consumed the chocolate. During this phase, salivary pH values varied among participants. For some individuals, the pH remained unchanged from the second stage, while others experienced either a further decrease or a slight increase in pH, indicating variability in the oral cavity's buffering capacity and individual salivary responses. In the fourth and final stage, saliva was collected one hour after consuming the chocolate. At this point, salivary pH values returned to their initial baseline levels recorded in the first stage, demonstrating the oral cavity's ability to recover and stabilize its pH over time. Throughout all stages, salivary pH was determined using pH indicator strips, which were immersed in the saliva samples and compared against a color chart to estimate pH values. While this method provided a convenient and cost-effective means of measuring pH, its precision was limited compared to more advanced tools such as pH meters. Strict adherence to collection protocols ensured reliable results, and the study design allowed for a comprehensive analysis of salivary pH dynamics following sugar exposure.

Statistical analysis was conducted using SPSS v23 (Statistical Package for Social Sciences, IBM, Chicago, IL, USA). Descriptive statistics, including mean and standard deviation, were used to summarize salivary pH values across the four stages of the study. The normality of data distribution was assessed using the Shapiro-Wilk test. Differences in mean salivary pH between the stages were evaluated using a paired t-test for normally distributed data. For all analyses, a significance threshold of $p < 0.05$ was applied to determine

statistically significant differences. This simplified approach ensured the results were analyzed effectively while adhering to the study's methodological constraints.

RESULTS

The study was conducted on 45 participants (16 males and 29 females) aged between 20 and 23 years, with a mean age of 22.0 years (±0.75). All participants were enrolled in the "Oral Health" course at the Faculty of Dental Medicine, UMF "Victor Babeș," Timișoara, Romania. Participants were from both urban and rural residential backgrounds, reflecting a diverse demographic profile relevant to the study's objectives. Of the 45 participants, 22 (48.9%) were smokers, with the number of cigarettes smoked per day ranging from 2 to 20. Among the smokers, the majority reported smoking traditional cigarettes, while a smaller proportion used electronic cigarettes. The remaining 23 participants (51.1%) were non-smokers. All participants were healthy, with no acute or chronic oral conditions, and complied with the study's inclusion criteria by refraining from food, beverage, or oral hygiene practices for at least two hours prior to saliva collection.

Baseline salivary pH values, measured before sugar consumption, ranged from 6.5 to 7.0, with an average of 6.75 (±0.2), providing a consistent reference point for subsequent measurements. In Stage 1, prior to any stimulus, the salivary pH values were predominantly at the higher end of the range, indicating a stable starting condition. Stage 2, immediately after consuming 4.2g of milk chocolate, showed a marked decrease in pH, with values ranging from 5.0 to 6.0 and a mean of 5.5 (±0.5), reflecting a rapid acidification of the oral environment due to sugar exposure. In Stage 3, 30 minutes' post-consumption, pH values showed partial recovery, clustering between 6.0 and 6.5, with reduced variability compared to the previous stage. By Stage 4, one hour after consumption, salivary pH had largely returned to baseline levels, with many participants recording values close to 7.0. Across all stages, salivary pH values fluctuated within a range of 5.0 to 7.0, with most measurements falling between 6.0 and 7.0. These findings highlight the dynamic response of salivary pH to sugar intake, characterized by an initial drop followed by gradual recovery, maintaining a near-neutral to slightly acidic balance throughout the process (Figure 1).

Figure 1. ph Values across stages

The data reveals that the initial average pH values for participants are the same for both men and women, each measuring 6.75. This consistency suggests that no significant differences existed between the gender groups at the start of the study regarding their average pH levels. The overall average pH value of 6.75 further highlights this equilibrium across the two groups. This finding establishes a uniform baseline for the experiment, facilitating a more equitable comparative analysis of future variations.

Saliva samples were collected 30 and 60 minutes after sugar consumption to observe pH fluctuations.

Table 1. Salivary pH values after chocolate consumption

Time	Initial Average pH
30 minutes	5,7
60 minutes	6,5

The average salivary pH values measured before sugar consumption were 7 (±0.5). After consuming chocolate, the average salivary pH values decreased to 5.5 (±0.5), indicating a significant acidification of the oral environment. The significant decrease in salivary pH immediately after sugar consumption (from 7.0 to 5.5) indicates a rapid acidification of the oral environment, which may promote the development of dental caries. The partial recovery of pH at 60 minutes suggests that saliva begins to neutralize the acidity, but fails to fully return to the initial value within the one-hour period (Figure 2).

