UNIVERSITATEA DE MEDICINĂ ȘI FARMACIE
GRIGORE T. POPA IAȘI

HABILITATION THESIS

MODERN APPROACHES OF ORAL HEALTH FROM THE PERSPECTIVE OF COMMUNITY DENTISTRY

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Table of contents:

ABBREVIATIONS

ACP-Amorphous calcium phosphate

AFM- Atomic Force Microscopy

ATR-FTIR- Attenuated Total Reflection Fourier Transform Infrared

Bis-EMA-Ethoxylated bisphenol A glycol dimethacrylate

Bis-GMA- Bisphenol A-glycidyl methacrylate

CI-Confidence Interval

CPP-Protein casein‑phosphopeptide

CPP-ACP- Casein phosphopeptide-amorphous calcium phosphate complex

CPP-ACFP- Casein phosphopeptide-amorphous calcium phosphate with fluoride

CAHPO4-Calcium phosphate ions

DMFT- Decay Missing Filling

EDX- Energy dispersive spectroscopy

GI-Gingival Index

GOHAI-Geriatric Oral Health Assessesment Index

HEMA- Hydroxyethyl methacrylate

ICDAS-International Caries Detection and Assessesment System

IOTN-Index of Orthodontic Treatment Need

IR- Infrared spectra

OR-Odds ratio

OHRQoL-Oral-health-related quality of life

ppm-parts per million

SEM- Scanning Electron Microscopy

SES- Socio-economic status

SPSS- Statistical Package for Social Sciences

TEGMA-Triethylene glycol dimethacrylate

UDMA-Urethane dimethacrylate

UBA- Universal bonding agent

WHO-Word Health Organization

ABSTRACT

This habilitation thesis entitled *"Modern approaches of oral health from the perspective of Community Dentistry"* presents the main scientific achievements of 2008-2020 period after I obtained the title of Doctor of Dental Medicine, and it is structured into three sections, according to CNATDCU recommendations: Section I – Scientific achievements in postdoctoral period; Section II – Future plans in the professional, academic and scientific activity; Section III – Bibliography.

Before the first section I made a short presentation of my professional, academic and scientific achievements for my whole teaching career that started in 1992.

The **1st Section** is dedicated to postdoctoral scientific researches; it is structured into 2 research domains and comprises the most relevant articles of my scientific activity indexed in *Web of Science Core Collection* and international databases.

The **first chapter** of this section entitled *"Promotion of oral health and quality management in dental helath care"* presents researches specific to the field of Community Dentistry being preceded by a section which details the latest and most relevant information in the literature regarding this theme.

From this perspective, *in my first line of research,* I highlighted the role of risk factors, unhealthy behaviours and social determiners in the occurrence of oral diseases in population groups of different ages such as children, teenagers and old people.

In *my second line of research*, I focused on the study of classical and modern methods for the prevention of dental caries, including researches regarding the efficiency of fluoride-based products in topic applications, as a classical method, as well as the use of the products of CCP-ACP (casein phosphopeptide and amorphous calcium phosphate) type, as an innovative method for the re-mineralization of incipient enamel cavity.

The third line of research identified prediction factors for the successful management of the dental practice as well as the impact of economic factors on the oral health system. In this context, I analysed the influence of the economic crisis on the performance and quality of the dentistry activity in the dental practices and dental technique labs.
Another aspect tackled with focused on the knowledge of dentists' satisfaction and motivation towards their career, the challenges and potential negative effects that may appear as a result of stress, chronic fatigue and even the decrease of interest for one's career.

In **the second chapter** entitled *"Clinical and experimental researches in preventive and restorative dentistry*" I followed two lines of research preceded by an update of the latest information in the literature regarding the toxic effects of dental materials.

The *first line of research* focused on the study of biocompatibility of dental materials while following the toxic effects caused by the materials currently used in the dental practice.
In this chapter I selected 4 researches having an experimental character that showed the modifications produced at the level of enamel and dentine by the following dental materials:

orthophosphoric acid 37% used in the therapy of dental cavity, and carbamide peroxide, having different concentrations, from 6% to 40%, used to treat teeth with discolorations.
The last research study tested the hypothesis according to which fluoride topic applications made after dental whitening procedure may restore the enamel affected from the morphological and structural viewpoints.

The *second line of research* approached the use of composite resins in the restorative treatments while analyzing by *in vitro* researches the adhesive property and the property to prevent dental cavity of the composite materials of the latest generation.
In this chapter, I selected the most relevant studies showing pertinent conclusions and having practical applicability.

The 2nd Section presents the future lines of research both from the scientific and academic viewpoints. In this respect, on one hand I wish to continue the already approached themes specific to Community Dentistry subject and, on the other hand, I wish to approach new and innovating lines of research that may allow interdisciplinary researches with national and international teams.
In this section, I underlined the strategies and projects relating to my activity with future doctoral candidates while detailing the research themes that may be approached by them, namely clinical and experimental researches regarding the use of materials of glass-ionomer type for the primary prevention of dental cavity, researches in the field of quality of life for disabled children as well as screening programmes for the population necessary to identify early preneoplasic and tumoral lesions.

The 3rd Section includes a list of the main papers that I consulted in order to elaborate the habilitation thesis.

REZUMAT

Prezenta teză de abilitare, cu titlul *"Abordări moderne ale sănătăţii orale din perspectiva Stomatologiei Comunitare"*, prezintă principalele realizări ştiinţifice din perioada 2008-2020 după obţinerea titlului de Doctor în Medicină Dentară şi este structurată în trei secţiuni, conform recomandărilor CNATDCU: Secțiunea I – Realizări științifice din perioada post-doctorală; Secțiunea II – Planuri viitoare în activitatea profesională, academică și științifică; Secțiunea III – Referințe bibliografice.

Înainte de prima secţiune am realizat o scurtă prezentare a realizărilor profesionale, academice şi ştiinţifice din întreaga mea carieră didactică începută în anul 1992.

Secţiunea I este destinată cercetărilor ştiinţifice postdoctorale, fiind structurată pe 2 domenii de cercetare și cuprinde cele mai relevante articole din activitatea mea științifică, indexate în *Web of Science Core Collection* și în baze de date internaționale.

Primul capitol al acestei secțiuni, intitulat *"Promovarea sănătății orale şi calitatea managementului în sistemul de sănătate orală"*,prezintă cercetări specifice domeniului Stomatologiei Comunitare, fiind precedate de o secțiune care detaliază cele mai noi și relevante informații din literatura de specialitate cu privire la această tematică.

Din această perspectivă am evidenţiat *în prima direcție de cercetare,* rolul factorilor de risc, al comportamentelor nesanogene și al determinanților sociali în apariţia afecţiunilor orale la grupele populaționale cu vârste diferite: copii, adolescenţi şi vârstnici.

În a *doua direcție de cercetare* m-am axat pe studierea metodelor clasice și moderne de prevenție a cariei dentare, incluzând cercetări privind eficiența produșilor pe bază de fluor în aplicații topice, ca metodă clasică, precum și utilizarea produșilor de tip CCP-ACP (cazein-fosfo-peptidă şi fosfat de calciu amorf), ca metodă inovativă de remineralizare a cariei incipiente de smalț.

A treia direcție a identificat factorii de predicție pentru un management performant al cabinetului dentar, precum și impactul determinanților economici asupra sistemului de sănătate orală. În acest context am analizat influența crizei economice asupra performanței și calității actului stomatologic din cabinetele dentare și laboratoarele de tehnică dentară.
Un alt aspect abordat a urmărit cunoașterea satisfacției și motivației medicilor stomatologi față de cariera profesională, provocările și posibilele efecte negative care pot apare determinate de stress, oboseală cronică și chiar scăderea interesului faţă de carieră.

În **al doilea capitol** intitulat *"Cercetări clinice și experimentale în stomatologia preventivă și restaurativă* " am urmărit două direcții de cercetare, precedate de o aducere la zi a ultimelor informații din literatura de specialitate referitoare la efectele toxice ale materialelor dentare.

O *primă direcție* a vizat studiul biocompatibilității materialelor dentare, urmărind efectele toxice determinate de materialele utilizate curent în practica stomatologică.
În acest capitol am selectat 4 cercetări cu caracter experimental care au pus în evidenţă modificările produse la nivelul smalţului şi dentinei de următoarele materiale dentare: acidul ortofosforic 37% utilizat în terapia cariei dentare și peroxid carbamida, cu diferite concentrații, de la 6% la 40%, utilizată în tratamentul dinților cu discolorații.

Ultimul studiu de cercetare a testat ipoteza conform căreia aplicațiile topice cu fluor realizate după procedeul de albire dentară poate să refacă smalțul afectat din punct de vedere mofologic şi structural.

A doua direcţie de cercetare a abordat utilizarea rășinilor compozite în tratamentul restaurativ, analizând prin cercetări *in vitro* proprietățile adezive și de prevenire a apariției cariei dentare ale materialelor compozite de ultimă generație.
Am avut în vedere în acest capitol selectarea celor mai relevante studii din care să rezulte concluzii pertinente şi cu aplicabilitate practică.

Secţiunea II prezintă direcţiile viitoare de cercetare, atât din punct de vedere ştiinţific, cât şi academic.
În acest sens doresc, pe de o parte, continuarea tematicii deja abordate, specifice disciplinei de Stomatologie Comunitară, iar pe de altă parte, doresc să abordez direcţii noi, inovatoare, care să permită cercetări interdisciplinare în echipe naţionale şi internaţionale.
În această secțiune am subliniat strategiile și proiectele privind activitatea cu viitorii doctoranzi, detaliind temele de cercetare care pot fi abordate de către aceștia, si anume: cercetări clinice şi experimentale privind utilizarea materialelor de tip glassionomer pentru prevenția primară a cariei dentare, cercetări în domeniul calității vieții pentru copiii cu dizabilități, precum și programe de screening populațional necesare depistării precoce a leziunilor preneoplazice si tumorale.

Secţiunea III include o listă a principalelor lucrări de referinţă care au fost consultate în vederea elaborării tezei de abilitare.

OVERVIEW OF ACADEMIC, PROFESIONAL AND SCIENTIFIC ACHIEVEMENTS

My whole career has had and still has **excellence** as its fundamental objective in all fields of activity: professional, didactic and scientific research.
I have summarized the professional presentation of my academic career according to the following plan: *professional and academic activity; scientific research activity; achievements in the scientific publication area; recognition of the national and international level.*

1. Professional and academic activity

I graduated the Faculty of Dentistry, University of Medicine and Pharmacy „Grigore T Popa" Iasi in 1991, diploma series J nr. 1189. In 1992 I became Junior assistant at Community Dentistry discipline, Faculty of Dental Medicine; in 1996 I continued my didactic activity as Assistant Professor since 2014 when I became Lecturer. Since February 2018 until present I am Associate Professor at the Community Dentistry discipline, Surgical Department, Faculty of Dental Medicine, „Grigore T. Popa" University of Medicine and Pharmacy, Iasi.

My didactic activity has been carried out in the field of Community Dentistry with the 6^{th} year students (period 1997-2001) and the 5^{th} year students (2001-2020). I have always been concerned with the quality of clinical internships performed and their scientific substantiation while making great efforts to continuously improve the contents and quality of the demonstrative didactic materials.
Through my teaching activity I got involved, as coauthor, into the elaboration of the Community Dentistry course in 1995 and 1999, and this was introduced into the academic curriculum of the faculty for the first time. In 2016, I published the course for the French language department.
Once with the introduction of university's e-learning platform, I elaborated the teaching materials (course packet/practical works) in electronic form for the subjects in the teacher workload. I have supervised so far more than 25 graduation theses of the students in the Romanian and French language departments, and I have coordinated 5 scientific papers for student scientific sessions.
During my teaching activity as lecturer and associate professor I guided students of both series in the elaboration of graduation theses and I was involved in organizing the annual Stomis student congress, where I was moderator and member of the awards jury.

Currently I carry out my teaching activity with 5th year students, Romanian and French language series. In 2016 I introduced an optional course for the students of the French language series, entitled "*The social and psychological determinants of oral health*". A constant concern was the elaboration of teaching materials for the students of the Romanian and French language series, respectively, courses, guides and protocols, monographs, the last material published in 2019, refers to the *social and behavioral aspects in community oral health*.

In the elaboration of these teaching materials I took into account the updating of the curriculum in accordance with the current training priorities in the European space, in accordance with the current state of knowledge and with the requirements of the labor market.
In the activity of the practical works I followed the presentation of some diagnostic algorithms, the solving of problems specific to the topic and the elaboration of questionnaires, in order to structure the clinical thinking of the students.

I introduced in the didactic process of the discipline the realization of *thematic reports* by the students in the idea of stimulating the individual study and of the diversification of their area of knowledge. Moreover, I proposed that the presentation of these papers be in meetings in which the students of several groups were involved, offering the possibility to participate in joint discussions / analyzes / comments.

The involvement of the students in the health promotion actions at community level was achieved with the 5th year students enrolled in the optional course "*Quality of life related to oral health*". They carried out oral health education actions for preschool children, carried out in kindergartens in Iasi, as well as for the elderly institutionalized at the "Sf Cuvioasa Parascheva" retirement home in Iasi.

I had the quality of *internship coordinator* and I taught notions in the area of community dentistry and oro-dental prevention to students from all years of study, in two projects with European funding: POSDRU / 86 / 1.2 / S / 63699 and POSDRU / 160 / 2.1 / S / 139881.

The relationship with the students was a relationship of interaction, efficient communication and understanding of the situations underprivileged in terms of ethnicity, family problems or those caused by lack of integration in the student community. In this sense, I mention my involvement as *an expert in the coaching activity* within the ROSE project (BeMeDTech project) in which I held interactive courses about possible obstacles that may occur in the first academic year, concrete ways to avoid or overcome them through the process of psychological counseling specific to coaching.

In 2020, as a result of the situation imposed at national level by the pandemic with SARS-CoV-2, I readapted the topic offered to the practical works for the online education process, through educational platforms. It was a challenge from the point of view of designing plans, preparing reports, case presentations and developing subjects, adapted to this way of teaching.

Another activity in the didactic area aims at carrying out courses and practical works for the *residents of the 1st year of General Dentistry* within the Public helath dentistry, recently introduced in 2020.

This challenge requires a permanent concern to update the curriculum of courses and practical works, by completing the topics offered during the faculty and by creating an educational platform in collaboration with other specialists of the traditional faculties in the country.

In all these 27 years I have kept on improving through different methods and techniques necessary to the didactic and research activity by participating to workshops, post-university courses and courses for the recognition of competences**.**

The most relevant are the following ones:

-*Digital smile design,* The 11th International Congress of the Romanian Dental Association for Education, 23rd edition of the Open Days of the Faculty of Dental Medicine: Excellence in the interdisciplinary management of Dental Medicine, Iasi, 2019;

-*Diode laser application in soft tissue,* The 11th International Congress of the Romanian Dental Association for Education, 23rd edition of the Open Days of the Faculty of Dental Medicine: Excellence in the interdisciplinary management of Dental Medicine, Iasi, 2019.

-The 41st Annual Conference of European Prosthodontic Association, Bucharest, 28-30 September 2017;

- *Medico-dental emergencies*, Bucharest, April 14th, 2016;

- *Interdisciplinarity - success factor in general and oral rehabilitation,* Iaşi, July 13th, 2012;

- *Modernization of the Dental Medicine curriculum in accordance with the requirements of the European Union,* Iaşi, December 8th -9th, 2011;

-Workshop on "*Critical appraisal, peer review and writing scientific papers and abstracts in English*", May 28th – 30th, 2009, Constanta;

- *Abstract writing workshop*, Prague, November 2008;
- *Workshop on life quality and oro-dental health*, Cluj–Napoca, October 2006;
- *Strategies to promote oral health in the context of Romania's integration into the European Union,* Iaşi, April 24th, 2007;
-International Symposium - *Interrelation between quality of life–oral health*, Constanţa, May 28th, 2007;
- Post-academic course – "*Statistical methods used in population dental research"*, Iaşi, November 2004 - January 2005.

In the period 2009-2013 I was involved in the *Programme for prevention of oral diseases*, a programme conducted by a team of teaching professionals from the Oro-dental prevention Department.

My specializations in terms of **professional training** are:

- *Dental Practitioner*- Stomatological Polyclinic no. 1, Iaşi, 1991, 1992
- *Junior Specialist* - General Dentistry, 1998
- *Senior Specialist* – General Dentistry, 2006 (Confirmed by Order of Minister of Health no. 1051).

Main activities and responsibilities were: consultations, preventive and curative treatments for patients attending clinic in the discipline of Preventive and Community Dentistry.

In the academic community I mention my role in the elaboration of the necessary documentation for the evaluation process by ARACIS of the Dental Medicine study programs, in Romanian, French and English in 2016 and of the newly established program in 2019, of Dental Prophylaxis Assistance.

2. Scientific research activity

In 2007 I became PhD in Dental Medicine-confirmed by Order of the Minister of Education and Research no.1418 , series E no. 0007459, with the title entitled: "Odonto-periodontal health of the adult population (35-44 years) from Iasi county", coordinator: Professor Ioan Danila, with the distinction CUM LAUDE.

My doctoral thesis was divided into 2 sections: the first one, odonto-periodontal health status of the adult population on a representative sample of 928 adults aged 35-44 residing in Iasi.

The objectives of my doctoral thesis focused on the evaluation of oral health in the adult population of Iasi County through the calculation of the frequency and severity indicators for odonto-pariodontal diseases (DMFT, DMFS, and CPITN, respectively), the calculation of the treatments needs and, consequently, the number of needed profesional staff, according to the methodology of the World Health Organisation.

In the second part I conducted a study on quality of life of 1030 adults aged between 18 and 64 years old by resorting to a specially designed instrument and particularly useful in medical practice: *Oral Health Impact Profile-14*.

The aim of this research aimed to establish the impact that these oral diseases have on life quality while resorting to specially designed instruments that are very useful in the medical practice.

The novelty and originality of my doctoral thesis resides in the epidemiological approach of the two oral diseases considered as important public health issues due to their endemic spread and multiple medical and socioeconomic implications at population level on a significant sample of Iasi County, and the validation for the first time in Romania of the quality of life questionnaire: *Oral Health Impact Profile*.

Health state is also conditioned by the quality of medical services, their area of extension and organisation, in other words, the medical care system. To establish the quality of health

services it is important to know patient's level of satisfaction in relation to the medical act and the costs of it in the context of the social and community life to which it belongs. That is why I have considered as important the aspects that relate to qualityof life through the evaluation of the satisfaction and optimism in terms of medical care, in general, and dental care, in particular.
The pertinent results of the study showed that oral health is strongly conditioned by socio-cultural and economic factors, social hierarchy and background which contribute to the maintaining and promotion of individual and population health state.
The research results were put to good use through the publication of:
The research results were published :

- ✓ 3 articles *in extenso* in the volume of 2005 and 2006 "Days of the Dental Medicine Faculty" Congress;
- ✓ 1 article in Medical- Surgical Journal, 2007 ;
- ✓ 2 articles in Medicina Stomatologică Journal, 2003, 2005.