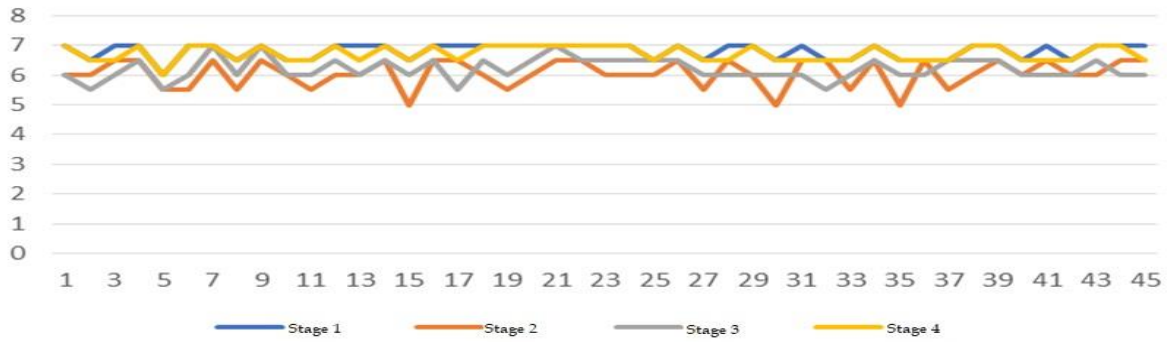


Figure 2. Dynamic Changes in Salivary pH Across Four Stages of the Study

In Stage 1, the mean pH value was 6.81, with a small standard error of 0.0398, indicating a low margin of sampling error. The median and mode were both 7, reflecting a slight tendency toward higher pH levels. Variability among the measurements was minimal, as indicated by a standard deviation of 0.2673 and a sample variance of 0.0715. The distribution was slightly left-tailed, with a skewness of -0.9834, and nearly flat, with a kurtosis value of -0.1032. The pH values ranged from 6 to 7, suggesting limited variability.

In Stage 2, the mean pH decreased to 6.05, accompanied by a higher standard error of 0.0697, signaling increased variability compared to Stage 1. The median and mode, at 6 and 6.5 respectively, were close to the mean. The standard deviation of 0.4674 and sample variance of 0.2184 pointed to greater dispersion of values. A kurtosis of -0.3618 and skewness of -0.7536 indicated a slightly left-skewed and flat distribution. The pH values spanned from 5 to 6.5, with a total of 45 samples and a cumulative sum of 272.5.

Stage 3 showed a slight increase in the mean pH to 6.2, with a moderate standard error of 0.056, indicating a balanced level of variability. Both the median and mode remained at 6, reflecting consistent central tendencies. The standard deviation of 0.3754 and sample variance of 0.1409 highlighted moderate variability. The skewness of 0.1889 suggested a slight right-

tailed distribution, while the kurtosis value of -0.1276 indicated a nearly flat distribution. The pH values ranged from 5.5 to 7, with a total sum of 279 across 45 samples.

In Stage 4, the mean pH increased to 6.73, with a low standard error of 0.0408, indicating precise sampling. The median was 6.5, and the mode was 7, showing a slight tendency toward higher pH levels. Variability was reduced, as evidenced by a standard deviation of 0.2739 and sample variance of 0.075. The kurtosis of -1.0594 and skewness of -0.2972 suggested a flatter and slightly left-skewed distribution. The pH values ranged from 6 to 7, with a total sum of 303 across 45 sample.

DISCUSSIONS

This study provides valuable insights into the impact of dietary sugars on salivary pH dynamics and their broader implications for oral health. The primary objective was to assess the fluctuations in salivary pH across four distinct stages—before sugar intake, immediately after consumption, 30 minutes' post-consumption, and one-hour post-consumption—highlighting the physiological processes underlying these changes. The findings emphasize the importance of understanding the relationship between sugar consumption and salivary pH, a critical factor in maintaining oral health and preventing cariogenic bacterial growth. The results revealed a rapid and significant decrease in salivary pH immediately following the consumption of 4.2g of milk chocolate, followed by a gradual recovery over time. This pattern is consistent with existing literature, which describes a similar acidification of the oral environment after sugar intake, contributing to increased bacterial activity and the risk of dental caries. The study also demonstrated the buffering capacity of saliva, which effectively neutralized the acidic conditions induced by sugar exposure. However, the partial recovery observed within one hour suggests that this process is not immediate, leaving the oral cavity vulnerable to demineralization during the recovery phase. Additionally, the findings highlighted inter-individual variability in salivary pH responses, likely influenced by factors such as smoking habits, dietary patterns, and individual differences in salivary buffering capacity. Despite these variations, the consistency of baseline pH values across participants ensured a reliable framework for comparative analysis.

The findings of this study align with existing literature on the critical role of saliva in maintaining oral health through its buffering capacity, antimicrobial properties, and ability to regulate the oral microbiota [7]. Our research demonstrated a significant decrease in salivary pH following sugar consumption, followed by a gradual recovery, emphasizing saliva's role in counteracting acidification [8]. This aligns with studies highlighting the presence of natural defensive molecules in saliva, such as antimicrobial peptides (AMPs), mucins, and proline-rich proteins (PRPs), which play a key role in neutralizing acidic conditions and preventing dental caries. Moreover, the buffering action of ammonia derived from amino acids such as arginine and lysine, noted in previous studies, complements our findings by explaining saliva's ability to stabilize pH levels post-sugar intake [9,10].

However, this study primarily focused on pH fluctuations, while the literature points to additional salivary factors, including protein concentration, enzymatic activity, and glycoproteins, that contribute to oral health. For instance, the role of defensins and lactoferrin in controlling microbial flora and immunoglobulin A (IgA) in regulating bacterial activity could further explain individual differences in salivary pH buffering capacity observed in our participants. Additionally, the impact of age, sex, and protein composition on salivary function, as described in prior research, suggests areas for further exploration, particularly as our sample was limited to a younger demographic. The broader insights into salivary protein composition, enzymatic activity, and antimicrobial action from previous research underscore the multifaceted role of saliva, beyond just pH regulation, in maintaining oral health [6].