After 2007, I continued the same research line while analyzing quality of life correlated with oral health in different population groups of different ages and exposed to various risk factors.
Besides this direction, I also followed and analyzed in detail other *aspects* among which I mention:
- promotion of oral health in communities by establishing the effects caused by different risk factors from the environment, social factors and food risk factors on oral health;
- economic aspects of oral health (the economic analysis of oral health programmes, the influence of economic crisis on the management of dental office and dental technique labs);
- clinical and experimental studies relating to the primary and secondary prevention in case of dental treatments using dental materials and alloys;
-the analysis of dental students' knowledge and attitude towards the patients suffering from communicable diseases, dental traumatisms or psychiatric diseases;
-the importance of knowing the ethic aspects in dental practice;
-the level of students' satisfaction with the academic curriculum and dentist career.

In the interval 2009-2010 I continued the research on quality of life correlated with oral health by approaching a vulnerable category of population, namely the institutionalized old people.
This was the object of the study conducted within the internal grant of the University of Medicine and Pharmacy " Grigore T Popa" Iasi obtained following the contest launched for the first time in 2009.
The study aim initially focused on the validation for the first time in Romania of *Geriatric Oral Health Assessment Index* (GOHAI) indicator, an instrument frequently used for the old population and which must necessarily be adapted to the cultural requirements of the Romanian population.
The second phase of the research focused on the evaluation and improvement of quality of of life of 186 institutionalized old patients of "Sf. Cuvioasă Parascheva" Retirement Home of Iaşi through specialized visits and treatments as well as by oral health education sessions where the fifth year students enrolled for *Life quality correlated to oral health* optional course were involved.
The study results clearly showed, via the statistic analyses made, the negative influence of the institutionalized environment on the general and oral health state as well as of the lack of information regarding the prevention of oral diseases specific to old age.

The results of the research study were presented at *The 6th International Seminar on Quality Management in Higher Education* congress, Web of science indexation of "Teaching dental students concerning specific aspects on social responsibility" paper, and by the publication of 3 articles in *Oral Health and Dental Management* Journal in 2009, 2010, and 2011, and of 1 article in *Romanian Journal of Oral Rehabilitation* Journal in 2014.

Other relevant activities in the field of scientific research are:

Project leader

1. CNCSIS Grant, Human Resources Program, Mobility project, no. 75/2007
2. Research grants of „Grigore T. Popa" University of Medicine and Pharmacy Iasi, 2009, title: „*Oral health and quality of life among elderly population"*

Member in 6 national research projects CEEX, CNCSIS

- The International Visibility Increase of Oral Health Promotion Researches in Context of European and International Programmes – CEEX M3, C3, 140/2006, Project director: Prof. Dr. Stela Carmen Hanganu (SANOR);
- Integration of the Oral Public Health Romanian Dental School in the European and International Programmes regarding the Oral Health Related Quality of Life – CEEX M3, C3, 192/2006. Coordinator Constanta Ovidius University (CALVITDENT);
- Regional Excellence Network in mocro-nano-bio-technologies and textile materials for medical applications. CEEX C3, Me, 181/2006. Coordinator – Gheorghe Asachi Technical University of Iasi (EUROTEXMED);
- CNCSIS Project nr. 824/ 2006: Oral Health – Essential Factor in Oral Health Prevention. Project Director – Prof. Dr. Ioan Dănilă;
- Subgingival microbiota in healthy and periodontitis Romanian patients determined by DNA Probes. MC- CNCSIS 165/2007 Project Director – Prof. Dr. Stela Carmen Hanganu;
- National partnership in oral health area on tobacco use prevention and smoking cessation – premises of the integration of Romanian research in the European operational space. Nr. 42123/2008 (SANFACTOR) - Project Director – Prof. Dr. Hanganu Carmen.

Project leader

This project was won in the competition launched by the Francophone University Agency and is entitled: „L'assurance de la qualité dans l'enseignement supérieur par la formation de spécialistes dans le domaine de la Réhabilitation Orale Complexe", the period being June-December 2020.

The project aimed at conducting courses for French-speaking teachers in the member countries of the CIDCDF association and 6th year students, French language series, Faculty of Dentistry, UMF "Grigore T Popa" Iasi. The theme of the courses addressed the problem of the edentulous patient whose dental treatment includes complex oral rehabilitation, in terms of diagnosis and dental, periodontal, prosthetic and surgical treatment. In addition, the curriculum also provided interdisciplinary courses, presented by specialists in the fields of anatomy, biochemistry, radiology, internal medicine and cardiology, providing a complete picture of common clinical situations in current practice.

Member in 3 educational projects:

1. „Adaptation of the educational offer in Dental Medicine to the needs of the labor market and of a knowledge based society"
Contract no: POSDRU/86/1.2/S/63699
Period: 2010-2013;Position: Member
2. „Professional Counselling for Medical Students and Integrated Program of Practice in the Field of General and Dental Medicine"
Contract no: POSDRU/160/2.1/S/139881
Period: 2014-2015; Position: Tutor in Cariology Domain
3. "Prevention of school dropout and counseling in choosing the career path for first year students in Dental Medicine and Dental Technique" (BeMeDTech)
Period: 2019-2020; Position: Specialist in coaching activity.

3. Achievements in the scientific publication area

-Monographs in the national publishing house: 2
- Courses for dental students Romanian and French sections: 3
-Articles published in extenso in Web of sciene Core Collection-indexed journal with IF-17
-First/last/correspondent author in International database listed papers: 47
-Co-author in International database listed papers: 10
- Articles published in extenso in the volumes of international conferences:6
- Oral presentation at national congress as Invited Speaker: 13
-Abstracts at national al international manifestations : 27
-Hirsch Index (Clarivate Analytics):7.

4. Recognition at the national and international level

I am currently member in 3 international scientific societies and 4 national societies:

- European Association of Dental Public Health (EADPH)
- Balkan Stomatological Society (BASS)
- International Congress of Oral Implantologists (ICOI)
- Romanian Dental Association for Education (ADRE)
- Romanian Association of Oral Rehabilitation (ASRRO)
- Society of Physicians and Naturalists (SSM) Iasi Branch
- The College of Stomatologists from Romania (CMSR)-President of Discipline Committee, 2015-present.

In 2013 and 2014 I won 2 awards UEFISCDI with the papers published in ISI journals located in the top area:

1. Alice Murariu, Stela Carmen Hanganu. *Family influences on adolescent's oral health behaviour and sugar consumption,* Revista de cercetare şi intervenţie socială, 2013, 41, 60-74, cod PN-II-RU-PRECISI-2013-7-2656, position 992

2. Diana Diaconu, Anca Vitalariu, Monica Tatarciuc, Alice Murariu, *The economic crisis effects on the cross contamination control in dental laboratories,* Revista de cercetare şi intervenţie socială, 2014, vol. 47 105-116, PN-II-RU-PRECISI-2015-9-8471, position 1073

My scientific publlications have counted over 100 citations in ISI Clarivate Analytic Indexed Journal.

SECTION I

SCIENTIFIC ACHIEVEMENTS FROM THE POSTDOCTORAL PERIOD

Chapter 1

ORAL HEALTH PROMOTION AND QUALITY MANAGEMENT IN DENTAL HEALTH CARE

1.1. RISK FACTORS OF ORAL HEALTH IN POPULATION WITH DIFFERENT AGE

State of art

Oral health is fundamental to general health and well-being. Oral disease can lead to pain and tooth loss, a condition that affects the appearance, quality of life, nutritional intake and, consequently, the growth and development of children. The burden of oral disease is considerable. Tooth decay and gum disease are among the widespread condition in human population, affecting over 80% of schoolchildren in some countries (World Health Organization, 2019).

Dental diseases, despite being largely preventable, remain a major public health problem across the world. Dental caries, periodontal diseases and oral cancers, the main oral diseases, are highly prevalent chronic conditions that have a significant negative impact on quality of life (Watt *et al*., 2016; Baiju *et al.*, 2017).

The *Global Burden of Disease Study 2016* estimated that oral diseases affected at least 3.58 billion people worldwide, with caries of the permanent teeth being the most prevalent of all conditions assessed. Globally, it is estimated that 2.4 billion people suffer from caries of permanent teeth and 486 million children suffer from caries of primary teeth (Global Burden Disease, 2017).

It is estimated that oral diseases are the fourth most expensive disease to treat and curative dental care is a significant economic burden for many developed countries (Listl *et al.,* 2015).

Oral diseases disproportionally affect the poor and socially-disadvantaged members of society (Gomes *et al.,* 2015). There is a very strong and consistent association between socioeconomic status (income, occupation and educational level) and the prevalence and severity of oral diseases. This association exists across the life course from early childhood to older age, and across populations in high, middle and low-income countries.

Education represents an important social determiner of health knowing that the individuals who have a high level of education have superior health to those having a lower education level. This aspect may be explained by:

-the knowledge and attitude in relation to the possibility to solve the health problems;

- a superior level of education increases the possibility to have a well paid job which may bring material satisfactions and a decent life standard;

- the attainment of healthy life skills/behaviours (Macek *et al.,* 2017).

More educated and learned individuals are defined by more adequate lifestyles which allow them to resort more frequently to medical services in order to take care of their health (Márquez-Arrico *et al.,* 2019).

Individual behaviour is a proximal determinant of health, which in turn is strongly influenced by a person's position and status in the social hierarchy and their social, economic and political environments. Behaviour change is relevant for both oral and general health, as well as having social and psychological benefits (Newton *et al*., 2015; Alkan *et. al,* 2014).
Parents' oral health behaviors have a direct influence on the number of decayed teeth of their children, indicating that oral health strategies should be focused not only on children but also on their parents. Children of parents who control their children's toothbrushing and sugar intake have favorable oral health habits, demonstrating that parental attitudes have a positive impact on their children's oral health status (de Castilho *et al*., 2013). Ideally, dental professionals should inform parents of the influence that their dental health behaviors and attitudes might have on their children's oral health, including the benefits of pediatric oral care, oral health educational programs, and other dental-health-related issues (Villalta *et al.,* 2019).Using the school as a setting for oral health promotion interventions was recommended in 2002 by the World Health Organization (Petersen and Kwan, 2004).

Risk factors of oral health for young people

Dental caries is a multifactorial disease caused by interactions between acidogenic bacteria, biofilm and individual caries risk factors (e.g., saliva composition, fluoride exposure and dietary components) (Paris *et al.,* 2013). Despite the great strides made in caries control in developed countries, caries remains the most common chronic childhood disease and a major financial burden on society (Ribeiro Dias *et al*., 2017; Tweetman, 2016).
In recent years, there has been an increased emphasis on formal *caries risk assessment* to guide treatment planning decisions and recall intervals for individual patients, and various risk assessment tools have been developed for this purpose (Hänsel Petersson *et al.,* 2017).
Poor oral health and frequent and abundant consumption of sugars have been known for many years to play a key role as behavioural risk factors for oral diseases, such as dental caries and periodontal disease (te Morenga *et al*., 2012). Moreover, the prevalence of other oral disease such as dental erosion caused by consumption of carbonated drinks is rising. The consumption of fruits and vegetables decreases the risk of developing degenerative chronic diseases, such as cardiovascular diseases and cancer.
The interventions on food hygiene and oral hygiene behaviors are two of the main measures recommended by the World Health Organization for dental caries primary prevention (WHO, 2015). Toothbrushing and other behaviours that comprise young people's lifestyles may directly or indirectly influence on their health in the short or long term (Trubey *et al.,* 2015). Around the world, the school is used as a platform for promoting the oral health to schoolchildren and adolescents. Dental health professionals should play an instrumental role in promoting a healthy diet and school environment which supports healthy food and drink choices (Moynihan *et al*., 2018).

Although the link between *sugar intake* and dental caries has long been demonstrated, current conditions make this link no longer so obvious. A study conducted in the UK by the Nutrition Foundation showed that the significant decline in dental caries level in school-age children in Western European countries is due to increased fluoride exposure and improved oral hygiene, as consumption of sugar remained practically the same (WHO, 2015; Sanders, 2004).

Preventive caries strategies

A school is a closed environment that concentrates a considerable number of individuals of the same age group who regularly attend the institution. For this reason, it has been considered ideal for developing health and *oral health programmes* with children in age

groups that are favorable for adopting preventive measures. Moreover, oral health behavior is a result of a lifelong learning process; this process can best be achieved by an interdisciplinary collaboration among dentists and professionals in other areas, such as psychologists and teachers. A systematic review indicated that knowledge and attitudes could be improved through oral health education programme, studies showing positive effects (Habbu and Krishnappa, 2015).The benefits of such programs can be expanded with continuous school-based oral health programs involving oral health providers, school personals, parents, and their children (Alotaibi *et al.,* 2017).

Activities in school programs must include: oral health education/promotion, supervised tooth brushing, fluoride and fissure sealant application, and/or various treatments. These activities can shape children's health-related beliefs, attitudes, values and behaviors. In addition, evidence suggests that oral health services in childhood can influence a healthy lifestyle into adulthood (Alsumait *et al.,* 2019; Lemos *et al.,* 2014; Skeie and Klock, 2018).

Socio-economic factors are closely related to behavioral factors (Dean *et al.,* 2013). Poor living conditions, unhealthy lifestyles, limited access to preventive dental services constitute major risk factors for oral health (Syme, 2004).In some countries, lack of available and accessible regular dental care constitutes a barrier and, especially in those countries, the children who need dental care the most are the ones least likely to visit a dental clinic.

Dental sealant programmes generally are targeted to vulnerable populations less likely to receive dental care that could benefit from sealants.

In USA, national data show that children from low-income families have a significantly higher proportion of untreated caries compared to children from high-income families. Only 25% of 6–9 year olds from low-income families had sealants compared to 34% of children from high-income families (25.5%). School-based sealant programs have been associated with reducing the incidence of tooth decay by 40 to 60 percent (Association of State and Territorial Dental Directors, 2017).

Caries preventive programmes are focused on school-aged children and concentrate on the prevention of caries in permanent teeth. Public dental services for children are not comprehensive, is limited to children in "target" primary school classes. Adolescents in secondary school and the students may also be targeted, because at this age, other risk factors, such as smoking and alcohol, are incriminated (Jordao *et al.*, 2018; Aimée *et al.*, 2016).

Reducing inequality in oral health between different socio-economic groups has been one among the major global goals for oral health. For children with a low socio-economic status, fluoridation programs, sealing and treatments for incipient dental caries are required (Apouey and Geoffard, 2014).

Risk factors of oral health for elderly

According to the WHO, the global population is increasing at the annual rate of 1.7%, while the population of those over 65 years is increasing at a rate of 2.5%. Both the developed, as well as the lesser-developed countries, are expected to experience significant shifts in the age distribution of the population by 2050. The fastest growing population segment in most countries is the adults older than 80 years, which according to the United Nations estimates will make up nearly 20% of the world's population (Razak *et al*., 2014).

Oral problems encountered in the *elderly patients* are tooth loss, periodontal disease, tooth decay and oral cancer. Dental status is considered to be an important contributing factor to health and adequate nutrition in elderly. Missing dentition and ill-fitting dentures cause difficulty in chewing and perception of taste of foods. The diminished function of salivary gland is commonly associated with aging and the main oral health problem is mouth dryness and dental caries have been attributed to the reduced salivary flow.

Xerostomia affects 30% of patients older than 65 years and up to 40% of patients older than 80 years; this is primarily an adverse effect of medication(s), although it can also result from comorbid conditions such as diabetes, Alzheimer's disease, or Parkinson's disease (Eke *et al.*, 2015). Xerostomia, while common among older patients, is more likely to occur in those with an intake of more than 4 daily prescription medications. Dry mouth can lead to mucositis, caries, cracked lips, and fissured tongue.

Older adults are at increased risk for root caries because of both increased gingival recession that exposes root surfaces and increased use of medications that produce xerostomia; approximately 50% of persons aged older than 75 years of age have root caries affecting at least one tooth (Stein and Aalboe, 2015). Ten percent of patients 75 to 84 years of age are affected by secondary coronal caries; this is likely related to the prevalence of restorations in the older population (Jablonski and Barber, 2015).

In cognitively impaired elderly, the increased incidence of oral disease might be favored by their general conditions: cognitive decline, loss of memory, learning disabilities, attention deficits, and motor skills deterioration, which result in reduced ability to perform routine oral care. A frequent difficulty among these subjects is also the refusal of oral hygiene care, not opening their mouth, using abusive language, or being aggressive (Lauritano *et al.*, 2019). Due to systemic problems, any infectious source in oral cavity can compromise general health. Some malignancies are more prevalent in this age group which can in turn affect patient survival. These disorders must be diagnosed and managed appropriately by dentists to treat disease, restore function, and improve the quality of a person's life (Mozafari *et al.*, 2015; Dhama *et al*., 2017).

An important risk factor is *malnutrition*. Rates of malnutrition vary, among older adults in Europe and North America, malnutrition is present in 1-15% of those living independently, 25-60% of those in geriatric care facilities, and 35-65% of those in hospitals (Fávaro-Moreira *et al*., 2016). The specialized literature cites studies in which the association between deficient oral status and lack of vitamins A and C, Carotene, Folic acid , with the explanation that the elderly avoid hard foods due to edentation or inadequate prosthesis (Latime Lauritano, 2019; Kazemi *et al.*, 2011; Iwasaki *et al.*, 2017).

There are some *barriers* concerning delivery oral health for elderly patients, like costs and free acces to dental services.Cost has been stated to be a barrier in some studies of the receipt of care by older people who were functionally disabled or attended with a functionally-disabled partner (Smith *et al*., 2020). Access to dental services may present a barrier as a result of physical incapacity or disability, travel problems, lack of knowledge of dental services or lack of dental services in given area (van der Putten GJ *et al*., 2013).

Kossioni in 2018 has identified three major sources of oral health barriers in old age:

(a) person related issues, such as physical illness, reduced mobility, cognitive impairment, care dependency, low socioeconomic background, living in rural areas or in residential care, financial problems;

(b) lack of professional support, including limited training of nondental health care providers in oral health;

(c) lack of effective oral health policies, including poor legislations, policies and regulations on dental care in the community and in institutional care, and limited public dental care coverage combined with the high cost of dental treatment (Kossioni *et al.*, 2018).

The management of older patients requires not only an understanding of the medical and dental aspects of ageing, but also many other factors such as independent living, socialization and sensory function (Bharti *et al.*, 2015; Alzoubi *et al.*, 2017; WHO, 2019).

Publications on this topic:

1. Bobu L, Birlean L, **Murariu A.** The impact of school based dental sealant programme in reducing oral health inequalities caused by socio-economic status. *Romanian Journal of Oral Rehabilitation*. 2015; 7(2):27-32.
2.Murariu A, Hanganu SC. Family influences on adolescent's oral health behavior and sugar consumption. *Revista de cercetare și intervenție socială*. 2013; 41:60-74, FI=1,141.
3.Surdu A, Bobu L, Topoliceanu C, Filip C, Goriuc A, Scutaru M, **Murariu A.** Study regarding the relationship between nutritional status and oral health in the elderly patients. *Revista de Chimie (Bucharest)*. 2019; 70(7):1085-1088, FI=1,755.

1.1.1. The impact of school based dental sealant programme in reducing oral health inequalities caused by socio-economic status

Introduction

School-based dental sealant program and fluoride methods are community-based public health approaches to preventing dental caries.

In Romania, in 1999, the National Program for Oral and Dental Diseases Prevention was implemented, consisting of weekly mouthrinses with 10 ml Fluorostom solution (0.2% NaF) for 1 minute (Baciu *et al*., 2015). The program targeted primary schoolchildren and was implemented in four major centers in the country, including the city of Iasi. In 2004 the program was supplemented with first permanent molars sealants. In 2007, because of the rising cost of the necessary kits, the number of children included in the program began to decline, and in 2010, because of the lack of funds, the program was suspended.

The ***aim*** of the study was to evaluate the dynamic evolution of oral health status of schoolchildren in Iasi, depending on the socioeconomic status of their family, under the impact of preventive treatments provided within the National Program for Prevention.

Material and methods

The study was longitudinal clinical type and was conducted between 2003-2007 with a sample of 600 children aged 6-12 years, attending schools in different districts of Iasi, with different socio-economic status (SES). Informed consent was obtained for all participants.
The study method included calculation of dental caries morbidity indicators, evaluation of dental sealants prevalence and of the average number of sealed surfaces per subject.
Data were analyzed with the SPSS 16.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Variations in distributions of the answers were analyzed by cross tabulations. Statistical significance of the analysis was assessed by ANOVA and Kruskal-Wallis chi-square, at the 0.05 level.

Results

At the beginning of study, in 2003, the DMFT index presented, in all age groups, the highest values in children with low socioeconomic status (table I), with differences being more pronounced starting with the age of 8. In 12 year-old children, the DMFT was 0.90 in subjects with high socio-economic status, 2.29 in those with medium socio-economic status and 4.50 in those with low socioeconomic status.

Table I. The DMFT index depending on socio-economic status (year 2003)

Socio-economic status	***Age***						
	6 years	**7 years**	**8 years**	**9 years**	**10 years**	**11 years**	**12 years**
Low	0.50	0.88	1.70	2.38	3.15	3.32	4.50
Medium	0.22	0.30	0.42	0.50	1.32	2.00	2.29
High	0.04	0.06	0.12	0.21	0.36	0.61	0.90

Statistical analysis (ANOVA and Kruskal-Wallis - chi-square tests) showed that differences between the DMFT values in children belonging to the three socioeconomic levels were statistically significant ($p < 0.01$).

Bivariate correlation analysis showed, at baseline, a moderate ($r > 0.50$ - in 6-8 years age group) or strong ($r > 0.70$ - in 9-12 years age group) correlation between the socio-economic status and the DMFT value. The test was statistically significant ($p < 0.01$) and the negative sign of Pearson coefficient indicated an inverse correlation: the lower was the socioeconomic level, the higher were the caries indices.

Differences were found between socioeconomic levels also in terms of **the number of sealed surfaces per subject**. In 2003, the highest number of sealed tooth surfaces was found in subjects with high socioeconomic status (table II), while subjects with low socioeconomic status presented the fewest sealed surfaces.

Table II. Percentage distribution of children by number of sealed surfaces per subject, depending on socioeconomic status

Age	***Socio-economic status***	***Nr. of sealed surfaces (%)***									
		0		**1**		**2**		**3**		**4**	
		2003	2007	2003	2007	2003	2007	2003	2007	2003	2007
7 years	Low	100	80.8	0	0	0	0	0	0	0	19.2
	Medium	100	82.1	0	0	0	3.6	0	0	0	14.3
	High	93.8	80.8	0	0	6.2	7.7	0	0	0	11.5
12 years	Low	100	57.6	0	9.1	0	24.2	0	6.1	0	3
	Medium	100	75.8	0	0	0	18.2	0	0	0	6.1
	High	61.3	84.4	19.4	0	19.4	6.2	0	3.1	0	6.2

The comparison in 2007 showed that, in all age groups, the percentage of children with no sealed surfaces was lowest in subjects with low socioeconomic status (according to their preventive treatment needs), while the percentages of children with 3 or 4 sealed surfaces were highest.

Comparing data from 2003 with those from 2007, an increase in the number of sealed tooth surfaces per subject was found in all socioeconomic levels. However, the highest increase was found in children with low socioeconomic status, where chi-square statistical analysis indicated statistically significant differences ($p < 0.05$).

The impact of these preventive measures on oral health status were reflected in the evolution of the DMFT index (table III). Although the index presented, in 2007, too, the highest values in children with low socioeconomic status, the differences are much attenuated compared to

the data from the beginning of the study. Statistical analysis showed that, throughout the study, the correlation between the DMFT index and socioeconomic status became less strong: in 2007 there was a moderate correlation, although still inverse, in all age groups.

Table III. The DMFT index depending on socio-economic status (year 2007)

Socio-economic status	***Age***						
	6 years	**7 years**	**8 years**	**9 years**	**10 years**	**11 years**	**12 years**
Low	0.38	0.46	1.04	1.58	2.12	2.79	3.73
Medium	0.17	0.22	0.35	0.40	1.03	1.47	2.02
High	0.03	0.04	0.09	0.18	0.28	0.43	0.79

Discussions

In childhood, about 90% of carious lesions develop in the pits and fissures of occlusal surfaces, whose complex morphology implies a higher vulnerability to tooth decay, especially in the early years after eruption, requiring, for this reason, protection with sealants. This was, in fact, the reason for which the mouthrinses program was supplemented, in 2004, with the **dental sealants program**, as the benefits of such combined programs are documented by numerous studies (Griffin *et al*., 2008; Kitchens, 2005). Such a study, conducted in Australia in the 90s, showed that subjects included in a prevention program consisting of fluoride mouthrinses, pits and fissures sealings and annual lessons for oral health education presented on average 1.49 fewer decayed, missing, filled teeth compared to the control group (Morgan *et al*., 1998). Reasons for disparities in oral health are complex. There are differences caused by biological factors (eg gender, age), whose existence is normal and unavoidable in a balanced society.

There are, however, inequalities that are avoidable and unacceptable in modern society, caused mainly by *socio-economic differences* (Christensen *et al*., 2010; Capurro *et al*., 2015).

Significant differences were observed also in terms of the preventive treatments. When the study began in 2003, none of the children with low or medium socioeconomic status presented sealed teeth, even at the age of 12 years. Considering that dental treatments provided by the Health Insurance to children aged up to 18 years are free of charge, this aspect can not be caused by low income, but, most likely, by low educational level of the parents, which causes reduced addressability to dental offices. Such differences were highlighted in the present study: caries indices of children with low socioeconomic status had higher values compared to those of children with high socioeconomic status. However, throughout the study, *differences in oral health status of children with different socioeconomic levels decreased*. Thus, in 2003 the DMFT index of 12-year-old children with low socioeconomic status was 88.22% higher than the DMFT index of children with high socioeconomic status, while in 2007 the difference decreased by 10%.

Conclusions

This study underline the importance of school oral health services and of the implementation of preventive and curative programs in schools, that offer all the children available control and early treatments and thus may cancel differences in addressability and socio-economic levels.

1.1.2. Family influences on adolescent's oral health behavior and sugar consumption

Introduction

Oral health outcomes for adolescents are grounded in their social environments and are frequently influenced by family, school and social level. Parents' health-related habits can affect adolescent well-being in several ways including providing positive or negative role models and by contributing to healthy or unhealthy physical and social environments. Parents' habits can also shape adolescent health behaviour by increasing easy access to cigarettes or alcohol in their home, or, on the positive side, increasing access to healthy food and good oral hygiene (Pearson *et al.*, 2009; de Castilho *et al*., 2013).

The oral health concern of an individual is dependent on the attitude of a person. These attitudes naturally reflect their own experiences, cultural perceptions, familial beliefs and other life situations and strongly influence the oral health behaviour. The broad categories of factors that may influence individual oral health behaviour include: knowledge, beliefs, values, attitudes, skills, finance, materials, time, and the influence of the family, friends, community. Oral health outcomes for adolescents are grounded in their social environments and are frequently influenced by family, school and social level. Parents' health-related habits can affect adolescent well-being in several ways including providing positive or negative role models and by contributing to healthy or unhealthly physical and social environments (Shah and ElHaddad, 2015; Murariu, 2008).

From the point of view of public health, there is a recent tendency exerting a strong negative influence on the general health, especially the oral health. We are speaking about the increasing number of smokers and alcohol consumers at earlier ages as well as the exaggerated consumption of carbonated drinks and concentrated sweets by children and youngsters (Damle *et al*., 2014). The public health specialists must cope with this challenge: to understand the causes of this alarming phenomenon, on one hand, and to find the necessary methods to prevent it, on the other hand.

The ***aim*** of this study is to appreciate the knowledge and attitudes of a teenager group from 2 high schools, a medical high school of Iasi and a general high school of Suceava, in relation with oral health, and to analyse the influence of the parental model over the teenagers' behaviour.

Materials and methods

The study sample comprised of 284 adolescents, 144 (51%) from "Spiru Haret" School and 140 (49%) from Sanitary School, 126 (44%) boys, mean age 16.4, SD =0.6 years, and 158 (56%) girls, mean age 16.8, SD=0.6 years). The questionnaire used in study was based on experiences gained from surveys carried out by a special WHO research program: The Health Behaviour in School-aged Children-HBSC (Currie *et al.,* 2008). The questionnaire included 19 questions divided in three sections as follows: *socio-demographic information, dietary habits* and *oral health behaviour*. Informed consent was obtained for all participants.

Data were analyzed with the SPSS 16.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Statistical significance of the bivariate analysis was assessed by the Pearson chi-square, at the 0.05 level. The multiple logistic regression statistic analysis was performed in order to establish the predictors for unhealthy behaviour of children depending on their parents' attitudes and habits**.**

Results:

After the questionnaire has been filled in, we identified both positive and negative aspects related to the attitude and behaviour regarding the oral health (table IV).

Table IV. Distribution of items according to socio-demographic factors

Dietary habits and oral health behaviour	Nr	%	School			Gender		
			General Profile (%)	Medical Profile (%)	p value	Girls (%)	Boys (%)	p value
Eating fruits								
▪ daily	63	22.3	11.3	11	0.553	11.9	10.4	0.255
▪ not daily	221	77.7	39.7	38		44.1	33.6	
Eating sweets								
▪ more than once a day	217	76.6	39	37.6	0.350	43.9	32.7	0.012*
▪ once a day	67	23.4	12	11.4		12.1	11.3	
Carbonated drinks								
▪ more than once a day	168	59.5	32.5	27		31.8	27.7	
▪ once a day	82	29	14.8	14.2	0.029*	18	11	0.068
▪ less than once a day	34	11.5	3.7	7.8		6.2	5.3	
Snack between meals								
▪ sweets	199	70	37	33		38	32	
▪ fruits	7	9	4	5	0.705	5	4	0.750
▪ salt foods	78	21	10	11		13	8	
Eating fruits								
▪ daily	63	22.3	11.3	11	0.553	11.9	10.4	0.255
▪ not daily	221	77.7	39.7	38		44.1	33.6	
Visited dentist during the last year								
▪ yes	130	45.5	21.3	24.2	0.560	25	20.5	0.442
▪ no	154	54.5	31.2	23.3		31	23.5	
Reasons for visiting dentist	92	32.4	10.3	21.1		23.1	9.3	
▪ routine control	192	67.6	40.7	27.9	0.002*	32.9	34.7	0.001*
▪ oral pain								
Smoking status								
▪ yes	40	14.2	6.9	7.3	0.312	6.7	7.5	0.551
▪ no	244	85.8	44.1	41.7		49.3	36.5	
Drinking alcohol								
▪ yes	98	34.6	15.8	18.8	0.107	11.8	22.8	0.003*
▪ no	186	65.4	35.2	30.2		44.2	21.2	
Toothbrushing								
▪ once a day	84	29.7	12.6	17.1		19.4	10.3	
▪ more than once a day	145	51.3	19.4	31.9	0.004*	32.4	18.9	0.032*
▪ less than once a day	55	19	19	0		4.2	14.8	
Toothpaste used								
▪ fluoridated	278	98.1	49.1	49	0.877	55	43.1	0.566
▪ non-fluoridated	6	1.9	1.9	0		1	0.9	
Flossing the teeth								
▪ yes	40	14.2	2.7	11.5	0.023*	10.7	3.5	0.027*
▪ no	244	85.8	48.3	37.5		45.3	40.5	

*Pearson chi-square, $p<0.05$

The positive attitudes regarding the oral health are the following:
-of a total of 284 students, only 40 declared that they are smokers, thus the value of smoking prevalence being 14.2%;
-almost half of the questioned students brush their teeth twice a day, namely 145 students (51.3%) and the number of those who brush their teeth less than once a day is low, only 55 (19 %);
-278 students (98.1%) use fluoride toothpaste that has protective effects on the dental enamel.
The negative aspects of the life style of teenagers who participated in the study are:
- a large number of students, namely 217 (76.6%) have an unhealthy diet by the huge consumption of sweets several times a day and the consumption of carbonated drinks, 168 students (59.5%);
-192 students (67.7 %) go to the dentist only for oral pain;
-the prevalence of alcohol consumption is much higher than that of smoking, namely 34.6%;
-very few students, only 40 (14.2%), use the flossing as an additional measure to dental brushing.

If we take into consideration the **high school profile**, we could notice significantly statistic differences meaning that the students coming from the medical high school have positive behaviours and attitudes regarding the dental brushing made twice a day (p=0.004) and the use of flossing (p=0.023). As for the regular visits to the dental office, 21.1% of the students from the medical high school declared that they got for a routine control as compared to 10.3% of the students attending a general high school (p=0.002). We did not find statistical differences in terms of smoking, alcohol consumption or unhealthy eating habits: sweets.

Logistic regression analysis between family factors and oral health behavior

The use of the logistic regression analysis aimed at calculating the Odds ratio of a teenager to have an unhealthy behaviour depending on their parents' attitudes and habits regarding the oral health (Table V, VI, VII). We noticed a strong association between parents' low education level, on one hand, and the high consumption of sweets by their children, OR=3.14 and extra sweet products consumers, OR=3.78 (table V).

Table V. Logistic regression: family factors associated with consumption of sweets (more than once a day) among adolescents

Family factors	p value	Odds ratio (OR)	95% (CI)
Financial status ▪ average/below average ▪ very well and quite well off	0.271	0.21	0.993-2.310
Father's/mother's education ▪ less than university degree ▪ university graduate	*0.013**	**3.14**	1.63-7.55
Eating sweets ▪ more than once a day ▪ once a day	*0.002**	**3.78**	1.77-6.61
Eating fresh vegetables and fruits ▪ daily ▪ not daily	0.541	0.34	0.58-2.34
Carbonated drinks ▪ more than once a day ▪ once a day/ less than once a day	0.762	0.24	0.23-5.78

*p<0.05

A strong level of association was signaled about the low level of oral hygiene of the teenager coming from parents having a low level of education, OR=4.12 (table VI). Parents' lack of a correct oral hygiene is a risk factor for the acquirement of the same unhealthy behavior by the teenager, OR=6.23. We did not identify significant statistic associations in terms of family's low financial situation (p<0.05).

Table VI. Logistic regression: family factors associated with toothbrushing (less than once a day) among adolescents

Family factors	p value	Odds ratio(OR)	95% (CI)
Financial status ▪ average/below average ▪ very well and quite well off	0.113	0.05	0.331-2.116
Father's/mother's education ▪ less than university degree ▪ university graduate	*0.001**	**4.12**	3.213-12.563
Smoking status ▪ yes ▪ no	0.188	0.03	0.554-1.980
Visited dentist last year for routine control ▪ yes ▪ no	0.053	0.95	1.225-2.887
Toothbrushing ▪ once a day and more than once a day ▪ less than once a day	*0.001**	**6.23**	4.855-13.122

*p<0.05

Other strongly associated variables in the logistic regression model refer to the parents' unhealthy life style, (smokers, OR=3.55, alcohol consumers OR=2.11 (table VII).

Table VII. Logistic regression-family factors associated with smoking status and regularly alcohol drinking among adolescents

Family factors	p value	Odds ratio(OR)	95% (CI)
Financial status ▪ average/below average ▪ very well and quite well off	0.445	0.231	0.775-1.276
Father's/mother's education ▪ less than university degree ▪ university graduate	0.059	0.123	0.112-1.913
Smoking status ▪ yes ▪ no	*0.002**	**3.55**	2.336-11.913
Alcohol drinking ▪ yes ▪ no	*0.003**	**2.11**	1.765-5-225

*p<*0*.05

Discussions

Dietary habits

The study results confirm this hypothesis through the high percentage of teenagers, namely 76.6% who declared they eat sweet products more than once a day.

One of the reference surveys is Cross-National Survey on Health Behaviour in School-aged Children-World Health Organization Collaborative Study-HBSC carried out every four years in more and more countries. The last round was run in 2010 and 43 countries participated in it, Romania being involved in the last two rounds (2005/2006 and 2010/2011(Currie *et al.*, 2008). According to the data supplied by this survey, there are variations between countries in terms of the daily *sweets consumption* by children and teenagers from 9% in Finland, 11% in Denmark, 15% in Sweden and Norway, up to 49% in Ireland, 52% in Malta, and 70% in Poland. The same trend has been noticed in this survey for the *consumption of carbonated drinks,* but with a lower percentage, since 59.5% teenagers declared a daily consumption of such drinks without significant statistic differences in terms of gender distribution ($p=0.068$). Correlated with the data supplied by World Health Organization, Romania is closer to Finland where the percentage is 51% or Israel with 56%. At the opposite site, the healthy habits meaning the daily consumption of fresh fruits and vegetables are reduced in terms of frequency, only 22.3% of teenagers as compared to other countries such as Belgium 47% and France 45%.

Despite our expectations, the students from the medical high school did not have a more encouraging attitude as compared to their colleagues from the other high school. This affirmation relies on the finding that the significant statistic differences which were noticed only focused on the consumption of carbonated drinks ($p=0.029$), where the percentage of those consuming such drinks *more than once a day* is higher for the students from the general high school than the students from the medical high school, more precisely 32.5% versus 27%.

Oral health behaviour

If the situation is encouraging in terms of the use of fluoride toothpastes meaning that 278 (98.1%) of teenagers use such toothpastes, we may not say the same thing about the dental brushing. There is still a high percentage of students (29.7%) who brush their teeth only *once a day* or, even worse, 19% of students declared that they brush their teeth *less than once a day*. 51.3% of teenagers declared that they brush their teeth *more than once a day*.

The situation is less favorable than in countries such as Switzerland, where 88.7% of girls and 79.8% of boys brush their teeth at least twice a day, but it is more encouraging as compared to the teenagers from other countries such as Greece, 40%-boys, Spain 42%-boys, Ukraine 38.7%-boys, and Malta 25.1%-girls and 14.5% boys (Zaborskis *et al.*, 2004).

Smoking and alcohol consumption

According to a World Health Organization report, about 30% of the teenagers aged between 15 and 18 are smokers (WHO, 2015). In Romania, according to the data supplied by the specialized institutions, the prevalence of smoking among teenagers is 24.24% with an ascending trend in recent years (ESPAD, 2015; Special Eurobarometer, 2015). In this survey, the prevalence of smoking has much lower values as compared to the national average of 37% (ESPAD, 2015). Unlike the adult population where the prevalence of smoking is higher for men than women, for teenagers the prevalence is equal for both sexes. In this survey, we don't identified statistic significance differences ($p>0.05$) in terms of smoking for girls (6.7%) as compared to the boys (7.5%). Unfortunately, we noticed the same trend for both high schools, suggesting that the decision to smoke is not influenced by the information

offered by teachers, but it results from a complex of factors such as attitude, social norms, company or one's own convictions.