Similar to previous investigations highlighting a deeper pH drop in individuals with elevated caries risk, our research observed a significant reduction in salivary pH immediately following sugar consumption, with a gradual but incomplete recovery within one hour. This reflects the vulnerability of the oral environment during the acidogenic challenge. Additionally, studies show that individuals without caries exhibit a stronger buffering capacity, suggesting that the resilience of salivary systems plays a vital role in mitigating the effects of pH drops [11]. The incomplete pH recovery observed among participants mirrors the weakened physiological response described in the literature when the oral environment is exposed to repeated fermentable carbohydrate intake. This is particularly relevant, as the continuous exposure to such dietary components may impair the saliva's ability to neutralize acid effectively, increasing the risk of caries progression. The consensus in the literature supports the idea that the pH control mechanisms in the oral cavity are governed by complex ionic and protein interactions, a dynamic that is consistent with the buffering effects observed in our findings [12].

Previous research has consistently demonstrated that food consumption induces an initial decrease in salivary pH, followed by a gradual recovery [13]. Acidic foods, such as apples and citrus fruits, often lower salivary pH below the critical threshold of 5.5, significantly increasing the risk of enamel demineralization. These studies further highlight the slow oral clearance of certain foods, such as apples, leading to prolonged acidogenic effects that persist beyond 12 minutes [14]. Similar findings indicate that fresh fruits maintain a low pH for extended periods, thereby posing a sustained risk to oral health. Additionally, comparisons of various foods, such as chocolate and biscuits, reveal that both significantly reduce salivary pH, though the levels typically remain above critical thresholds. Notably, the recovery rate of salivary pH is slower for chocolate during the initial minutes post-consumption but ultimately exceeds that of biscuits due to its faster clearance from the oral cavity [14-16]. In contrast, sugar-free chewing gum demonstrates a favorable effect on salivary pH, promoting an immediate increase attributed to enhanced salivary buffering and flow [17].

The study's findings align with this body of research, particularly in observing a significant initial decline in salivary pH following the consumption of sugar-containing chocolate, accompanied by a gradual recovery within one hour. However, unlike the immediate and substantial recovery associated with sugar-free chewing gum, the response to chocolate was slower and incomplete, underscoring the limitations of salivary buffering mechanisms in counteracting prolonged acidogenic challenges [17,18]. Furthermore, the study supports the notion that food texture and retention properties significantly influence salivary pH dynamics. The slower clearance time of sugary foods, such as chocolate, highlights their potential to sustain an acidic oral environment, increasing the risk of enamel demineralization compared to foods with more rapid clearance rates. These observations emphasize the importance of considering food-specific characteristics when evaluating their impact on salivary buffering capacity, oral health, and the development of dietary recommendations aimed at reducing caries risk.

The implications of this research extend beyond individual observations, offering a foundation for targeted strategies aimed at reducing sugar consumption. Measures such as implementing sugar taxes, clear labeling of sugar content in food products, and establishing guidelines for daily sugar intake could effectively address the root causes of sugar-related oral health issues. These approaches contribute to the broader goals of preventive dentistry and public health by prioritizing oral health maintenance and reducing the burden of dental diseases on populations.

Future studies should aim to investigate the variability in salivary buffering capacity among individuals, considering factors such as salivary flow rate, composition, and lifestyle

influences like smoking and dietary habits [8]. Additionally, expanding the research to include a variety of dietary stimuli, such as acidic beverages or sugar substitutes, could provide a broader understanding of their effects on salivary pH. The use of more precise measurement tools, such as pH meters, should be considered to improve the accuracy of pH assessments, particularly in studies requiring detailed biochemical analysis. From a public health perspective, integrating educational programs that promote awareness of the impact of dietary sugars on oral health could play a vital role in mitigating the risk of dental caries. These programs, targeting schools and community health centers, could help instill healthier dietary habits from an early age, ultimately reducing the burden of sugar-related oral health conditions.

These advancements in research design could significantly contribute to the development of comprehensive public health strategies. By understanding the long-term effects of sugar and other dietary factors on salivary pH, targeted interventions to mitigate oral health risks can be devised. Such efforts could include education campaigns, dietary guidelines, and policy measures to reduce sugar consumption, ultimately benefiting public health and reducing the prevalence of dental and periodontal diseases. The results of this study align closely with previous research, which has demonstrated that sugar consumption lowers salivary pH, creating favorable conditions for the proliferation of cariogenic bacteria. These studies consistently show that salivary pH drops rapidly following sugar intake and gradually returns to normal levels over time, a pattern that confirms the previously noted observations. This concordance with existing literature reinforces the validity of the findings and highlights the well-established relationship between sugar consumption and changes in salivary pH.

In conclusion, the interplay between sugar intake, salivary pH, and oral health represents a significant area of study with profound public health implications. By elucidating the physiological mechanisms and risks linked to sugar consumption, this research underscores the necessity for collective efforts to curb sugar intake. Such initiatives have the potential to markedly reduce the prevalence of dental caries and periodontal diseases, thereby improving oral health outcomes and enhancing the quality of life for individuals and communities worldwide.