Family's role in the development of positive attitudes regarding the oral health

Starting from the premise that the family plays an important role in the formation of children's healthy habits, the results of the survey demonstrate that the families where sweets are consumed in excess, or one parent is a smoker/alcohol drinker, the risk for the child to adopt the same life style is high. The proof of these affirmations is child's OR risk ranging between 2.11 where there is a parent who drinks alcohol and 3.55 for a smoking parent and it reaches to 3.78 for the families where sweets are eaten daily. However, the highest OR value of 6.23 was signaled for the children coming from families who neglect their own oral hygiene by making an inadequate tooth brushing in terms of frequency and additional methods for oral hygiene such as oral floss.

Conclusions:

Starting from the research hypothesis of the survey, we noticed that parents' positive or negative attitudes regarding the risk factors for oral illnesses contribute to a large extent to the maintaining of health or, conversely, to the exacerbation of children's unhealthy behaviour. Otherwise, this research confirmed that parents' low educational level may also represent a risk factor for the health of their own children. Family's primordial role in the formation of a healthy life style is known because healthy attitudes are leant from early ages and their subsequent modification is difficult to make. Therefore, the family needs both a specialized support and social protection to fulfill its essential role of an educative factor. Though there are not yet programmes addressed to the family for the change of non-healthy attitude or prophylactic programmes addressed to the vulnerable families, the success obtained by other countries by such actions may be a real motivation for the Romanian politicians.

1.1.3. Study regarding the relationship between nutritional status and oral health in the elderly patients

Introduction

The increase of the proportion of aged people in total population is a global phenomenon, with an increment from only 8% in 1950, to 10% in 2010, being estimated to reach 21% in 2050 (D'Albis and Collard, 2013).

In Romania, due to demographic changes (migration of young adults) and low birth rate, the old population (> 60) reached 21% (Consiliul national al persoanelor virstnice, 2014). This percent is similar to other developed countries like Japan (26%), Italy (21%), Germany (21%), Sweden (20%), and United Kingdom (18%) (Word Bank Data, 2019).

Elderly people are a population with unsatisfactoryoral health and high risk of poor nutritional status, due to physical, physiological, and psychosocial factors (Gil-Montoya *et al.*, 2015). The diet of old people is characterized by low energy and nutrient content, as well as deficiencies in calcium, zinc, magnesium, iron, vitamin D, vitamin B6, vitamin B12, vitamin E, thiamin, retinol, carotenes, and folic acid (Montgomery *et al.*, 2014).

The supply of proper oral health care to old people is deficient due to inadequate resources and time, the lack of motivation and interest for oral health care of seniors or their relatives, change deating habits or saliva quality and composition, and behavioral changes in terms of oral hygiene, and decrease income as well (Ríos-Erazo and Borges-Yañez, 2016). Despite the evidences that suggest the implications of the unsatisfactory oral health for

general systemic health, the association between oral health and nutritional status is still debatable (Hugo *et al.*, 2016).

The study ***aimed*** to investigate the relationship between oral health, nutritional status and quality of life in a population of elderly patients with systemic chronic or acute pathology.

Materials and methods

The research consisted of a prospective, cross-sectional clinical investigation of 115 aged patients (> 60years; mean age 66.2) from Clinical Foundation, Faculty of Dental Medicine, "Grigore T. Popa" University of Medicine and Pharmacy of Iasi. The inclusion criteria were as follows: patients without dialysis, cancer, malabsorption syndrome, patients able to understand and communicate. The demographic data of the study group were collected, the information regarding the systemic status of the study group being either recorded. Nutritional input along with data related to the oral health of the study group was also collected. The oral health status was determined, by using clinical and radiographical exams. Informed consent was obtained for all participants.

The nutritional status was evaluated by using *Mini-Nutritional Assessment questionnaire (*Soysal *et al.,* 2019*)*.The questionnaire included anthropometric evaluation, diet features, environment data, as well as self-assessment of the systemic health and nutritional status. The final score allowed the classification of subjects in: *good nutritional status* and *poor nutritional status i*ncluding: malnutrition risk and malnutrition.
Also, it was used *Geriatric Oral Health Assessment Index* (GOHAI) to determine subjects' self-perception of the oral health status. The oral health recorded parameters were as follows: number of the remaining teeth (≥20, <20, total edentation); type and status of dentures (well-fitted, ill-fitted); pain during mastication; xerostomia.

The *GOHAI questionnaire* (4 dimensions and 12 questions) was used to evaluate the self-perception of the patients for their own oral health-related issues regarding: psysical functions (dimension1); pain and discomfort due to the oral pathology (dimension 2); psychological (dimension 3) and social aspects related to the oral pathology (dimension 4). (Atckinson and Dolan, 1990).

Results

The main collected data related to the oral health of the study group are presented in table VIII, while main results concerning the GOHAI score for all the subjects included in the study are presented in table IX.
In what concerns the oral status, only 5.2% of subjects presented at least 20 natural teeth, 69.6% being affected by xerostomia and 69.9% are total edentated. 21.1% of the completely or partial edentulous people were not treated with removable dentures, 19.2% of the edentulous patients complaining of ill-fitted removable dentures (table VIII).
From table 9 it is found that most patients (39.1%) accused the decrease of the quality of life by limiting the functions (dimension 1), 14.8% accused pain and discomfort, 22.6% psychological dimension (woried about teeth) and 23.5% social dimension (limit contact with people).

Table VIII. Oral health status in the studied group

Study group data	%
Nr. of remaining teeth:	
≥20	5.2
<20	25.2
Total edentation:	
Yes	69.9
No	30.4
Prostheses:	
Yes, well-fitted	59.6
Yes, ill-fitted	19.2
No	21.1
Xerostomia:	
Yes	69.6
No	30.4

Table IX. GOHAI score

Study group data	%
Need for treatment:	
Yes	55.6
No	44.4
GOHAI scores dimensions:	
1-psysical dimension	39.1
2-pain and discomfort	14.8
3-psychological dimension	22.6
4-social dimension	23.5

The results related to the relationship between the nutritional status and the oral health are presented in table X, while main results concerning the relationship between the nutritional status and GOHAI score are presented in table XI.

Table X. Oral status and nutritional status

Study group data	Good nutritional status (%)	Poor nutritional status (%)
Nr of remaining teeth:		
>20	66.7	33.3
<20	58.9	41.1
Total edentation	55	45
Edentation:		
Yes	55	45
No	60	40
***Prostheses**:*		
Yes, well-fitted	63.1	36.9
Yes, ill-fitted	52.4	47.6
No	39.1	59.9
Xerostomia:		
Yes	43	57
No	56	44

Table XI. GOHAI score and nutritional status

Study group Data	Good nutritional status (%)	Poor nutritional status (%)
Need for treatment:		
Yes	46.9	53.1
No	68.6	31.4
GOHAI scores dimensions:		
1-psysical dimension	37	63
2-pain and discomfort	50	50
3-psychological dimension	68.9	31.3
4-social dimension	64.7	35.3

Table X shows that 45% of patients with low nutritional status are completely edentated and 59.9% of them haven't prosthetic dentures.

In the same trend is the association with the quality of life (table XI), 63% of the elderly accuses its decrease determined by the physical limitation (for example, low consumption of hard foods).

Discussions

Older people are associated with multiple acute and chronic diseases, greater medications usage as well as physiological changes of the ageing body systems. In addition to that, impaired nutritional state has also become a significant problem among elderly worldwide (Rosli *et al.*, 2019).

Oral health, as one of the associated factors, plays an important role in nutritional intake of older people. Compromised dentition can lead to functional limitation (trouble biting and chewing food), psychological impacts (uncomfortable eating in front of others), pain and discomfort (discomfort when eating) and behavioural impacts (limit kinds or amount of foods) (Hew *et al*., 2018).

Only a few studies were focused on the relation between oral health, nutrition and quality of life (Cousson *et al.,* 2012). A systematic review of the relationship between poor nutrition and oral health status in the elderly found lack of methodological robustness and the use of validated assessments. Of the 16 considered studies, only 3 of them used a validated assessment tool (Van Lancker *et al.,* 2012). In this context, interpretation of the literature data is challenging, due to the absence of universally agreed tests and the multifactorial nature of both, poor oral health and malnutrition along with a range of confounding factors. Interpretation of the results reported by studies must consider that poor oral health and xerostomia have previously been associated with reduced chewing function and avoidance of firm foods by elderly people (Cousson *et al.,* 2012). Also, the poor dental status and the decrease of the life quality can influence meals time and loneliness which will negatively impact dietary intake (Raynaud-Simon and Lesourd, 2000; Kazemi *et al.,* 2011; Kossioni, 2018). In this study, according to the nutritional status, resulted that the highest percentage of patients with low nutritional status is those without prostheses (59.9%) and patients with xerostomia (57%).

The same trends is observed according with quality of life, appreciated with GOHAI indicator: poor nutritional status is associated with physical dimension (limit the kind of food; trouble biting and chewing; discomfort to eating any kind of food) for 63% of persons. Only 31.3% old persons with psychological problems (like: worried about teeth, gums and dentures, self conscious of teeth) accused poor nutrition status. In a similar study in Malaysia, Rosli made the same findings: logistic regression analysis showed a statistically significant association between the GOHAI and Body Mass Index scores ($OR = 2.3$; $p < 0.01$) (Rosli *et al.,* 2019).

Oral pathology can lead to improper nutritional status, by pain and discomfort related to dental caries, periodontal disease and ill-fitted fixed dentures or removable dentures. Also, even treated with removable dentures, the extended partial edentation or total edentation affect severely the digestive function and the nutritional status (Kshetrimayum *et al.,* 2013).

The interpretation of the results reported by various researches is difficult due to the heterogeneity of populations in anthropometric and nutritional parameters and the use of different assessment tools related to oral health status and nutritional status.

Conclusions

Poor nutrition status is associated with impaired oral health: total edentation, xerostomia and prosthes ill-fitted and patients with need for treatement.

Th same trand was observed for patients with poor nutritional status and psysical dimension and pain and discomford dimension of GOHAI score.

1.2.CURRENT APPROACHES IN CARIES PREVENTION STRATEGY

State of art

Strategies and programmes in oral health

According to the World Health Organization, good health is a major resource for social, economic and personal development. Political, economic, social, cultural, environmental, behavioural and biological factors can enhance or impair health. Health promotion action aims at making these conditions conducive to health (WHO, 2019).

At the **individual level**, health status depends on many interrelated factors, such as: genetic inheritance, social position, lifestyle choices, behaviours, attitudes and values regarding health status (Chandran *et al*., 2016).

At **community level,** the determinants of health are classified into "structural" and "intermediary", according to the model by the World Health Organization (WHO, 2008):

Structural determinants of health correlate with the socio-economic and political contexts that generate the social hierarchy in any society and the resulting socio-economic position of its individuals.

Intermediary determinants of health refer to how socioeconomic position then influences health through the circumstances and risks for disease. People from lower socio-economic groups are born, live, work and age in less favorable circumstances than those from higher socio-economic groups. These include material and social circumstances such as housing and working conditions and quality of neighborhoods; psychosocial factors such as stress and social support and behavioural and biological factors. Finally, the model also includes health services and the importance of fair access to good quality care (Watt *et al.*, 2015).

Reducing inequality in oral health between different socio-economic groups has been one among the major global goals for oral health. The development of equitable oral health system, which improves oral health outcomes and responds to people's legitimate demands with a fairness in finance, is one of the major strategic implications for WHO's oral health program (Bastos, 2019).

Curent strategies in dental prevention

The occurrence of oral diseases is the result of the complex interaction of the etiological factors and of a number of risk factors, modulated by means of protective factors (Anil and Anand, 2017).

In the last 25 years, in most industrialized countries, a significant decrease in the *prevalence of caries* has been seen in children, and this is attributed particularly to changing conditions and lifestyle. These positive trends were seen in some Eastern European countries, too, but for most countries in the developing world, the prevalence of dental caries in children continues to be high. This is due to economic and political characteristics that also affect health systems and, consequently, oral health systems (Tellez *et al*., 2014). At the same time, both in developed countries and in developing ones, impairment is particularly important among disadvantaged population groups. Socio-economic factors are closely related to behavioral factors (Dean *et al.*, 2013). Poor living conditions, unhealthy lifestyles, limited access to preventive dental services constitute major risk factors for oral health (Watt *et al.*, 2015; Blas *et al.*, 2010).

The most important factor in prevention of dental caries includes remineralization of the initial carious lesion which requires the presence of calcium, phosphate, and fluoride (Hemadi *et al.*, 2017).

Saliva acts as the nature's primary defense system for the oral cavity and is important for protecting the exposed tooth surfaces. Saliva has the capacity to reverse the demineralization of the exposed tooth surface by simple mechanical rinsing, antimicrobial activity, buffering

capacity, calcium phosphate binding proteins, immune surveillance, and the secretion of antimicrobial peptides (Shetty *et al.,* 2017).

The *salivary pH* is an important biomarker for dental caries. The dentifrice and mouth rinse pH range might influence the salivary pH. Demineralization and remineralization processes of the teeth, occurring in the oral cavity, are dependent on the pH of the saliva. The saliva is rich in the calcium and phosphates and is nearly always supersaturated with respect to enamel minerals and other biological appetites. The alkaline pH of the saliva neutralizes the acid produced by the plaque bacteria. Further, the more basic is the pH of the saliva, more is the remineralization of tooth surface by the precipitation of bicarbonate ions (Ditty *et al*., 2018).

The landmark discovery of *fluoride* as an agent that could prevent dental caries, and the widespread use of fluoride-based caries-preventive programmes, have been responsible for the significant reductions seen in caries prevalence of developed countries in the latter half of the 20th century (Philip *et al.,* 2018).

While fluoride is a highly effective and economical agent for dental caries prevention and will remain the mainstay of any caries-preventive programme, it must be recognized that in many situations fluoride alone may not be sufficient and the effectiveness of fluoride could be enhanced when combined with additional cariostatic agents (Philip *et al.,* 2018).

A recent study showed that the brief fluoride exposure from toothpastes or mouthwashes could not sustain anti-acid production activity, with the biofilms recovering acidogenicity over time regardless of the fluoride concentration used (Dang *et al.,* 2016). Preventive approaches that combine fluoride with other protective agents have been advocated to enhance the ability of fluoride to modify biofilms and diminish the cariogenic bacterial challenge (Li *et al.,* 2015).

Mouthrinses can prevent plaque growth and improve oralhealth by inhibiting the proliferation rate of bacteria in plaque or by preventing attachment of bacteria to dental surfaces. Over the past 100 years, phenolic com-pounds (e.g. LISTERINE®) have been acknowledged to be germicidal and effective in reducing plaque and gingivitis. Recently, several studies have shown the combined effectiveness of essential oil containing mouthrinse-LISTERINE® in achieving healthy gingival tissue and reduc-ing plaque (Alshehri, 2018).

According to the specialists, oral hygiene practice with commercially available fluoridated followed by fluoridated mouth rinse/other anti-plaque agent for children 2 times a day can be recommended in *moderate caries risk* children (Ditty *et al*., 2018).

The recommendation of the specialists is that the preventive programmes, comprising combinations of interventions that include fluoride or fissure sealants and new methods for remineralization should be considered for *high caries risk* children (Horst *et al.,* 2018).

Modern caries management

The principles of minimally invasive dentistry clearly dictate the need for clinically effective measures to remineralize early enamel caries lesions and remineralization is a major advance in the clinical management of the disease (Philip, 2019).

Recently, researchers have been testing *new methods to enhance the remineralization of enamel.* The development of novel enamel remineralization systems has significantly progressed in recent years with many of them already in clinical use, while others are in various stages of development. The most promising of these remineralizing technologies (table XII) are categorized into *biomimetic regenerative systems* and approaches that *synergize fluoride efficacy* (Philip, 2019).

Table XII Non-fluoride enamel remineralizing technologies (Philip, 2019)

TECHNOLOGY	COMMERCIAL PRODUCT
BIOMIMETIC SYSTEMS	
Dentin phosphoprotein 8DSS peptides	Not available
P11-4 peptides	Curodont Repair/ Curodont Protect
Leucine-rich amelogenin peptides	Not available
Poly(amido amine) dendrimers	Not available
Electrically accelerated and enhanced remineralization	Not available
Nanohydroxyapatite	Apagard toothpaste
FLUORIDE BOOSTERS	
CALCIUM-PHOSPHATE SYSTEMS	
Casein phosphopeptide-amorphous calcium phosphate	Tooth Mousse/MI Pastecrèmes
	Recaldent/Trident White sugar-free gum
	MI Paste One toothpaste
CRYSTALLINE CALCIUM PHOSPHATES	
Functionalized β-tricalciumphosphate	ClinPro toothpaste
Calcium sodium phosphosilicate (NovoMin™ technology)	Oravive toothpaste
UNSTABILIZED CALCIUM PHOSPHATES	
Amorphous calcium phosphate	Enamelon toothpaste
(EnamelonTM technology)	2 Polyphosphate systems (Oral B Pro expert toothpaste)
NATURAL PRODUCTS	Not available

Recent developments in the area of remineralization include ***Casein phosphopeptide-amorphous calcium phosphate nanocomplexes (CCP-ACP).***

This remineralization system was developed based on the idea that the tryptic digestion of milk caseinate produced multiphosphorylated casein phosphopeptides, substantially increasing the milk protein's solubility and ability to stabilize Ca^{2+} and PO_4^{3-} ions (Philip, 2019).

The suggested mechanism of action is the localization of calcium and phosphate ions in plaque, which provides a reservoir of soluble calcium phosphate ions to promote remineralization (Reynolds *et al.*, 2003; Bataineh *et al.*, 2017).

CPP-amorphous calcium phosphate nanocomplexes are readily soluble in saliva, creating a diffusion gradient that allows them to localize in supragingival plaque. Low pH conditions that arise during a cariogenic attack facilitate the release of Ca^{2+} and PO_4^{3-} ions, inhibiting demineralization and favouring the remineralization of the incipient lesion by precipitation of the released ions. The subsurface remineralization pattern produced by CPP-ACP has been shown to significantly improve the aesthetics, strength, and acid resistance of the demineralization.

One of the new caries remineralizing technologies is the biomimetic systems, among which are the synthetic ***hydroxyapatite***, $Ca_5(PO_4)_3(OH)$, applied in microcluster or nanocrystalline forms in oral care products (Amaechi *et al.* 2019). Hydroxyapatite is a bioactive and

biocompatible material with similar chemical composition to the apatite crystals of human enamel. Randomized controlled clinical trials, some of which have led to the approval of hydroxyapatite as an anti-caries agent in Japan in 1993 and in Canada in 2015, have demonstrated its non-inferiority and equivalence to fluoride (Schlagenhauf, 2019; Amaechi *et al.*, 2019). Amaechi in 2019, showed that hydroxyapatite containing in toothpaste may be a better choice for children and individuals at high caries risk since the dosage can be increased to obtain higher efficacy without any safety issue such as the risk of fluorosis in children associated with high fluoride dose. Furthermore, the use in oral care products may eliminate the need of combining fluoride and antimicrobials in a dentifrice, as well as having different dosages for infants, children and adults (Amaechi *et al.*, 2019).

Publications on this topic:

1.Bobu L, Vasluianu R, Baciu ER, Bulancea B, **Murariu A**. Study on the correlation between salivary pH and the use of mouthrinses in young adults. *Revista de Chimie (Bucharest).* 2019; 70(3):1085-1088, FI=1,755.
2. Bobu L, **Murariu A***, Topor G, Beznea A,Vasluianu R. Comparative evaluation of Casein Phosphopeptide – Amorphous Calcium Phosphate and fluoride in managing early caries lesions. *Revista de Chimie (Bucharest).* 2019; 70(10): 3746-3749, FI=1,755.
3. Laură Gavrilă, Adriana Balan, **Alice Murariu***, Andrei Victor Sandu, Carmen Savin. *In vitro* study regarding the effect of various commercial remineralizing products on primary and permanent teeth dentine caries lesions. *Revista de Chimie (Bucharest).* 2016; 67(11): 2228-2230, FI=1,232.

1.2.1. Study on the correlation between salivary pH and the use of mouthrinses in young adults

Introduction

Salivary parameters (flow rate, pH and buffering capacity) exert a profound influence on caries risk status and gingivitis. Reduced salivary flow rates result in reduced salivary pH and buffer capacity, whilst stimulation of salivary flow results in greatly inhanced levels of bicarbonate, which increases the pH and buffering capacity of the saliva (Stoleriu *et al.*, 2017). The critical pH of dental caries is well established to be in the range of 5.5-5.7, in which pH levels below this threshold will initiate the dissolution of enamel. In conjunction with mechanical hygiene, mouthrinses may aid in controlling supragingival plaque and gingivitis. A mouthwash may be recommended to treat infection, to reduce inflammation, relieve pain, reduce halitosis or to deliver fluoride locally for caries prevention (Van Nieuw Amerongen *et al*., 2004). The efficiency of *Listerine*® as an oral antiseptic is based on a formula of four essential oils: thymol 0.064%, eucalyptol 0.092%, methyl salicylate 0.060% and menthol 0.042%. This essential oil penetrates oral microbial biofilm and kills microorganisms by disrupting their cell wall and by inhibiting their enzyme activity. This reduces bacterial load, slows plaque maturation and decreases plaque mass and pathogenicity.

The ***aim*** of the present study was to assess the correlation between salivary (flow rate, pH) and clinical (Gingival Index, Plaque Index) parameters and the use of two common mouthrinses: 0.05% sodium fluoride and Listerine® in young adults.

Material and methods

A randomized blinded controlled trial was conducted on 90 students (50 female and 40 male) attending the Faculty of Dental Medicine of the "Grigore T. Popa" University of Medicine and Pharmacy in Iasi, Romania.

Mouthrinses used and saliva collection

Commercially available Listerine® mouthwash (Johnson & Johnson) and commercially available 0.05% sodium fluoride mouthwash (Oral-B Pro-Expert) were used as experimental solutions. Distilled water was used in the control group. The mouthwashes were bottled and coded in similar containers (250 ml). The subjects were randomly assigned to three groups, i.e. Group A – Listerine®, Group B – 0.05% sodium fluoride, and Group C – distilled water, with 30 subjects in each group.

Sufficient amount of mouthrinse was provided for the six- week period of the study and each subject was given detailed instruction in its use. The subjects were asked to continue with their normal oral hygiene procedures but, in addition, to rinse their mouth after brushing at morning and night, with 20 ml of the mouth rinse containing Listerine®, 0.05% sodium fluoride or distilled water, for 30 s, twice a day, for 6 weeks. After each application, they were requested not to eat or drink for 1 h. After 6 weeks of regular application, the participants were instructed to stop using mouth rinses. The participants were given the same tooth brush and fluoride tooth paste to brush their teeth twice a day during the study. Before starting the first phase, professional oral hygiene, which included scaling and root planning with polishing, was done and the plaque score was brought to zero.

Before saliva collection, patients were kept seated for 5 min, relaxed and without talking. Unstimulated saliva was collected over a period of 5 min. Before collection, the mouth was emptied by an initial swallow. The examinator asked the subjects to spit out the produced saliva each 60 s in a plastic container. Salivary pH analysis was performed using the chair side kit M-S Saliva Check Buffer Kit (GC America Inc.). Unstimulated saliva was collected and the pH test paper was dipped in the sample for 10 seconds, then the color changes were compared with the chart provided by the manufacturer and the values were recorded.

Clinical examinations

Data were collected at baseline, immediately after the first rinse, and every week until the 6th week of study. The subjects were assessed for salivary flow (unstimulated) and pH, as well as for gingival status using the Gingival Index and bacterial plaque using the Quigley-Hein Index (Plaque Index). Materials used for the clinical examinations were mouth mirror, periodontal probe and disclosing solution (Mira-2-Tone). All patients signed an informed consent. Data were statistically analyzed using the SPSS (Statistical Pakage for Social Sciences) 17.0. ANOVA tests were used to identify significant differences between the means of the study groups. Paired t-tests were used to assess the significance of changes within each group between time periods. Correlations were analyzed with the Spearman coefficient. Critical *p* values of significance were set at 0.05 and a confidence of 95%.

Results

A total of ninety subjects of age range 20 to 24 years were recruited into the study and none were excluded throughout the 6 weeks period of evaluation.

Table XIII shows the values of the salivary pH (mean ± SD) in the three groups at baseline (before rinsing) and at each time interval of the study.

Table XIII. Distribution and comparison of salivary pH values (Mean ± SD) in the three groups

Time	Group A	Group B	Group C	*p* value	Inference
Baseline	6.60 (0.033)	6.63 (0.031)	6.65 (0.035)	0.973	NS
1 min.	7.93 (0.058)	7.83 (0.029)	6.80 (0.060)	0.002	S
60 min.	7.82 (0.051)	7.76 (0.049)	6.73 (0.087)	0.003	S
3 weeks	7.56 (0.048)	7.47 (0.046)	6.70 (0.053)	0.009	S
6 weeks	7.58 (0.043)	7.46 (0.039)	6.70 (0.041)	0.009	S
t test	p=0.010 S	p=0.030 S	p=0.907 NS		

NS=Non-significant; S=Significant;

No statistical difference was observed between the three groups at baseline. The evaluation performed 1 minute after the first rinse showed an increase of the salivary pH, statistically significant in groups A (pH=7.93) and B (pH=7.83) (p=0.010 and p=0.030, respectively) and non-significant in group C (pH=6.80; p=0.907). In groups A and B the pH remained higher than in the baseline examination until the end of the study, with a small decrease in the follow-up examinations; at the same time, the values were significantly higher than in group C (p<0.05), with the highest values for group A.
The values of unstimulated salivary flow rate are shown in table XIV.

Table XIV. Distribution and comparison of salivary flow rate (ml/min) in the three groups (Mean ± SD)

Time	Group A	Group B	Group C	*p* value	Inference
Baseline	0.51 (0.153)	0.52 (0.124)	0.51 (0.116)	0.992	NS
1 min.	1.02 (0.212)	0.78 (0.325)	0.52 (0.213)	0.005	S
60 min.	0.91 (0.175)	0.73 (0.521)	0.52 (0.214)	0.008	S
3 weeks	0.81 (0.182)	0.71 (0.312)	0.51 (0.183)	0.014	S
6 weeks	0.82 (0.280)	0.70 (0.240)	0.52 (0.170)	0.012	S
t test	p=0.043 S	p=0.070 NS	p=0.983 NS		

NS=Non-significant; S=Significant

The highest increase was observed in group A, 1 minute after the first rinse: 1.02 ml/min, as compared to 0.78 ml/min in group B and 0.52 ml/min in group C; after that, the flow rate decreased slightly at the follow-up examinations, but still remained at the highest value in group A (0.82 ml/min at the 6-weeks examination) and significantly higher than at the baseline examination (p<0.05). In group B the flow rate increased during the study (0.52 ml/min at the baseline examination and 0.70 ml/min at the 6-weeks examination), but the increase was not statistically significant (p>0.05). No increase was seen in group C. Inter-group comparison showed statistically significant differences (p<0.05).

The *Gingival Index* (table XV) was recorded at the baseline examination and then at the 3-weeks and 6-weeks examinations, as no changes were expected 1 minute or 60 minutes after the first rinse. The only significant decrease was seen in group A (0.79 at the 6-weeks examination, compared to 1.20 at the baseline examination, $p< 0.05$), meaning a reduction of 34%. In group B the decrease was not significant, and in group C the GI increased during the study. Except the baseline examination, inter-group comparison showed statistically significant differences ($p<0.05$).

Table XV. Mean (± SD) values of the Gingival Index (GI) in the three groups

Time	Group A	Group B	Group C	*p* value	Inference
Baseline	1.20 (0.158)	1.05 (0.218)	1.18 (0.315)	0.873	NS
3 weeks	0.82 (0.182)	0.98 (0.215)	1.81 (0.821)	0.000	S
6 weeks	0.79 (0.177)	0.96 (0.311)	1.92 (0.817)	0.000	S
t test	p=0.015 S	p=0.120 NS			

NS=Non-significant; S=Significant

The same time intervals of examination were used for the Quigley Hein plaque index, too (table XVI). Significant decreases of the Quigley-Hein index were seen in both group A (from 1.80 to 1.30, p=0.007) and group B (from 1.91 to 1.56, p=0.042), with the highest reduction of the index in group A (28%). In group C the index increased from 1.86 to 2.21 at the end of the study. Inter-group comparison showed statistically significant differences ($p<0.05$).

Table XVI. Mean (± SD) values of the Quigley-Hein plaque index in the three groups

Time	Group A	Group B	Group C	*p* value	Inference
Baseline	1.80 (0.471)	1.91 (0.516)	1.86 (0.482)	0.798	NS
3 weeks	1.36 (0.412)	1.62 (0.453)	2.18 (0.501)	0.001	S
6 weeks	1.30 (0.375)	1.56 (0.412)	2.21 (0.508)	0.000	S
t test	p=0.007 S	p=0.042 S			

NS=Non-significant; S=Significant

Discussions

The findings of the present study are in agreement with the data in the literature, as other authors showed that Listerine® reduced plaque and gingivitis by 20-35 per cent and 25-35 per cent respectively, by disrupting cell walls and inhibiting bacterial enzymes, without disrupting the normal oral flora (Alshehri, 2018). Phenolic compounds exhibit anti-inflammatory properties by inhibiting prostaglandin synthetase, an enzyme involved in the formation of prostaglandins, which are primary inflammatory mediators (Raju *et al.,* 2017).
Spearman correlation analysis showed significant correlations ($p<0.05$) between the use of mouthrinses and the salivary and clinical parameters examined: the salivary pH and flow rate increased, while the gingival index and plaque index decreased with the use of mouthrinses.

The differences found between the two mouthrinses used in increasing the salivary pH and reducing the plaque index may be explained by the more reduced antimicrobial effect of fluoride, which is mainly exerted on the cariogenic flora. Fluoride inhibits glycolysis of oral microorganisms by interfering with enolase enzyme and by blocking oxygenation of metabolic cycle for energy supply and reproduction and stabilizes oral eco-system. Moreover, accumulated fluoride in plaque by application of sodium fluoride mouthrinse can interfere with the metabolism of bacterial dental plaque (Latimer *et al.*, 2015). Similar results in what concerns the effect of sodium fluoride mouthrinse on salivary pH were found in other studies, too (Hambire *et al*., 2015).

As some essential oil mouthwashes have a pH below 5.5 there is some concern they may cause tooth erosion. Although the Listerine® used in this study has a pH of 4.35, rinsing with this mouthwash actually significantly raised salivary pH levels at the measured times postrinsing, and salivary pH remained above baseline values (Belardinelli *et al.*, 2004). Other authors have suggested that stimulation of salivary flow provides an increase in calcium and phosphate concentrations as well as the alkaline environment. Acidic mouth rinses may trigger the same mechanism, stimulating salivary flow and producing a rise in pH (Dehghan *et al.,* 2017).

Conclusions

The use of mouthrinses significantly increased salivary pH and flow rate of the young adults included in the study. In addition, Listerine® significantly decreased Gingival Index and Quigley-Hein Plaque Index after six weeks of daily use.

1.2.2. Comparative evaluation of Casein Phosphopeptide – Amorphous Calcium Phosphate and fluoride in managing early caries lesions

Introduction

Dental caries pathophysiology is not simply a continual cumulative loss of tooth minerals, but rather a dynamic process characterized by alternating periods of demineralization and remineralization (Philip, 2019). Lesion progression or reversal depends on the equilibrium between demineralization-favouring pathological factors (cariogenic bacteria, fermentable carbohydrates, salivary dysfunction) and the protective factors (antibacterial agents, sufficient saliva, remineralizing ions) that tip the balance towards remineralization (Featherstone and Chaffee, 2018).

Remineralization can occur as a natural repair process where plaque/salivary calcium (Ca^{2+}) and phosphate (PO_4^{3-}) ions are deposited into crystal voids of the demineralized tooth structure, resulting in net mineral gain (Alkilzy *et al.*, 2018).

A number of home-use and clinical products have been developed to enhance the calcium and phosphate concentrations of saliva and plaque (Nongonierma and Fitzgerald, 2012).

These include dentifrices, chewing gums and topical pastes (Güçlü *et al.*, 2016). Bioactive agents based on milk *proteincasein–phosphopeptide* (CPP) with *amorphous calcium phosphate* (ACP) have been also developed to release elements that enhance remineralization of the enamel and dentin.

The ***aim*** of the present study was to evaluate the efficacy of 10% casein phosphopeptide-amorphous calcium phosphate complex (CPP-ACP) –Recaldent, used alone or with fluoride

(CPP-ACFP) as compared to fluoride mouthrinse for the remineralization of occlusal non-cavitary caries lesions *in vivo*.

Material and methods

A randomized controlled trial was conducted on 80 students (37 female and 43 male) attending the Faculty of Dental Medicine of the "Grigore T. Popa" University of Medicine and Pharmacy in Iasi, Romania. The inclusion criteria for the study were: adults with good general health and at least one occlusal surface with incipient carious lesions in the pits and fissures. All patients signed an informed consent.

Examination and DIAGNOdent measurements

Professional oral prophylaxis was performed for all subjects using an ultrasonic scaler and prophylaxis paste, then the teeth were thoroughly rinsed with water. Areas of demineralization were identified based on the presence of a white opaque area following re-wetting and drying. The occlusal surfaces were scored using Full ICDAS criteria (International Caries Detection and Assessesment System). Tooth surfaces classified 1 and 2 were included in the study.

Because clinical detection of early carious lesions is a challenge, several detection systems based on laser/light fluorescence are currently being used as an adjunct to visual detection. DIAGNOdent (Kavo; Biberach, Germany) is a caries detections system based on laser-stimulated fluorescence.

Treatment procedures

Subjects identified with tooth demineralization were randomly and equally (n=20) allocated to one of the following four groups:

- group 1 –10% CPP-ACP (Tooth Mousse, GC; Tokyo, Japan) – the patients were advised to apply the topical crème 2 times/day on the occlusal surfaces, after brushing teeth; a minimum of a pea-sized amount was recommended for each dental arch, left undisturbed on the teeth for 3minutes, after which eating and drinking were prohibited for 30 minutes;
- group 2 – 10% CPP-ACP + 0.2% NaF (Tooth Mousse Plus, GC; Tokyo, Japan) – the same manner of application;
- group 3 –0.05% NaF mouthrinse (Colgate Plax) – 20 ml, for 30 seconds, 2 times/day after tooth brushing;
- group 4 – control. All groups were provided with oral hygiene instructions and a package of dental products for home-use.

All patients were instructed to brush twice daily (morning and evening) using a soft-texture toothbrush and fluoridated toothpaste (Blend-a-Med, 1450 ppm F). The patients were also advised to avoid any supplementary fluoridated products and prevent from eating too much sugar and acidic food or drink.

The lesions were evaluated at the start of the study and at 4, 8 and 12 weeks. For DIAGNOdent readings, declining values represented an improvement while increasing values represented deterioration of carious lesions.

The data were analyzed using SPSS statistical software package for Windows version 16.0. Paired sampled t-tests were performed to compare the changes in remineralization between baseline and post-treatment measurements within the same group. One way ANOVA was used to determine significant differences between the four groups. The confidence interval was 95% and the significance was set at a level of $p< 0.05$.

Results

A total of 80 subjects of age range 21 to 26 years were recruited into the study and none were excluded throughout the 12 weeks period of evaluation. The number of occlusal surfaces examined in each group was comparable: group 1 (*n*=43), group 2 (*n*=46), group 3 (*n*=40), group 4 (*n*=41).

The dynamic of ICDAS scores from baseline during the 12 weeks of examination is presented in table XVII. The change was evaluated as decrease, increase or no change (stagnation).

The highest percentage of teeth with a decrease in the ICDAS score was found in group 2 (CPP-ACFP, 6.2%), at the 12 weeks examination, while the highest percentage of teeth with an increase in the ICDAS score was found in group 4 (control, 18.4%), at the same examination. However, the only statistically significant differences were found between the treatment and the control groups, in what concerns the percentage of teeth with an increase in ICDAS score, during the three recall examinations ($p<0.05$).

Table XVII. Change from baseline ICDAS score, by treatment group

Time interval	**Change in ICDAS scores from baseline**	**Study group(% teeth)**				*p* value
		Group 1	**Group 2**	**Group 3**	**Group 4**	
T_1 (4 weeks)	*Decrease*	2.4	3.6	1.8	0.0	0.062
	No change	94.9	94.2	95.3	94.9	0.956
	Increase	2.7	2.2	2.9	5.1	*0.036**
T_2 (8 weeks)	*Decrease*	4.2	5.2	4.4	2.6	0.070
	No change	92.3	91.7	91.4	88.9	0.630
	Increase	3.5	3.1	4.2	8.5	*0.009**
T_3 (12 weeks)	*Decrease*	5.1	6.2	4.8	4.5	0.095
	No change	86.1	86.2	86.0	77.1	0.540
	Increase	8.8	7.6	9.2	18.4	*0.012**

*=statistically significant

Comparison of DIAGNOdent values evaluated before and after the application of treatment showed a decrease in fluorescence, suggesting an increase in lesions mineralization, significant in groups 1, 2 and 3 and not significant in group 4 (control), at the comparison between baseline and final examination (table XVIII).

Table XVIII.Description and comparison of DIAGNOdent scores at various time intervals of observation among subjects of 4 groups

Study group	**DIAGNOdent scores (mean ± SD)**				Significance (*p* value, t test) betweenT_0 andT_3
	T_0 (baseline)	*T_1 (4 weeks)*	*T_2 (8 weeks)*	*T_3 (12 weeks)*	
Group 1	15.70±1.82	11.68±1.80	9.52±0.92	8.18±0.70	*0.004**
Group 2	16.28±1.40	11.25±1.36	8.21±0.86	6.53±0.59	*0.002**
Group 3	14.32±1.72	12.16±1.55	9.13±0.91	7.88±0.68	*0.005**
Group 4	15.18±1.60	14.82±1.46	14.12±1.15	13.25±0.97	0.070
p value, inter-group	0.932 NS	0.070 NS	0.012*	0.005*	

*=statistically significant

The highest decrease in fluorescence was found in group 2 (CPP-ACFP, p=0.002), where the difference between T_0 and T_3 examination was 9.75(meaning a reduction of 60% of the baseline value), followed by group 1 (CPP-ACP, p=0.004), with a decrease of 7.52 or 48% of the baseline value and group 3 (NaF mouthrinse, p=0.005), with a decrease of 6.44 or 45% of the baseline value. Inter-group comparison showed significant differences only for the T_2 and T_3 examination, between the treatment and control groups (p=0.012 and p=0.005, respectively).