CONCLUSIONS

This study demonstrates the significant impact of sugar consumption on salivary pH, highlighting a rapid drop in pH immediately after intake and a gradual, yet incomplete, recovery within one hour. These findings emphasize the critical role of saliva in buffering oral acidity and the risks posed by prolonged acidogenic conditions, such as increased vulnerability to dental caries. Addressing sugar consumption through dietary education, public health policies, and targeted interventions is essential for mitigating oral health risks. Future research should explore broader dietary influences, individual variability in salivary buffering capacity, and more precise measurement methods to deepen our understanding and enhance preventive strategies.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] Featherstone JD. Prevention and reversal of dental caries: role of low level fluoride. Community Dent Oral Epidemiol. 1999 Feb;27(1):31–40.

[2] Schwarz C, Balean O, Dumitrescu R, Ciordas PD, Marian C, Georgescu M, et al. Total Antioxidant Capacity of Saliva and Its Correlation with pH Levels among Dental Students under Different Stressful Conditions. Diagnostics. 2023 Jan;13(24):3648.

[3] Barajas-Torres GC, Klünder-Klünder M, Garduño-Espinosa J, Parra-Ortega I, Franco-Hernández MI, Miranda-Lora AL. Effects of Carbonated Beverage Consumption on Oral pH and Bacterial Proliferation in Adolescents: A Randomized Crossover Clinical Trial. Life. 2022 Nov;12(11):1776.

[4] W W, Sh A, Mh T. Saliva pH Changes in Patients with High and Low Caries Risk After Consuming Organic (Sucrose) and Non-Organic (Maltitol) Sugar. IIUM Medical Journal Malaysia [Internet]. 2013 Dec 1 [cited 2024 Dec 11];12(2). Available from: https://journals.iium.edu.my/kom/index.php/imjm/article/view/504

[5] Sava-Rosianu R, Campus G, Matichescu A, Balean O, Dumitrache MA, Lucaciu PO, et al. Caries Prevalence Associated with Oral Health-Related Behaviors among Romanian Schoolchildren. International Journal of Environmental Research and Public Health. 2021 Jan;18(12):6515.

[6] Gasmi Benahmed A, Gasmi A, Dadar M, Arshad M, Bjørklund G. The role of sugar-rich diet and salivary proteins in dental plaque formation and oral health. Journal of Oral Biosciences. 2021 Jun 1;63(2):134–41.

[7] Hans R, Thomas S, Garla B, Dagli RJ, Hans MK. Effect of Various Sugary Beverages on Salivary pH, Flow Rate, and Oral Clearance Rate amongst Adults. Scientifica. 2016;2016:1–6.

[8] (PDF) Evaluation of change in salivaryPh, following consumption of different snacks and beverages and Estimation of their oral clearance time. ResearchGate [Internet]. 2024 Oct 22 [cited 2024 Dec 12]; Available from: https://www.researchgate.net/publication/344308346_Evaluation_of_change_in_salivaryPh_following_consumption_of_different_snacks_and_beverages_and_Estimation_of_their_oral_clearance_time

[9] Takahashi N, Nyvad B. The role of bacteria in the caries process: ecological perspectives. J Dent Res. 2011 Mar;90(3):294–303.

[10] Takahashi N, Nyvad B. Caries ecology revisited: microbial dynamics and the caries process. Caries Res. 2008;42(6):409–18.

[11] Singh S, Sharma A, Sood PB, Sood A, Zaidi I, Sinha A. Saliva as a prediction tool for dental caries: An in vivo study. Journal of Oral Biology and Craniofacial Research. 2015 May 1;5(2):59–64.

[12] De Sousa ET, Lima-Holanda AT, Nobre-dos-Santos M. Changes in the salivary electrolytic dynamic after sucrose exposure in children with Early Childhood Caries. Sci Rep. 2020 Mar 5;10(1):4146.

[13] Bibby BG, Ludwig TG. Acid production from different carbohydrate foods in plaque and saliva. J Dent Res. 1957 Feb;36(1):56–60.

[14] König KG. Diet and oral health. Int Dent J. 2000 Jun;50(3):162–74.

[15] Thaweboon S, Suddhasthira T, Thaweboon B, Soo-Ampon S, Dechkunakorn S. Plaque pH response to snack foods in children with different levels of mutans streptococci. Southeast Asian J Trop Med Public Health. 2007 May;38(3):598–603.

[16] Dodds MW, Edgar WM. The relationship between plaque pH, plaque acid anion profiles, and oral carbohydrate retention after ingestion of several "reference foods" by human subjects. J Dent Res. 1988 May;67(5):861–5.

[17] Dawes C, Macpherson LM. Effects of nine different chewing-gums and lozenges on salivary flow rate and pH. Caries Res. 1992;26(3):176–82.

[18] Chewing Gum: Effect on pH and Streptococcus Mutans of Saliva IADR Abstract Archives [Internet]. [cited 2024 Dec 12]. Available from: https://iadr.abstractarchives.com/abstract/afrmde05-67613/chewing-gum-effect-on-ph-and-streptococcus-mutans-of-saliva

Efficacy of Resin-Modified Glass Ionomer Varnish in Preventing Occlusal Caries in Permanent Molars: A 12-Month Trial

Liana Beresescu[1], Elena Stepco[2], Alexandra Mihaela Stoica[3], Raluca Sabau[4], Daniela Elena Esian[5]