Discussions

The difference between visual examination and DIAGNOdent readings in what concerns the evolution of lesions may be explained by the fact that, in case of early caries in pits and fissures, remineralization is not followed by a return of the lesion to the initial aspect of sound enamel. Therefore, although the laser-fluorescence evaluation proved a significant increase in the mineral content of the lesions in the three treatment groups until the end of the study, the decrease in ICDAS scores of the same groups was not significant.

The optimal efficacy of topical fluoride therapy for enamel remineralization of incipient carious lesions and reduction of enamel solubility is generally recognized. Fluoride agents that release a high dose off fluoride initially (burst effect) are more effective for increasing enamel resistance against decalcification. A low concentration of fluoride is more effective in enamel remineralization. The high dose of fluoride physically blocks the surface layer of enamel to penetration of calcium ions to subsurface layers. Thus, high dose of fluoride is recommended in inhibiting lesion formation and low dose of fluoride for the remineralization and controlling lesion progression (Singh *et al.,* 2016).

CPP-ACP is currently marketed under the brand name Tooth Mousse. It can stop the progression of caries since it decreases demineralization and enhances remineralization. The synergistic effect of CPP-ACP and fluoride in reducing early carious lesions is due to the formation of CPP-stabilized amorphous calcium fluoride phosphate, resulting in increased concentration of bio available calcium and phosphate ions. The CPP-bound ACP acts as a reservoir of calcium phosphate ions, including the neutral ion pair CaHPO4 which is formed in the presence of acid. When acid is formed by the plaque bacteria, the CPP-bound ACP buffers the plaque pH, and in doing so, it dissociates to calcium and phosphate ions including CaHPO4. The increased plaque calcium and phosphate ions offset any fall in pH, thereby preventing enamel demineralization. In the presence of fluorides, formation of CPP-ACFP nano-complexes takes place, and when the pH falls, breakage of the nano-complex leads to formation of calcium ions, phosphate ions, and neutral species CaHPO4 and HF. These ions following concentration gradient move inside the subsurface lesion, thus leading to formation of fluorapatite (Reynolds, 2008).The resulting surface would probably be much more caries-resistant compared to the original enamel, but it still retains a demineralized appearance.

The results of the present study are in line with those of other authors, who found that the use of CPP-ACP combined with fluoride produced a better remineralization than the use of fluoride alone, although no significant differences were observed. A meta-analysis conducted in 2017 concluded that fluorides combined with CPP-ACP treatment produce significantly better efficacy for occlusal early caries lesions than fluorides alone (Bataineh *et al.,* 2017). At the same time, the use of 1450 ppm of fluoride toothpaste twice daily alone had some beneficial effect on the regression of early carious lesions, although not statistically significant.

The development of CPP-ACP technology is relatively recent, and it is currently acknowledged that further clinical studies are required before definitive recommendations for its use can be made.

Conclusions

The findings of this 12-week clinical study indicated that CPP-ACP, CPP-ACFP and fluoride mouthrinse all produced remineralization of early carious lesions, significantly higher than that in the control group. The highest remineralization was produced by CPP-ACFP.

1.2.3. *In vitro* study regarding the effect of various commercial remineralizing products on primary and permanent teeth dentine caries

Introduction

Dentin is a complex tissue that contains apatite, collagen, other proteins and water. Initial caries affects the mineral component of dentin and exposes collagen fibers, creating conditions for rapid destruction of the entire network dentin. An important requirement in operative dentistry and preventive restorations is developing smart materials capable of inducing the remineralization in carious dentin demineralized.The remineralization of demineralized dentin (bioremineralization) is the process of mineral restoring by forming inorganic mineral material (Stoleriu *et al.*, 2012).

Several in vitro and in situ studies have provided evidences supporting the caries remineralization and prevention potential of *hydroxyapatite* in oral care products based on its demonstrated ability to strongly adsorb to tooth surfaces, plaque components and bacteria.

Hydroxyapatite, a bioactive and biocompatible material with wide applications in both medicine (e.g., bone substitute) and dentistry, is currently used in nanocrystaline or microcluster forms in toothpaste and mouthrinses in varying concentrations for caries prevention and remineralization (Schäfer *et al*., 2009).

The ***aims*** of this research were to investigate the dentine surface topography of temporary and young permanent teeth before and after remineralization using various commercial products and to compare the potential of various commercial remineralizing products containing *fluoride* and *hydroxyapatite* to remineralize the dentine of primary and permanent teeth.

Material and methods

For this study eight premolars were used that were extracted by orthodontic reason and eight primary molars were extracted. The teeth selected in this study presented no dental caries, erosive or wear lesions on their buccal or lingual surfaces. After the extractions, the teeth were rinsed with water, cleaned of debris and stored in distilled water until the start of the study.

The dentine samples were obtained by cutting the buccal and lingual surfaces of premolars and primary molars using low speed diamond discs (Komet Dental, Brasseler GmbH&Co, Germany), under watercooling. The dentine samples were stored in 0.1 M lactic acid solution adjusted to a pH of 4, for 14 days. The solution was renewed every five days.

After artificial caries lesion formation, all the dentine samples of permanent and primary teeth were divided into five experimental groups:

- group 1 (control group): the samples have been stored in distilled water;
- group 2 (Colgate® 6+): the dentine samples was brushed two times a day for fourteen days, using an electric toothbrush with a constant pressure and using a bean sized toothpaste for 30 seconds on brushing session;
- group 3 (CarrefourKids® +6): the dentine samples was brushed two times a day for fourteen days, using an electric toothbrush with a constant pressure and using a bean sized toothpaste for 30 s on brushing session
- group 4 (Remin Pro®, Voco): on the dentine samples a water-based cream with fluoride and hydroxyapatite was applied for 5 min two times a day for fourteen days;
- group 5 (Colgate® Plax): the dentine samples were rinsed with 20 ml antibacterial mouthwash with alcohol free natrium fluoride for 30 s two times a day for fourteen days.

Between the remineralizing cycles, the samples have been stored in artificial saliva (AFNOR NF S90-701). All the samples were then washed and kept in distilled water. The dentine samples were analyzed using a scanning electron microscope (VEGA II LSH, TESCAN, Czech Republic) and an EDX detector (QUANTAX QX2, BRUKER/ ROENTEC, Germany).

Results

In the control group for young permanent teeth and deciduous teeth is observed widening of dentinal tubules (figure 1). SEM aspects of dentin in the groups 2 and 3 for youth permanent teeth and deciduous teeth shows dentiari partially filled tubules (figure1).

The remineralization of groups 2 and 3 were very similar where the remineralization agent appears to be linked collagen. A SEM aspect of dentin in the group 4 for youth permanent teeth and deciduous teeth clearly shows dentiari tubules are almost completely obliterated. Additionally mineral crystals precipitated during remineralization appear better treatment associated with the network of collagen (figure 1).

The remineralization model in this group was observed this process to a greater extent than previous remineralization agents used in the previous study groups. SEM aspects of dentin in group 5 shows partially obliterated dentinal tubules.

Although not observed any precipitation the agent remineralization seems to be related to the collagen (figure 1).

Chemical analysis showed that dentin highest concentration of ions in dentin was represented by ions of calcium and phosphorus. For this reason, only ions of calcium and phosphorus values were reported as a result of the quantitative chemical analysis of samples dentin (table XIX).

In permanent teeth samples, the concentration levels of calcium and phosphorus ions were very close to those of the control group in the study groups 2 and 3. In group 4 ion concentration value was higher than in the study groups 2, 3 and 5, lesser but less than those in the control group. In group 5 they were recorded the lowest values of calcium and phosphorus ion concentration toward all study groups.

For temporary teeth samples, lower values of ion concentration of calcium and phosphorus were recorded in 2-5 groups compared with group 1. For groups 2 and 3 values of calcium and phosphorus ion concentration were almost identical. Lot 4 ion concentration in both highest levels in all study groups (groups 2-5). The lowest concentration of calcium ions and phosphorus were observed in group 5.

In all groups ion concentration of calcium and phosphorus they had the same variation trend; the values of both ions were lower in samples dentin of temporary teeth compared to dentin of permanent teeth samples.

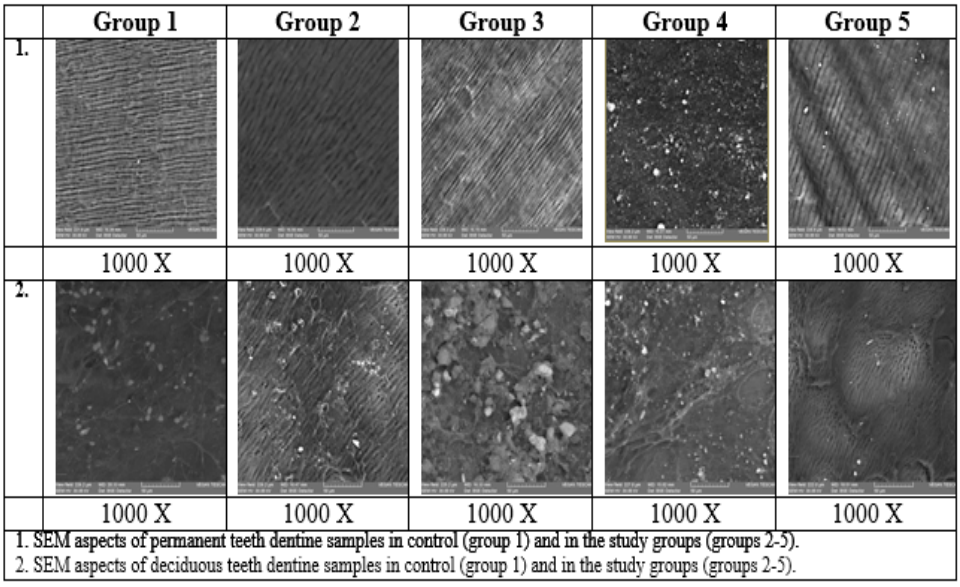

Figure 1. Dentine SEM aspects in control and in the study groups

Table XIX
Mean values of dentine Calcium and Phosphorus ions concentrations (%) ± SD in control and study groups

Permanent teeth dentine					
Ions concentrations (%)	Group 1	Group 2	Group 3	Group 4	Group 5
Calcium	31.35±0.12	20.74±2.08	20.51±0.34	26.03±0.93	19.05±0.23
Phosphorous	14.28±2.25	10.69±1.05	10.48±1.89	11.14±1.91	8.24±2.75
Deciduous teeth dentine					
Calcium	11.86±3.37	6.89±3.03	6.47±1.20	9.31±2.07	4.03±0.85
Phosphorous	6.76±3.25	4.51±1.94	3.74±1.85	5.79±0.56	2.89±1.16

Discussions

In studies in vitro test models are frequently used in dental research. The major advantage of in vitro models is the ability to conduct experiments with variable alone in a highly controlled environment (Skucha-Wak *et al.*, 2015).

The cyclic pH (chemical model caries), like the one used in this study, has become the model of choice to evaluate the caries, tooth decay main preventive measures. Although it is not possible to completely simulate complex biological aspects of decay, laboratory models are still of great importance for research caries. The substrates used for in vitro include the cavities in the enamel and/or dentin. To reduce variability and achieve more reliable results it is recommended to use unique sections of caries.

In this study, 0.1 M lactic acid solution was used to create the artificial caries lesions.

The ability of a material to induce the formation of apatite demineralized dentin (the ability remineralization) is strictly tied to the biointeractivitate and bioactivity, the ability to evoke a positive response from the biological environment. Various methods were used to assess the

effect of remineralization process in the dental tissues (Shetty *et al.*, 2014). The assessment methods can provide quantitative and qualitative information (Li *et al*., 2014). In this study analysis demineralized dentin remineralization process was used artificial scanning electron microscope (SEM) for surface topography dentin and EDX analysis of quantitative and qualitative chemical composition of dentin.
Using SEM it was noted that the remineralization of artificially demineralized dentin was more evident in case it is used the remineralization commercial product containing both fluorine and hydroxyapatite seen in the almost total closure of dentinal tubules.
The remineralization of artificial demineralized dentin had been likened to commercial products in the form of toothpaste containing fluoride only.
Analysis of the chemical composition of quantitative and qualitative dentine in this study able to show that the concentration levels of calcium and phosphorus were very close to those of the control group in the study groups that were used commercial products in the form of toothpaste containing only fluorine.
In the group that was used for remineralization commercial product containing both fluorine ions and hydroxyapatite both values were the highest compared with other study groups, but smaller than in the control group.

Conclusions

Remineralization type of study groups 2 and 3 showed the same pattern in the two groups using as a commercial product remineralization toothpaste with fluoride gel form from different two companies slightly different concentrations of fluoride (Colgate® 6+, 1450ppm F-; CarrefourKids® +6, 1000 ppm F-). Dentin remineralization, both in the temporary teeth and permanent teeth at young people, was more very best quality in the study group four, that the study group has been used Remin Pro® (Voco), a commercial product containing besides fluoride and hydroxyapatite.

In the study group 5 (in which we used fluoridated mouthwash Colgate Plax no alcohol) was present also remineralization, but meager toward the other three study groups. All products tested in this study had the ability to remineralize tooth dentin temporary and permanent youth, but remineralization was not complete. The values of both ions were lower in dentin of temporary teeth in young permanent teeth compared with samples.
Products containing fluorine and hydroxyapatite have demonstrated a greater remineralization of teeth dentin in both temporary and permanent young teeth when compared to products which contain only fluorine.

1.3. QUALITY MANAGEMENT IN DENTAL HEALTH CARE

State of art:

Major oral diseases (untreated dental caries, severe periodontitis and severe tooth loss) affect 3.9 billion people worldwide. (Marcenes *et al.*, 2013). In the 2010 Global Burden of Disease study showed that untreated dental caries in permanent teeth was the most prevalent disease identified in the entire study (a global prevalence of 35% for all ages combined). The experience of pain, problems with eating, chewing, smiling and communication due to missing, discoloured or damaged teeth have a major impact on people's daily lives and well-being (Haris *et al*., 2017). Moreover, oral diseases restrict activities at school, at work and at home causing millions of school and work hours to be lost each year throughout the world (Petersen, 2003). In addition, oral diseases combine to account for 15 million disability-adjusted life-years (DALYs) globally (1.9% of all years

lived with disability (YLDs); 0.6% of all DALYs), implying an average health loss of 224 years per 100,000 population (Marcenes *et.al*, 2013).

In this situation, the World Health Organization and many other international and national agencies have for the last few decades recognized that building healthy populations and communities on a sustainable basis requires a *reorientation of health services*, from the traditional biomedical model, to one more focused on anticipatory and preventive care (WHO 2010; Petersen, 2014; European Commission, 2015).

In 2013, World Health Organization recommended the development of oral health systems that equitably improve oral health outcomes, respond to people's legitimate demands, and are financially fair (WHO, 2013). For example, for adults with expressed needs, the overall coverage for oral health service ranges from 35% in low-income countries, 60% in lower-middle-income countries, 75% in upper-middle income countries to 82% in high-income countries (Hosseinpoor *et al*., 2012; Hettiarachchi *et al.,* 2018)

Many public health policy documents have now been produced at the global and national levels providing frameworks outlining effective policies to reduce *inequalities in oral health* using more upstream approaches (Lorenc *et al*., 2013; Listl *et al.,* 2015).

There are, however, many barriers to reorienting systems to promote health equity. In **Romania,** for example, the following negative aspects are highlighted:

There are major differences between access to medical and dental care in the population: at rural level only 25% of the population access dental treatment; at urban level, 75% of population access it. However, there are some shortages of dentists working in inner city areas and some specific social groups (children, farmers, retired persons) are having trouble accessing dental care at rural level (Popovici *et al.,* 2017).

Only 1% of the medical funds of the County Social Health Insurance House are spent on dental treatments - the greatest part of the funds is spent in hospitals (75%), or for family medicine (10%). It is estimated that patients directly pay at least 90% of the costs of dental treatments. This system underfunding forces dentists to settle only a small part of the treatments applied, in which case the patient is forced to fully pay for the whole dental treatment. In 2010, due to the economic and financial crisis which affected Europe and had also consequences and effects in Romania, the budget for dental care was transferred to patients who suffer from cancer. It was an unprecedented political measure taken by the Ministry of Health. Other important problem is related with the exodus of dentists to the European Union countries is currently seen as an opportunity especially for the young dentists, due to the higher wages than the ones offered by the health system of their home country (Lungu, 2014; Rossi *et al*., 2019). This exodus valid for all medical specialties has numerous social, demographic and medical consequences with obvious negative effects on the quality of medical procedure (Roman and Voicu, 2010; Popovici *et al*., 2017).

In the case of *private dental services*, it should be also taken into account the tolerance level of the population because it exists, for example, very costly materials, generally important and which could generate very high complete costs and which could not be supported by the "medium" patient of the dental surgery (Dutescu *et al*., 2012; Weyant, 2019; Eow *et al.*, 2019).

In Romania, the labour market in the field of oral health is facing a paradox – if in the case of private healthcare the number of dentists is sufficiently high, perhaps even too high in the big cities, in the case of public healthcare of hospitals and outpatient services their number is low being limited by the current health policy. Moreover, through the migration of dentists from the poor rural areas to the urban regions the inequities in the oral health system are even deeper. A dental clinic owner today is responsible for managing dental practice, coordinating marketing activities, and overseeing the budget, purchases, patient's

appointments, and clinic design. All those tasks need to be performed in an efficient yet profitable way to guarantee the success of the clinic (Das *et al.*, 2018).

If we also take into consideration the fact that nowadays the oral health system is characterized by low funding and the inefficient use of public resources, a low level of investments, some coherent public health policies at community level and mainly at macro-economic level are necessary in order to have a high quality management of the dental office (de Vogli, 2014, Oweis *al*., 2012; Dipayan, 2017; Centres, 2015).

Today, *burnout syndrome* is a phenomenon widely spread in our society. The World Health Organization included for the first time in 2019 the *burnout syndrome* on the list of medical disorders. Although efficient on a short term, it is unproductive on a long term because it reduces creativity and productivity. Overstress creates the illusion of increased efficiency, but adopted as a work style, it leads to exhaustion (Webel and Bolton, 2015; Chen-Yi *et al*., 2019). The job of a dentist faces a series of risk factors that may affect life quality, and among them we may mention physical overstress and stress with its multiple effects on our general health state, behavioral disorders and psychic symptoms (Nashleanas *et al.*, 2014; Alves da Silva *et al*., 2020).

The data in literature support specialists' affirmations who consider that burnout syndrome must not be neglected at all since over time negative consequences of our body's defense reactions start to appear such as heart diseases, cerebral strokes, digestive diseases such as gastric and duodenal ulcer, headaches and diverse infections (Singh *et al.*, 2016). In a multicentre study carried out in 2017 among the medical assistants of 5 European countries (Romania, Cyprus, Italy, Poland and Lithuania) who showed symptoms of professional overstress, it was noticed that they were more prone to unmotivated absenteeism, low work productivity, low satisfaction and more sick leaves (JOBIS, 2017).