[1]*Department of Preventive and Community Dentistry, Faculty of Dental Medicine, "George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Târgu Mureş, Romania*
[2]*Department of Oro-Maxillofacial Surgery, Pediatric Surgery, and Pedodontics, The State University of Medicine and Pharmacy "Nicolae Testemitanu", Chisinau, Moldova*
[3]*Department of Odontology and Oral Pathology, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Târgu Mureş, Romania*
[4]*Private practice, Tîrgu Mureş. Romania*
[5]*Department of Pedodontics, "George Emil Palade" University of Medicine, Pharmacy, Science and Technology of Târgu Mureş, Romania*

Correspondence to:
Name: Alexandra Mihaela Stoica
E-mail address: alexandra.stoica@umfst.ro

Received: 8 December 2024; Accepted: 17 December 2024; Published: 30 December 2024

Abstract

Preventing occlusal caries in children is a critical component of oral health management, given the susceptibility of newly erupted permanent molars to decay. *Aim and Objectives:* This study aimed to assess the efficacy of resin-modified glass ionomer varnish in preventing occlusal caries in newly erupted first permanent molars over a 12-month clinical trial. *Materials and Methods:* A split-mouth randomized clinical trial was conducted with 59 children aged 6–8 years, analyzing 86 pairs of newly erupted first permanent molars. Varnish™ XT (resin-modified glass ionomer varnish) was applied to one molar (Varnish Group), while the contralateral molar was left untreated (Control Group). Outcomes were evaluated using the International Caries Detection and Assessment System (ICDAS II) at 6 and 12 months. *Results:* The Varnish Group showed significantly better outcomes, with 96.51% of teeth remaining caries-free at 6 months and 90.7% at 12 months. In contrast, the Control Group had only 73.26% and 56.98% caries-free teeth at 6 and 12 months, respectively. Statistical analysis confirmed the efficacy of Varnish™ XT ($p \leq 0.001$). *Conclusion:* Varnish™ XT demonstrated superior effectiveness in preventing occlusal caries compared to untreated teeth.

Keywords: occlusal caries, resin-modified glass ionomer varnish, dental prevention

INTRODUCTION

Dental caries remains a widespread and chronic condition affecting children worldwide, and its prevention remains a critical public health priority [1]. Among dental surfaces, the occlusal surfaces of molars are particularly susceptible to decay, accounting for a significant proportion of caries cases in children and adolescents. Studies indicate that approximately 60–90% of caries in children occur on these surfaces, underscoring the need for targeted preventive measures [2-4].The permanent first molar holds unique significance in the dental arch. It is the first permanent tooth to erupt, typically appearing around the age of six, and plays a vital role in establishing occlusion, mastication, and arch stability [5,6]. Its early eruption into a young oral environment, often before the child has fully developed effective oral hygiene habits, makes it highly vulnerable to caries. Additionally, the molar's anatomical complexity, with its deep pits and fissures, creates an environment conducive to plaque retention and bacterial colonization. These factors collectively contribute to the molar's higher susceptibility to caries compared to other teeth [7,8].

The age group selected for this study, typically encompassing children between six and 12 years, faces specific challenges in maintaining oral health. This period coincides with the eruption of permanent teeth and transitional oral hygiene practices, making children particularly vulnerable to caries development. Inadequate oral hygiene habits, poor diet rich in fermentable carbohydrates, limited fluoride exposure, and socio-economic factors further compound the risk. Moreover, behavioral factors such as noncompliance with regular dental visits and a lack of awareness about preventive measures contribute to the prevalence of caries in this age group [9,10].

Among the strategies for preventing occlusal caries, fissure sealants and fluoride varnishes are widely employed. Traditional resin-based sealants have proven effective but rely heavily on proper isolation and application technique, which may limit their success in challenging clinical conditions such as partially erupted teeth [11-13]. Conventional fluoride varnishes, similarly, are effective only when optimal isolation from saliva is achieved, which may be difficult in certain clinical scenarios. However, their effectiveness in preventing occlusal caries, particularly in high-risk situations, lacks robust clinical evidence over extended periods [14]. These limitations necessitate the development of alternative materials like glass ionomer-based cements (GICs) and resin-modified glass ionomer varnishes (RMGIs), which offer moisture-tolerant properties and a more sustained fluoride release, making them more suitable for newly erupted teeth in challenging clinical conditions (15,16). Despite the potential advantages of these materials, limited research has compared their efficacy to that of traditional approaches, particularly over extended periods. Furthermore, there is a lack of robust clinical evidence assessing their performance in preventing occlusal caries in newly erupted permanent first molars.

Aim and objectives

This study aims to evaluate the effectiveness of a light-curable resin-modified glass ionomer varnish in preventing occlusal caries on newly erupted first permanent molars compared to untreated teeth over a 12-month period. The findings are expected to enhance clinical practices, particularly in pediatric dentistry, by offering evidence-based insights into innovative strategies for preventing occlusal caries and promoting better oral health outcomes.

MATERIAL AND METHODS

The study was conducted in accordance with ethical regulations, having received approval from the Ethics Committee of the Denta Aur Private Medical Center, Târgu-Mureş, Romania with the clinical trial registration number 032/21.03.2023. Clinical procedures took place between May 2023 and July 2024, and informed consent was obtained from the parents of all participants.

Oral Hygiene Training and Compliance Monitoring. All participants received detailed training on oral hygiene, including the Bass brushing technique or the use of electric toothbrushes, depending on individual preferences. Nutritional hygiene advice was also provided to support long-term oral health. Compliance with these recommendations was monitored throughout the study. The instructions were age-appropriate, and parents were actively involved in supporting their children's daily adherence to these practices, ensuring proper oral hygiene and dietary habits.

Study Design and Participants. The trial followed a split-mouth design, where one molar from a pair of contralateral maxillary or mandibular first permanent molars was randomly assigned to the Vanish™ XT group, and the other served as a control, receiving no treatment. The treated molars formed the Varnish group, while untreated molars formed the Control group.The inclusion criteria were healthy children aged 6–8 years, at high risk of dental caries, with a minimum of one pair of newly erupted, contralateral first permanent molars featuring deep pits and fissures, no dental abnormalities, and no clinical signs of carious lesions. Exclusion criteria included molars with suspicious or uncertain structural integrity, teeth with fillings or sealants, children not classified as high-risk for caries, or those unable to complete the follow-up evaluations.

Caries Detection and Classification. The ICDAS II classification system [17] was used to evaluate and track caries progression. This system includes a numerical scale from 0 to 6, used to classify lesions based on both visual and tactile assessments:

- ICDAS 0: No visible caries; healthy enamel.
- ICDAS 1: First visual changes in enamel, seen only after air drying; no cavitation.
- ICDAS 2: Distinct visual changes in enamel, visible without drying; no cavitation.
- ICDAS 3: Localized enamel breakdown due to caries with or without underlying shadow.
- ICDAS 4: Underlying dark shadow from dentin with or without enamel cavitation.
- ICDAS 5: Distinct cavity with visible dentin.
- ICDAS 6: Extensive cavity with visible dentin.

Two calibrated examiners conducted the caries assessment using visual and tactile methods based on the ICDAS II classification system. A dental probe was used to assess the surfaces for caries, and the teeth were examined after cleaning and drying.

Eighty-seven children were initially screened. Seventeen were excluded due to the presence of carious lesions, fillings, sealants, or because they were not at high risk of caries, and eight declined to participate. Sixty-two children met the inclusion criteria. During the study, three children were excluded due to missed follow-ups, resulting in a final sample of 59 children, comprising 86 pairs of molars (172 teeth) for analysis.

Clinical Procedures. Two calibrated dentists, assisted by trained chairside dental assistants, performed all clinical steps. Both operators completed an ICDAS-II calibration course to standardize the assessment of tooth surfaces and caries detection. Teeth were evaluated using visual and tactile methods based on the ICDAS-II classification system.

Teeth were cleaned using a rotating cup without paste, isolated with cotton rolls and a saliva ejector, and thoroughly dried. Materials were applied according to the manufacturer's instructions. The Vanish™ XT application involved etching the tooth surface with 35% phosphoric acid for 15 seconds, followed by rinsing for 60 seconds and drying for 5 seconds. Equal parts of Vanish™ XT liquid and paste were mixed for 15 seconds and applied in a thin layer (≤0.5 mm) to the occlusal and buccal/lingual surfaces using a brush. The material was then light cured for 20 seconds. After curing, the material was meticulously inspected to ensure proper setting and retention.

Outcome and Follow-Up. The primary outcome was the development of new caries (ICDAS II scores of 1, 2, or 3) on the occlusal surfaces of the molars at 6 and 12 months. Two calibrated examiners conducted caries assessments, with any detected carious lesions being treated and recorded as failures. To ensure consistency, the same baseline treatment was reapplied at each follow-up visit.

Sample Size Determination. The required sample size was calculated as 142 teeth using G-Power software™ (Heinrich Heine University, Düsseldorf, Germany), with 95% power ($\alpha = 0.05$, $\beta = 0.05$).

Statistical Analysis. The data were analyzed using GraphPad Prism™ V6.01 software for Windows. For categorical data, Fisher's exact test was applied in cases of small sample sizes, while the chi-squared test was used for larger datasets. Statistical significance was set at $p \leq 0.05$.

RESULTS

The final sample included 59 children (34 females and 25 males) aged 6–8 years, with a mean age of 7.08 ± 0.67 years. Females represented 57.62% of the participants, while males accounted for 42.37%. Of the 59 children included in the study, 27 had all four first permanent molars (2 pairs) analyzed, while the remaining 32 children had only one pair of molars (2 teeth) included in the analysis.

The Caries Status at Follow-Up:

In the Varnish group: At the 6-month follow-up, out of 86 treated teeth, 83 teeth (96.51%) remained caries-free (ICDAS II code 0), while 3 teeth (3.49%) showed early caries (ICDAS II code 1). At the 12-month follow-up, 78 teeth (90.7%) were caries-free (ICDAS II code 0), and 8 teeth (9.3%) were classified as ICDAS II code 1.

In the Control group: At 6 months, out of 86 untreated teeth, 63 teeth (73.26%) were caries-free (ICDAS II code 0), while 19 teeth (22.09%) scored ICDAS II code 1, and 4 teeth (4.65%) scored ICDAS II code 2. At 12 months, 49 teeth (56.98%) were caries-free (ICDAS II code 0), 14 teeth (16.28%) scored ICDAS II code 1, 13 teeth (15.12%) scored ICDAS II code 2, and 10 teeth (11.63%) developed more advanced caries (ICDAS II code 3).

Statistical analysis revealed significant differences between the Varnish and Control groups regarding caries progression. These differences were evident at both the 6-month and 12-month follow-ups. All these data are summarized in the following table (Table 1).