In conclusion, quality of dental care reflects a desired degree of excellence in the provision of oral health care (Harris *et al.*, 2017). Though quality is a subjective attribute, various characteristics usually associated with the health care delivery process are thought to be determinants of quality. These include: structural adequacy, access and availability, technical abilities of practitioners, practitioner communication skills and attitudes, documentation of services provided, coordination and follow-up, patient commitment and adherence to a therapeutic procedure, patient satisfaction, and clinical outcomes (Righolt *at al*., 2019).

Publications on this topic:

1.Murariu A, Bobu L, Forna N, Iordan A, Zelinschi D, Biciuşcă R, Iordache C. Prediction factors for a good management of the dental practice. *Romanian Journal of Oral Rehabilitation*. 2019; 11 (3):99-107.

2.Diaconu D, Vitalariu A, Tatarciuc M, **Murariu A.** The economic crisis effects on the cross contamination control in dental laboratories. *Revista de cercetare și interventie socială*. 2014; 47:105-116, FI=0,798.

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1.3.1. Prediction factors for a good management of the dental practice

Introduction

In a dental office, the dentist must demonstrate not only professional skills but also be a good manager who knows all the faces of a high quality activity in terms of planning, organization, management and activity coordination (Vladescu, 2004; Okuji, 2016). This is

obtained through the promotion of an adequate development policy, the continuous improvement of good quality medical services and, last but not least, employees' motivation (Goetz *et al*., 2014; Centres *et al*., 2015).
It is important that practitioners have a thorough understanding of what it takes to operate a successful private dental practice. In addition to excellent clinical dentistry and behavior management skills, strong leadership, business, and practice management knowledge are also necessary. Now more than ever, a dental practice must run like a business because of decreasing profit margins due to increased competition and lower managed care reimbursement (Weir, 2016).
This research ***aimed*** to show all the prediction factors necessary to have an efficient management in dental practice in the current social-economic conditions of Romania.

Materials and methods

The study comprised 150 dentists aged between 27 and 54 having dental offices in Iasi and in the neighboring rural areas; as for professional experience, 47 (31.3%) had a professional experience of up to 10 years, and 103 (68.7%) had a professional experience of more than 10 years; as for the distribution by gender, 79 (52.6%) were females while 71 (47.4%) were males. As research method, we elaborated and used a questionnaire made of 15 close-ended questions with answers of yes/no type grouped into 6 sections, a questionnaire that was adapted after the one made by the authors in 2015 (Forna and Murariu, 2015).
The data obtained after the filling in of questionnaires were analyzed statistically with SPSS.16 for Windows software and the logistic regression analysis to determine the factors that may predict the financial recovery of the dental office.

Results: The dentist's answers are presented in table XX.

Table XX. Dentists' answers to the questions referring to the activity in the dental office

QUESTIONNAIRE	Yes		No	
	Yes	%	No	(%)
Section 1-Planning short-term activity				
1. The maintaining of prices to a steady value for 5 years	96	64	54	36
2. The purchase of less expensive dental materials	88	58.6	62	41.4
3. Reduced additional expenses (internet, publicity)	103	68.6	47	31.4
Section 1-Planning long term activity				
4. Migration abroad	41	27.3	109	72.7
5. Giving up their career	12	8	138	92
Section 2- Dental office organization				
6. Gave up the provision of new treatments	42	28	108	72
7. Gave up the provision of new advanced equipment	64	42.7	86	57.3
Section 3-Activity coordination				
8. Decrease employees' salaries	85	56.7	65	43.3
9.Gave up to participation in specialized courses	91	60.7	59	39.3
Section 4- Cabinet leadership				
10. Change of location of the dental office	23	15.3	127	84.7
Section 5- Administrative efficiency				
11.Adapt working hours to those of the patients	93	62	57	38
12.Reduced patients' waiting time	38	25.4	112	74.6
Section 6-Control, monitoring				
13. Reduction of benefits in last 5 years	86	57.4	64	42.6
14. Reduction of the number of patients in last 5 years	79	52.7	71	47.3
15. Future recovery possibilities	90	60	60	40

*Section 1.*The strategies adopted for making the activity efficient in the *short-term* focused on the maintaining of prices to a steady value for 5 years, a solution chosen by 96 (64%) respondents, the purchase of less expensive dental materials, a solution chosen by 88 (58.6%) dentists, while 103 (68.6%) dentists reduced additional expenses.
Section 2. On the *long term*, migration abroad is an option for 41 (27.3%) respondents while giving up their career remains a situation described by a low number of dentists, namely 12 (8%).
Section 3. In the section dedicated to *dental office organization* we found out that 42 (28%) respondents gave up the provision of new treatments while 64 (42.7%) dentists declared that they could not afford to buy advanced equipment or devices. The negative aspects consisted in their giving up to specialized conferences and trainings, a situation declared by 91 (60.7%) respondents, and the decrease of their employees' salaries, mentioned by 85 (56.7%) dentists.
*Section 4.*A variant taken into consideration by 23 (15.3%) of the subjects who filled in the questionnaire was the change of location of the dental office in order to make the activity profitable.
*Section 5.*To render their activity efficient, 93 (62%) respondents consider they may adapt their working hours to those of the patients, and only 38 (25.4%) dentists are determined to reduce patients' waiting time.
*Section 6.*The last questions showed us that most dentists had to deal with the reduction of benefits of the dental office, 86 (57.4%), and the reduction of the number of patients, 79 (52.7%). Despite all that, 90 (60%) dentists are optimistic considering that they will recover financially and render their medical activity more efficient in the future.
The logistic regression analysis presented in table XXI establishes the factors that may predict the rendering of dental office more efficient. For this purpose, we analyzed the dependent variable – *financial recovery* in relation to independent variables.

Table XXI- Logistic regression analysis: Predictor factors for increase the financial efficiency of the dental office

Independent variables	OR (95% CI)	P value
Professional experience >10 years <10 years	**2.27** (2.10-11.84)	*0.022**
Dental office location -Urban -Rural	**2.34** (2.23-11.29)	*0.029**
Maintaining of prices at steady values -Yes -No	**4.23** (3.45-21.36)	*0.001**
Reduction of additional expenses -Yes -No	**2.11** (2.07-9.87)	*0.027**
The introduction of new medical services -Yes -No	0.95 (0.08-2.67)	*0.564*
The decrease of employees' salaries -Yes -No	0.66 (0.37-1.98)	*0.445*
The reduction of patients' waiting time -Yes -No	**0.33** (0.12-1.27)	*0.556*

*=statistically significant

We found out that **the best predictor** for rendering the activity more efficient from the financial viewpoint is the *maintaining of prices at steady values,* OR=4.23 followed by the *location of the dental office in Iasi*, OR= 2.34, *dentist's professional expertise* longer than 10 years, OR=2.27, as well as *the reduction of additional expenses*, OR=2.11. All the other variables did not have any statistic significance, p>0.05 (table XXI).

Discussions

The efficient planning of activity in the dental office requires a series of actions performed by the dentist on the short or long term in order to increase performance and benefits (Khare and Saxena, 2018).

The economic crisis in the recent years comprised all European countries and for Romania this meant an avalanche of social costs that resulted in the drastic reduction of the life standard by causing unemployment, the insecurity of jobs, and the decrease of wages (Suciu, 2015). All these aspects influenced both the private and the public oral health system. As for the public oral health system in Romania, this is currently facing a series of difficulties regarding the insufficient funds allocated (Stanciu, 2013).

In the private system, the lack of financial possibilities makes the socially and economically disfavored persons to avoid dental treatments thus accentuating the precarious status of their oral health. The system underfunding forces dentist to settle only a small part of the treatments applied, in which case the patient is forced to fully pay for the whole dental treatment. The dentist working in their own dental office must also be the manager of their activity, and the benefit obtained depends on the extent to which they know how to make proper decisions (Levin, 2010). On the other hand, the insecurity of economic conditions, the lack of patients and of a clear strategy to render the activity more efficient only lead to permanent stress with negative behavioral, psychological or physiological consequences (Afsharinia *et.al*., 2015). Thus, through our study we wished to find out which factors may predict the financial recovery of dental office facing the effects of health system underfunding, and lead to the increase of dental office profit.

The results obtained after the filling in of the questionnaire show that many dentists (57.4%) have faced the decrease of the benefits from their dental office in the last 5 years as well as the reduction of the number of patients (52.7%). Among the measures taken for recovery, most dentists considered as opportune to reduce the employee-related salaries, namely 56.7% of the respondents, or the additional expenses 68.6% (internet, advertising, consumables or bonuses offered to their employees). In the same line, 58.6% of dentists started buying less expensive dental materials, and 64% maintained prices constant for a long period of time.

The reduction of expenses also meant the giving up to the participation to post-academic courses and congresses for 60.7% of dentists. This decision is unfavorable from the viewpoint of professional training, since the participation to such manifestations might increase physician's professional performance through the acquisition of new techniques, thus contributing to the increase of patients' safety and trust in physician's qualities (Rosenthal, 2018).

Renouncing at the professional career is considered as possible only for a low percentage of dentists, namely 8%, and migration abroad is taken into account by 27.3% of them.

The exodus of physicians to the European Union countries is currently seen as an opportunity especially for the young physicians due to the higher wages than the ones offered by the health system of their home country. This exodus valid for all medical specialties has numerous social, demographic and medical consequences translated into the decrease of medical density rate, a medical system lacking diverse specialists (surgeons, anesthetists), the

increase of the number of patients examined by fewer physicians with obvious negative effects on the quality of medical procedure.
The logistic regression analysis showed the factors that may predict the best the increase of efficiency of the dental office, and implicitly the financial income. The best predictor refers to the *maintaining of prices to constant values for a long period of time, OR= 4.23* explained by the reduced financial possibilities of a large part of the population.
Dentist's professional experience longer than 10 years is another prediction factor, OR=2.27 being explained by the large number of patients, dentist's experience in managing the activity and the choice of the best development strategies.
The location of the dental office also represents one of the factors that may determine success or failure in this profession, OR= 2.34. The explanation is simple: the location in an area with very poor population that does not have health insurance cannot lead to a prosperous activity and when corroborated with other factors such as dentist's reduced professional expertise, the absence of legislative measures that may support the private system in such areas, may determine the bankruptcy of the dental office.
Another prediction factor refers to the *reduction of additional expenses*, OR= 2.11, explained through the elimination of some amounts that do not determine the expected results such as the advertising via mass-media.

Conclusions:
The good and efficient management of the dental office largely depends on all the factors described above, but we cannot exclude the macroeconomic and political factors characteristic to the respective country.

1.3.2. The economic crisis effects on the cross contamination control in dental laboratories

Introduction

The financial crisis started in 2008 has had not only a major impact but also a social one, all the segments of the society being affected to a smaller or higher level. Medical services suffered in this period of recession following the reduction of funds allocated to health and the decrease of individuals' addressability to private medical practices (Stanciu, 2013; WHO, 2013; Dobos, 2006). In this general context, the dental services have been strongly affected by the economic crisis, dentists noticing lately a significant decrease of the number of patients (DiMatteo, 2008; Parker, 2009; Caoyi *et al*., 2012). The dental practice supposes a series of clinical and technological stages involving a permanent change of prosthetic devices between the dental office and the dental laboratory (Centres for Disease Control and Prevention, 2016; Sofou *et al.,* 2002). In this context, there is a major risk of contamination for patients and practitioners if the prophylactic norms are not rigorously observed. If in the dental office asepsis and antisepsis rules are clearly established and the circuit of instruments is strictly controlled, the risk of crossed infection is still present in the dental laboratories (Vázquez *et al.*, 2018).

The ***aim*** of the study was to examine the knowledge and practices in infection control among dental technicians working in commercial dental laboratories in Iasi and also to analyze whether the economic crises determines the decrease of exigencies related to the prophylactic measures.

Materials and methods

To perform this research, it was used a questionnaire containing 13 questions divided into two sections: the first section containing 9 questions focuses on the testing of knowledge of dental technicians regarding the control measures of crossed infection; the second section containing 4 questions evaluates whether the observance of prophylactic measures has imposed additional expenses in the context of the economic crisis. The study was conducted between August-October 2013. Dental technicians who participated in the study were divided into three lots depending on their length of service in the dental lab: less than one year length of service (38, 35.2%), length of service between 1 and 5 years (33, 30.6%), and length of service over 5 years (37, 34.3%). Data were analyzed with the SPSS 16.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Variations in distributions of the answers were analyzed by cross tabulations. Statistical significance of the bivariate analysis was assessed by the Pearson chi-square, at the 0.05 level. Correlations between different questions were determined by Pearson correlation coefficients.

Results

The technicians' answers were systematized in table XXII.

From the dental technicians' answers we noticed that 95.4% are aware of the real risk of contamination correlated to the surfaces and instruments in the lab. The same high percentage of 95.4% represents those who are aware of the high risk of crossed infection having as a vector all the prosthetic devices coming from the dental office or leaving the laboratory. Answers to question no. 3 about the rendering sick of the lab personnel through the handling of contaminated prosthetic devices were affirmative for 92.6% of respondents.

A reduced percentage of 47.2% consider only impressions as the most important source of contamination, whereas 63% think that all devices coming from the dental office must be disinfected by the technician (question 5). A similar percentage was obtained for question no. 6 where 64.8% declared that the same devices must be disinfected as well when they are sent back to the dentist. A well known aspect regarding decontamination methods is the disinfection of lab surfaces sustained by the percentage of 90.7% of those who answered question no. 7.

At the opposite end there is the reduced knowledge of technicians about the air decontamination methods, and this is supported by the fact that only 38% of them do this every day (question no. 8), and in the context of reduction of lab budget 75% would give up this procedure (question no. 13). Wearing protective equipment (gloves, glasses) is a daily routine for 55.6% of respondents whereas 37% sporadically use these prevention measures (question 9).

The last four questions focus on the economic side of the activity in the dental laboratory due to the reduction of expenses in the context of decrease of clinical handworks (table XXII). Most respondents (75%) answered question 10 regarding the interval for changing the denture pumice saying that they do this every week, 5.6% daily and 9.3% after each use. 31.5% of technicians consider the application of all prevention methods as a supplementary financial effort, whereas a higher percentage 56.5% affirms that this does not represent a financial burden (question 11). In connection with the context of economic crisis, 53.7% answered negatively the question about the need to reduce the expenses allocated to the prevention methods (question 12).

If the lab expenses were to be reduced, 14.8% declared that they would not give up these procedures.

Table XXII. The technicians' answers

Questions	**Answers**	**Nr**	**%**
1. It is possible to contaminate surfaces and instruments in dental laboratory?	a. YES b. NO c. I dont't know	103 5 0	95.4 4.6 0
2. There is a risk of contamination for prosthesis/prosthetic parts sent from lab to dental office?	a. YES b. NO c. I dont't know	103 5 0	95.4 4.6 0
3. There is a risk of contamination for dental laboratory workers?	a. YES b. NO c. I dont't know	100 6 2	92.6 5.6 1.9
4. What do you think are the sources of contamination? Specify some of them.	a. impressions b. prosthesis c. everything d. I don't know	51 2 48 7	47.2 1.9 44.1 6.5
5. What pieces received from the dental office should be disinfected in the lab?	a. impressions b. prosthesis c. all d. I don't know	35 1 68 4	32.4 0.9 63 3.7
6. What pieces sent to the dental office should be disinfected in the lab?	a. wax-up b. prosthesis c. all d. none	2 30 70 6	1.9 27.8 64.8 5.6
7. Do you consider necessary the disinfection of the laboratory working tools?	a. YES b. NO c. I dont't know	98 9 1	90.7 8.3 0.9
8. Do you perform surfaces and air decontamination every day?	a. YES b. NO c. I dont't know	41 55 12	38 50.9 11.1
9. Do you wear protective equipment (gloves, goggles) during maneuvers?	a. YES b. NO c. Sometimes	60 8 40	55.6 7.4 37
10. Do you try to reduce the costs by changing polishing pastes and brushes at larger intervals of time?	a. I change them daily b. I change them weekly c. I change them after each use d. I don't know	6 81 10 11	5.6 75 9.3 10.2
11. Do you consider an additional financial effort using the cross-infection preventing methods?	a. YES b. NO c. I dont't know	34 61 13	31.5 56.5 12
12. You consider that the economic context of recent years imposed spending reduction regarding preventing methods?	a. YES b. NO c. I dont't know	26 56 24	24.1 53.7 22.2
13. Which contamination prevention methods you could give in order to reduce the laboratory costs?	a. mask, gloves, glasses b. surfaces decontamination c. air decontamination d. none	10 1 81 16	9.3 10.8 75 14.8

Besides the descriptive statistics analysis, by means of cross tabulations and Chi-square test we made a differentiation of answers to questions referring to the effect of economic crisis depending on the length of service (table XXIII).

Table XXIII. The answers according to the technicians' length of service

Questions	Answers	< 1 year (%)	1-5 years (%)	> 5 years (%)	p value; (χ^2)
10. Do you try to reduce the costs by changing polishing pastes and brushes at larger intervals of time?	a. daily b. weekly c. after each use d. I don't know	2.6 65.8 21.1 10.5	9.1 90.9 0 0	5.4 70.3 5.4 18.9	p=0.005 χ^2=18.47
11. Do you consider an additional financial effort using the cross-infection preventing methods?	a. YES b. NO c. I dont't know	31.6 50 18.4	30.3 57.6 12.1	32.4 62.2 54	p=0.531 χ^2=3.165
12. You consider that the economic context of recent years imposed spending reduction regarding preventing methods?	a. YES b. NO c. I dont't know	34.2 36.8 28.9	12.1 63.6 24.2	28.9 24.2 13.5	p=0.005 χ^2=9.372
13. Which contamination prevention methods you could give in order to reduce the laboratory costs?	a. mask, gloves, glasses b. surfaces decontamination c. air decontamination d. none	15.8 0 57.9 26.3	3 3 90.9 3.1	8.1 0 78.4 13.5	p=0.023 χ^2=15.85 4

As for the sparing of pumice and wheels (question 10), most dental technicians, regardless of their age, declared that they do this once a week. We have noticed statistically significant differences p=0.005 in terms of the daily change of pumice and wheels within the meaning that the highest percentage (21.1%) belongs to those having the length of service within one year as compared to the elderly ones who perform this activity every day in a percentage of only 5.4%. At the opposite end, there were the ones having the length of service between 1 and 5 years since no technician of this group declared anything about this aspect.

Answers to question no. 11 demonstrate that most technicians do not consider these prevention methods as an additional financial effort (50% of those having a length of service within one year, 57.6% having the length of service between 1 and 5 years and 62.2% having a length of service over 5 years), and the differences identified do not have a statistic significance p=0.531.

As for the reduction of lab budget, only 34.2% of those having a length of service within one year and 28.9% of those having a length of service over 5 years declared that they also reduced the expenses related to these decontamination methods (question no. 12). Most answers belonged to those who declared that they have reduced the lab expenses, the highest percentage belonging to those having the length of service between 1 and 5 years (63.6%) followed by the young ones 36.8%, and finally 24.2% of the old ones. The differences identified for the 3 age groups have statistic significance (p=0.005).

The methods for infection prevention (question no. 13) which they would give up are, for most categories of length of service, the ones used for air decontamination: 57.9% for the group having a length of service within one year, 90.9% for the group having the length of service between 1 and 5 years and 78.4% for those having a length of service over 5 years.

Only 3% of those having the length of service between 1 and 5 years would give up the methods for surface decontamination. The differences identified have statistic significance, p=0.023.