Table 1. Caries Status of Treated and Untreated Teeth at 6- and 12-Month Follow-Up

Group	**Follow-Up**	**ICDAS code 0**	**ICDAS code 1**	**ICDAS code 2**	**ICDAS code 3**	**Total Teeth**	***p*-value**
Varnish Group	6 months	83 (96.51%)	3 (3.49%)	0	0	86	< 0.001
	12 months	78 (90.7%)	8 (9.3%)	0	0	86	< 0.001
Control Group	6 months	63 (73.26%)	19 (22.09%)	4 (4.65%)	0	86	-
	12 months	49 (56.98%)	14 (16.28%)	13 (15.12%)	10 (11.63%)	86	-

DISCUSSIONS

The results of this study indicate that the use of a light-curable resin-modified glass ionomer varnish (Vanish™ XT) can significantly reduce the development of occlusal caries in newly erupted first permanent molars, as compared to untreated teeth. At both the 6- and 12-month follow-ups, molars treated with the Vanish™ XT varnish demonstrated a significantly higher percentage of caries-free teeth (ICDAS code 0) compared to the control group, which did not receive any treatment.

At 6 months, 96.51% of teeth in the Varnish group remained caries-free, a result that is consistent with other studies evaluating fluoride varnishes and resin-modified glass ionomer products. In contrast, only 73.26% of teeth in the Control group were caries-free at the same interval, and this difference was statistically significant. These findings align with previous research that has highlighted the effectiveness of fluoride varnishes and glass ionomer-based materials in preventing dental caries, particularly in children with deep fissures and high caries risk [18,19].

The efficacy of resin-modified glass ionomer varnishes like Vanish™ XT is attributed to their moisture-tolerant properties and sustained fluoride release, which allow for better adaptation to the oral environment, especially in partially erupted or difficult-to-isolate teeth [15,20,21]. Previous studies have shown that these materials provide long-lasting protection by releasing fluoride gradually, which is essential in high-risk groups, where traditional fluoride varnishes may not offer optimal protection due to issues with isolation [20,22].

Over the 12-month period, the results remained favourable for the Vanish™ XT group, with 90.7% of teeth remaining caries-free at the 12-month follow-up. This extended period of protection further supports the long-term benefits of using resin-modified glass ionomer varnishes in preventing occlusal caries. The Control group, on the other hand, exhibited significant progression of caries, with only 56.98% of untreated teeth remaining caries-free after 12 months, and a notable increase in the proportion of teeth classified as ICDAS code 2 and ICDAS code 3.

While this study provides promising results, it is important to acknowledge that the success of any preventive treatment depends on a combination of factors, including patient compliance, oral hygiene practices, and the technique used during application. In this study, the clinical procedure was standardized, with two calibrated examiners ensuring consistent caries detection and treatment, which reduces the potential for bias. However, further studies involving larger and more diverse populations, longer follow-up periods, and comparisons with other preventive measures (e.g., resin-based sealants) are necessary to further substantiate the findings.

Several studies have also examined the use of fluoride varnishes and sealants for occlusal caries prevention. For example, studies have demonstrated that fluoride varnishes can reduce the incidence of caries in high-risk children, but the level of efficacy may vary depending on the product and the clinical conditions under which it is applied [23]. Additionally, recent investigations into the use of alternative materials such as bioactive glass and fluoride-releasing cements suggest promising outcomes in caries prevention, particularly in pediatric dentistry [16,24].

While the findings of this study demonstrate the effectiveness of Vanish™ XT in preventing occlusal caries, some limitations should be considered. An important limitation of this study is the relatively small sample size, which may affect the generalizability of the results, alongside the short follow-up period (12 months) that does not allow for long-term assessment of the material's effectiveness, as well as the exclusive focus on a single product (Vanish™ XT) without direct comparisons to other available preventive materials. Further studies with larger, more diverse populations, extended follow-up periods, and direct

comparisons to other preventive materials are needed to confirm and expand upon these findings.

CONCLUSIONS

This study demonstrates that light-curable resin-modified glass ionomer varnish (Vanish™ XT) is highly effective in preventing occlusal caries on newly erupted first permanent molars. The varnish provides significant protection over 6- and 12-month periods, particularly in high-risk children, thanks to its ease of application, moisture tolerance, and sustained fluoride release. These characteristics make Vanish™ XT a promising addition to pediatric preventive care.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

[1] World Health Organization. Oral health. Available from: https://www.who.int/news-room/fact-sheets/detail/oral-health. [Accessed on 19 August 2024].

[2] Mačiulskienė V, Razmienė J, Andruškevičienė V, Bendoraitienė E. Estimation of Caries Treatment Needs in First Permanent Molars of Lithuanian 5–6-Year-Old Children, Based on Caries Lesion Activity Assessment. Medicina. 2020; 56:105.

[3] Khan Q, Farooq I, ArRejaie A, Khabeer A, Farooqi FA. Prevalence of first permanent molar caries among 8 to 12 years old school-going children living in Dammam, Kingdom of Saudi Arabia. Ann. Jinnah Sindh Med. Uni. 2017; 3, 18–21.

[4] Que L, Jia M, You Z, Jiang LC, Yang CG, Quaresma AAD, das Neves EMAA. Prevalence of dental caries in the first permanent molar and associated risk factors among sixth-grade students in São Tomé Island. BMC Oral Health 2021; 21, 483.

[5] Bratu E, Practica pedodontică, Timişoara: Orizonturi Universitare, 2005. pp 283-284.

[6] Alfuriji S, Alamro, H.; Kentab, J.; Alosail, L.; Alali, L.; Altuwaijri, N.; Alalwan, R. Ectopic Permanent Molars: A Review. Dent. J. 2023, 11, 206. https://doi.org/10.3390/dj11090206.

[7] Carvalho, J.C. Caries process on occlusal surfaces: evolving evidence and understanding. Caries Res. 2014;48(4):339-46. doi: 10.1159/000356307. PMID: 24577073.

[8] Moca, A.E.; Vaida, L.L.; Negruţiu, B.M.; Moca, R.T.; Todor, B.I. The Influence of Age on the Development of Dental Caries in Children. A Radiographic Study. J Clin Med. 2021 Apr 15;10(8):1702. doi: 10.3390/jcm10081702. PMID: 33920901; PMCID: PMC8071245.

[9] Wang, Z.; Rong, W.; Xu, T. Effect of Fluoride Varnish in Preventing Dental Caries of First Permanent Molars: A 24-Month Cluster Randomized Controlled Trial. Int. J. Environ. Res. Public Health. 2022, 19, 16656. https://doi.org/10.3390/ijerph192416656.

[10] Torlińska-Walkowiak, N.; Łukaszewicz, K.; Morawska, A.; Sowińska, A.; Pawlaczyk-Kamieńska, T.; Opydo-Szymaczek, J. Diet, Oral Hygiene Habits, and Approach to Dental Visits of Early School-Aged Children during the COVID-19 Pandemic and Possible Long-Term Health Consequences. J. Clin. Med. 2023, 12, 5690. https://doi.org/10.3390/jcm12175690.

[11] Gooch BF, Griffin SO, Gray SK, Kohn WG, Rozier RG, Siegal M, Fontana M, Brunson D, Carter N, Curtis DK et al. Centers for Disease Control and Prevention. Preventing dental caries through school-based sealant programs: Updated recommendations and reviews of evidence. J. Am. Dent. Assoc. 2009; 140, 1356–1365.

[12] Beauchamp J, Caufield, P, Crall, J, Donly K, Feigal R, Gooch B, Ismail A, Kohn W, Siegal M, Simonsen R. Evidence-based clinical recommendations for the use of pit-and-fissure sealants A report of the American Dental Association Council on Scientific Affairs. Dent. Clin. N. Am. 2009, 53, 131–147.

[13] Jafarzadeh M, Malekafzali B, Tadayon N, Fallahi S. Retention of a Flowable CompositeResin in Comparison to a Conventional Resin-Based Sealant: One-year Follow-up. J. Dent. 2010; 7, 1–5.
[14] Ahovuo-Saloranta A, Forss H, Hiiri A, Nordblad A, Makela M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Reviews. 2016;1(1361–6137): Cd003067.
[15] Gonçalves PSP, Kobayashi TY, de Oliveira TM, Honório HM, Rios D, da Silva SMB. Pit and fissure sealants with different materials: Resin based x glass ionomer cement–results after six months. Brazilian Res Pediatr Dentistry Integr Clin. 2016;16(1):15–23.
[16] Seixas GF, Guiraldo SBB, Lemos LVFM, Myaki SI, Balducci I, Moura SK. ClinproTM XT Sealant Adhesion to the Occlusal Surface of primary molars: longitudinal evaluation. J Health Sci 2018; 20(2).
[17] International Caries Detection and Assessment System (ICDAS) Coordinating Committee. ICDAS II system and criteria. Available from: https://www.iccmsweb.com/uploads/asset/592848be55d87564970232.pdf. [Accessed on 12 March 2022].
[18] Ahsan AS. The Preventions of Dental Caries in Children - A Short Scoping Review. 2022- 4(2) OAJBS.ID. 000416.
[19] Sicca C, Bobbio E, Quartuccio N, Nicolò G, Cistaro A. Prevention of dental caries: A review of effective treatments. J Clin Exp Dent.2016;8(5): e604-10.
[20] Baik A, Alamoudi N, Felemban O et al. Prevention of occlusal caries using VanishTM XT: an 18-month follow-up randomized clinical trial. BMC Oral Health.2024; 24, 1328.
[21] Virupaxi SG, Roshan N, Poornima P, Nagaveni N, Neena I, Bharath K. Comparative evaluation of longevity of fluoride release from three different fluoride varnishes–an invitro study. J Clin Diagn Research: JCDR. 2016;10(8):33–7.
[22] Cabral RN, Faber J, Otero SAM, Hilgert LA, Leal SC. Retention rates and caries-preventive effects of two different sealant materials: a randomised clinical trial. Clin Oral Invest. 2018;22(9):3171–7.
[23] Shen C, Autio-Gold J. Assessing fluoride concentration uniformity and fluoride release from three varnishes. J Am Dent Association. 2002;133(2):176–82.
[24] Kumar Jena A, Pal Singh S, Kumar Utreja A. Efficacy of resin-modified glass ionomer cement varnish in the prevention of white spot lesions during comprehensive orthodontic treatment: a split-mouth study. J Orthodont. 2015;42(3):200–7.