Correlations coefficients between economic crisis and infection control practices are appreciated with Pearson correlation analysis (table XXIV).

Table XXIV. Correlations coefficients (r): economic crisis and infection control practices

Questions (Q)	Q 10	Q 11	Q 12	Q 13	Q 9	Q8
Changing pumices at larger intervals of time (Q 10)	1.000					
Additional effort (Q11)	.064	1.000				
Reducing costs (Q12)	.125	.459*	1.000			
Quit preventive measures (Q13)	-.105	.350*	.073	1.000		
Wear protective equipment (Q9)	-.072	.080	.038	-.134	1.000	
Daily decontamination (Q8)	.101	.281*	.094	.303*	.085	1.000

* Correlation is significant at the 0.05 level (2-tailed).

From *Pearson correlation analysis* presented in table XXIV, we may notice a strong association between the answers obtained for questions 11 and 12, r=0.459, p=0.01. This aspect demonstrates that the methods dedicated to contamination prevention (question no. 12) represent, in the current context of economic crisis, an additional financial effort for the dental laboratory (question no. 11).The same positive correlation with statistic significance has been noticed between the answers given for questions 11 and 13, but with a lower intensity, r=0.350, p=0.01. The results of Pearson analysis show that out of the same financial motivation some technicians are ready to give up certain methods for crossed infection prevention (question no.13), one of these being the daily decontamination of surfaces (question no. 8). The association identified has a statistic significance and a lower correlation coefficient, r=0.303, p=0.05.

Discussions

If in the dental offices, asepsis and antisepsis rules are clearly established and the circuit of instruments is strictly controlled, the risk of cross-infection is still present in the dental laboratories (Oosthuysen *et al.*, 2010; Sandulescu *et al.*, 2012). Numerous studies have shown that in the labs the transmission of microorganisms takes place by means of impressions received from the dentist, and by processing of acrylic dentures and intermediate prosthetic devices which come back to the lab after they have been checked or adapted in the patient mouth (Barlean and Danila, 2003; Vitalariu *et al.*, 2012). Surveys published as early as the 90's show that more than 60% of the removable dentures coming from the dental office were contaminated with pathogen germs from the oral cavity (Sofou *et al.*, 2002; Verran *et al.*, 1996). In the specialized literature, they say that 9 out of 10 prosthetic devices sent completely sterile from the dentist were contaminated after their processing in the lab with microbial germs that do not belong to the oral saprophyte flora and which may cause serious diseases for patients (American Association of Public Health Dentistry, 1986; Almortadi and Chadwick, 2010).For these reasons, it is mandatory to decontaminate all prosthetic devices coming in the lab from the dental office. In this paper, we have noticed that only 63% of technicians decontaminate all the prosthetic devices coming from the dentist, impressions occupying the first place as contamination vectors in a percentage of 47.2%. The results obtained are similar to the percentage obtained by Barlean in the study carried out in 2011 in Iasi (Barlean *et al.*, 2011).In a survey carried in Brazil by Campahna, he found out that only

9.2% of technicians disinfect the prosthetic devices, the rest of them just washing them in water (Campahna *et al.*, 2004).

Another important source of contamination in the dental laboratory, overlooked by dental technicians, is represented by the wheels and pumices used in the processing of the prosthetic devices (Witt and Hart, 1990; Tatarciuc *et al.*, 2010). From our present research results that 75% of technicians change this type of instruments once a week, possibly due to the need to spare as many materials as possible, though the standard procedures for infection control in the labs provide a daily change (Agostinho *et al.*, 2004; Bhat *et al.*, 2007). This is performed by only 9.3% of all technicians and, depending on the length of service, we obtained statistically significant differences (p=0.005), only 21.1% of those having a length of service within one year declare this aspect and, unfortunately, no technician having the length of service between 1 and 5 years declares this. In a similar survey carried out in Jordan, it has been noticed that 85% of technicians very rarely change the dental burs (Nawaf Al-Dwairi, 2007).

In the dental laboratories, the procedures for cross-infection prevention focus on the following aspects: protection barriers against the microbial germs (gloves, mask, and glasses), decontamination measures for impressions, instruments and lab air and the immunization of the lab personnel against hepatitis B virus (Raghav, 2013).

In this study, we have noticed that only 55.6 % of technicians regularly use gloves, protection glasses and mask. Other researches in the field show that in the labs from the Great Britain, 44% of technicians wear gloves and 74% wear glasses, unlike the technicians from Jordan where only 24% of technicians wear gloves and 35% wear a mask (Nawaf Al-Dwairi, 2007).

In Romania, the results of the study of 2011 published by Barlean et al, demonstrated that only 49.1% of technicians use protective equipment (Barlean *et al.*, 2011).

From the correlation analysis carried out, we have noticed that there is a positive association and with strong intensity (r=0.459, p=0.01) between the answers for questions focusing on the possibility to give up the decontamination methods considered as an additional financial effort (questions 11 and 12). Although they are not in a high percentage, still the fact that 34.2% of those having a length of service within one year declared that they may give up decontamination represents an alarm signal in order to introduce these very important aspects for the public health in the conduct of young technicians as early as their academic studies. A third of them also declared that they would easily give up these procedures because they require supplementary funds. Also serious is the fact that a high percentage of 75% would give up the methods for lab air decontamination requiring the purchase of special equipment.

Depending on their length of service, we have noticed statistically significant differences within the meaning that 90.9% of those having the length of service between 1 and 5 years declared that they give up this procedure unlike those having a length of service within one year whose percentage is lower, 57.9%.

Otherwise, for this age category, we noticed that a very low percentage of only 3.1% would not give up any method for crossed infection prevention. These answers suggest an insufficient knowledge of the issues and require the increase of the knowledge level by post-academic courses and continuous professional training.

Conclusions

In the current conditions of reduction of the lab expenses caused by the lack of addressability to dental services, we notice an alarming aspect, namely the giving up on some decontamination methods (air, surfaces and devices) in the dental laboratory. This is caused not only by the lack of theoretical knowledge, but mostly by a certain degree of negligence towards one's own protection and a lack of interest towards the real risk of cross-infection.

1.3.3. Job satisfaction among Romanian dentists

Introduction

Job satisfaction is described at this point as a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience. Job satisfaction results from the perception that one's job fulfils or allows the fulfillment of one's own important job values, providing that and to the degree that those values are congruent with one's needs (Kaipa *et al.,* 2015).

The profession of a dentist in not only attractive and interesting, but it is also difficult sometimes. Without forgetting the satisfactions and benefits brought by this profession, we must also mention the risk factors which may affect the quality of life. Statistic studies have shown that a third of dentists are overweight or obese and more than 60% suffer from back pains, nervousness or depression (Newton *et al.,* 2006; Iamandescu, 2009; Singh *et al*., 2016). Exhaustion resulting from occupational stress might cause several mental disorders, including difficulties in relationships, attention and to cope with tension, sleep disorders, lack of relax and energy and anxiety attacks, which frequency might be three times higher compared to other healthcare workers. Also physical disorders are possible, such as weight gain or loss, immune system weakness, potentiation of digestive and cardiovascular problems, headache, arthritis, hormonal dysfunction, and musculoskeletal and nervous fatigue (Cui *et al.,* 2017).

As in any other career, job satisfaction and motivation do not come only from the financial profit, as they should corroborate with other factors: stress reduction, the existence of a pleasant and calm atmosphere in the dental office, collaboration and motivation relationships of the dental team which may result in the increase of performance (Murariu *et al.*, 2017).

Those who work in a profession that is extremely demanding and sometimes unpredictable can be susceptible to feelings of uncertainty and reduced job satisfaction.Job satisfaction of dental practitioners is also an essential part of ensuring high quality care. Dissatisfied dentist may give poor-quality and less-efficient care.

Studies have focused on job satisfaction of dentists, which have been conducted in many countries and a variety of variables have been studied. Most of the earlier studies used well-structured questionnaires, which measured both overall job satisfaction and satisfaction with different facets in dentistry (Cui *et al.,* 2017).

That is why understanding dentists' satisfactions/dissatisfactions towards their career represent a special interest both for the political stakeholder, in order to implement the best solutions for the oral health system, and for the students at the faculties of dental medicine who should be informed about these aspects (Watanabe *et al*., 2013; Kaipa *et al.,* 2015).

The ***aim*** of this study was to evaluate aspects related to dentists' satisfaction towards their own professional career.

Materials and methods

The cross-sectional survey was carried out in 2016 in Iasi county, Romania, using our own questionnaire. The questionnaire contained 16 questions with open and closed answers. Questions refereed to the following aspects: overall satisfaction, delivery of care, income value, working environment and psychological factors (patient relationship, staff relationship, personal and professional time).

Other elements envisaged were age, gender, place of employment and the legal status of the dental office.

The survey group contained 165 dentists aged between 26 and 54 with an age average of 36.02 ±8.033 years. Data were analyzed with the SPSS 18.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Statistical significance of the bivariate analysis was assessed by the

Pearson chi-square, at the 0.05 level. The multiple logistic regression statistic analysis was performed in order to establish the predictors for job satisfaction.

Results

Section 1- Overall satisfaction, delivery of care and income value

The first section of questionnaire containing 8 questions refers to the importance and satisfaction in relation with the job, delivery of care and the monthly income. Answers are given in table XXV.

Table XXV. Overall satisfaction, delivery of care and income value

ITEMS	Participants		p value
	Nr	%	
1. **Overall professional satisfaction**			
-satisfied and very satisfied	125	76	*0.001**
-dissatisfied and very dissatisfied	40	24	
2. **Work fatigue**			
-satisfied and very satisfied	75	45	0.122
-dissatisfied and very dissatisfied	90	55	
3. **Current place of work satisfaction**			
-satisfied and very satisfied	107	65	
-dissatisfied and very dissatisfied	58	35	*0.003**
4**. First place job satisfaction**			
-income	90	55	
-opportunity to develop professionally	46	27	*0.001**
-promotion opportunities	19	12	
-social security	10	6	
5.**Important aspects in professional career**			
-financial security	81	49	
-social insurances	11	6.6	*0.001**
-continuous medical education	20	12.1	
-professional training	53	32.3	
6. **Choosing the same professional career - again**	86	52.1	
-yes	18	10.9	*0.001**
-no	61	37	
-undecided			
7. **Attitude towards the income obtained**			
-paid according performances	61	37.1	*0.002**
-need to earn more	104	62.9	
8**. Salary****			
-average income (€600)	28	17.3	
-€600 - €1,000	70	42	*0.001**
> €1,000	67	40.7	

* statistically significant at $p<0.05$

** average monthly wage in Romania in 2016: € 600

For question 1 referring to the activity carried out in the dental office, most respondents, 125 (76%), declared that they are satisfied and very satisfied.

Fatigue (question 2) is a dissatisfaction factor for 90 (55%) of subjects. For satisfaction towards their current place of work, (item 3) 107, 65% feel satisfied.

The elements considered as important for the first job (question 4) vary from the *obtained income* considered as the most important element of career by 90 dentists (55 %) up to the *social security*, appreciated by only 10 respondents (6%).
Question 5 refers to aspects that dentists consider as important in their professional career: most of them, 81 (49%) place *financial security* on the first place, the less important elements being *social insurances*, appreciated by a reduced number of dentists, namely 11 (6.6%). Choosing the dentist career again (question 6) is an option for 86 dentists (52.1%).
For question 7 (Attitude towards the income obtained), 104 (62.9%), consider that they should earn more.
Question 8 refers to the *monthly average income* obtained as compared to the average income in Romania in 2016 (€600). Answers suggest that only 28 dentists (17.3%) have a modest income as compared to the average income; 70 (42%) gain between 600 and 1,000 euro, the rest of them 67 (40.7%) saying that they obtain an income higher than 1,000 euro.
The testing of statistic significance by means of Chi-square test shows that the 0.05 threshold was not obtained only for question 2 (work fatigue).

Section 2 Satisfaction with work environmental and psychological factors

Questions 9-12 appreciate the satisfaction determined by work the activity in the dental office. Another aspect that may create satisfaction or dissatisfaction in the dental profession is the interhuman one (questions 13-16); answers are given in table XXVI.

Table XXVI. Satisfaction with work environmental and pshychological factors

ITEMS	Satisfied and very satisfied		Dissatisfied and very dissatisfied		Chi-square test
	Nr	%	Nr	%	p value
9. Professional appreciation	150	90.9	16	9.1	*0.001**
10. Pleasant atmosphere	101	61.2	64	38.8	*0.021**
11. Autonomy	127	77	38	23	*0.002**
12.Promotion opportunities	85	51	80	49	*0.551*
13. Patient relations	117	71	48	29	*0.002**
14. Colleagues relations	123	75	42	25	*0.001**
15. Staff relations	140	85	25	15	*0.001**
16. Personal time	79	47.8	86	52.2	0.331

* statistically significant at $p<0.05$

Table XXVI shows that significant statistical differences were registered for: the appreciation of personal work, 90.9% of respondents consider this as a key element for motivation in career, ($p=0.001$); the pleasant atmosphere in the dental office represents a satisfaction factor for 61.2% of respondents ($p=0.021$); the level of autonomy is appreciated by 77% of dentists ($p=0.002$) Insignificant statistic differences were registered only for the appreciation of the promotion opportunities ($p=0.551$).
We obtained significantly statistic differences for answers to questions 13-15 ($p<0.05$): 71% are satisfied by their relations with patients ($p=0.002$); 75% are happy with the collaboration with other colleagues ($p=0.001$); 85% appreciate their relationships with the staff ($p=0.001$). No significant statistic association was registered for question 16-personal time.

The logistic regression analysis establishes the factors that may predict the job satisfaction. For this purpose, we analyzed the dependent variable – *career satisfaction* in relation to the following independent variables: *gender, age, employement, place of work,*

income value, fatigue, promotion opportunities, personal time, professional autonomy and patient relationship.

From table XXVII, it observed that the best predictors for job satisfaction are represented by:

- the monthly income higher than 1,000 euro (OR=6.32,CI=3.11-35.8);
- employment: private office (OR=3.21,CI=4.23-23.5);
- professional autonomy (OR=2.23, CI=1.45-17.6);
- the lack of fatigue (OR=2.01, CI=1.09-3.56);
- patient relationship (OR=1.56**,** CI=1.23-1.97).

Insignificant statistic associations were registered for the variables related to age, gender, place of work, promotion opportunities and personal time (p>0.05).

Table XXVII. Multiple logistic regression analysis: career satisfaction regarding independent variables

Independent variables	Odds ratio (95% CI)	P value
Gender -female -male	0.25 (1.08- 3.54)	0.123
Age (years) -26-35 -36-54	0.22 (0.70-3.84)	0.322
Employment -private office -public service	3.21 (4.23-23.5)	*0.001**
Place of work -capital: Iasi -county	0.23 (0.45-1.09)	0.112
Income value €600 - €1,000 > €1,000	6.32 (3.11-35.8)	*0.001**
Fatigue -satisfied and very satisfied -dissatisfied and very dissatisfied	2.01 (1.09-3.56)	*0.003**
Promotion opportunities -satisfied and very satisfied -dissatisfied and very dissatisfied	0.87 (0.11-1.02)	0.441
Personal time satisfied and very satisfied dissatisfied and very dissatisfied	0.09 (0.77-3.89)	0.234
Professional autonomy -satisfied and very satisfied -dissatisfied and very dissatisfied	2.23 (1.45-17.6)	*0.004**
Patient relationship -satisfied and very satisfied -dissatisfied and very dissatisfied	1.56 (1.23-1.97)	*0.048**

CI – confidence interval;* statistically significant at p<0.05

Discussions

The purpose of this survey is to understand if in today's Romania the dentist still has the *motivation* and *satisfaction* necessary to continue their job, if there still is any passion and wish to treat a patient as well as the afferent sacrifice. We must not omit other factors as well from this equation: the low economic level of certain communities that have a marginalized

and poor population, a certain degree of stiffness of the educational systems and the inadequate fiscal and budgetary policy (Chirca and Biclesanu, 2014). In parallel, the opportunities represented by the carrying out of the activity in other countries where the wages are clearly higher represent a special chance for the young graduate to have a prosperous career (Dornescu and Manea, 2013).

In this survey, we noticed that 76% of dentists consider themselves as satisfied and very satisfied by their current place of work, and 65% with their current place of work**.** In other country, in Poland for example, more than 90% of dentists declared satisfaction with their profession (Kobza *et al*., 2018). Only 52.1% of the total 165 dentists would choose the same career, 10.9% say that they would categorically change this domain, and the percentage of the undecided ones is surprisingly high, namely 37%. The satisfaction related to the dentist career also supposes the analysis of the elements that young graduates consider as essential at the beginning of their profession, among them being the income which occupies the first place for 55% of them. Unfortunately, professional training which represents an important factor for career development is appreciated by only 32.3% of the participants to the survey. On the other hand, this motivation is considered as a priority by the dentists from Lithuania and India (Puriene *et al.*, 2007; Kapoor *et al.*, 2014). The possible explanations for the situations encountered in our survey might be determined by the lack of promotion opportunities, the difficulty in finding a job for the orthodontists and maxillofacial surgeons, the reduced income from the public system of health insurances, as well as the lack of dental offices in the rural environment.

Another element considered as less important for a successful career is the continuous medical education appreciated by only 12.1 % of the respondents. In contradiction to these results, in a similar research carried out in Great Britain, the percentage of dentists who appreciate medical education (congress, conferences and post-academic courses) is 87% (Buck and Newton, 2002).

It is known that dentists' level of professional satisfaction in the light of income is dependent on the level of country's economic development. In our survey, we found out that the best predictor for job satisfaction is a monthly income of more than 1,000 euro (OR=6.32)

In the specialized literature, there are surveys showing that a small income represents the most import factor of dissatisfaction. In Lithuania, Puriene finds an OR value of 2.79 for the dentists who do not have a high income as compared to those who are happy with it (Puriene *et al.*, 2007).

As Luzzi shows in a survey on the satisfaction level of the Australian dentists, the level of professional autonomy is an important predictor for professional satisfaction (Luzzi *et al.*, 2005). This trend is also seen in this survey, where the autonomy level is appreciated by 77% of dentists as a good predictor for job satisfaction (OR=2.23).

The profession of a dentist is also facing a series of risk factors that may affect life quality among them being physical overload and stress with its multiple effects on the general health state, behaviour disorders and psychic symptoms (Varella-Centelles *et al*., 2005. In our survey, the percentage of those who consider fatigue as a dissatisfaction factor is 55%, and the logistic regression analysis shows that the lack of lack of tiredness and stress at the workplace may be a good predictor for job satisfaction (OR=2.01). If we add other specific factors, such as the stressful conditions, the lack of recognition and respect for the importance of the activity they carry out, to these elements related to the poor funding of the public health system, the emigration or professional reorientation becomes a fully motivated action (Gilmour *et al*., 2005).

In the study performed by Gilmoure and collaborators in England stress is considered the first dissatisfaction factor among dentists, while in Jordan the health problems caused by the practicing of this job occupy the first place (Gilmour *et al*., 2005; Oweis *et al.*, 2012). In

Brasil, Carneiro and collaborators found 32% of dentists had symptoms specific to professional exhaustion, and 44% of them had a weekly working hours of 21-40 hours (Carneiro *et al.,* 2013). The same issue was developed by Hautefeuille in a study performed in 2013 in France. He showed that 43% of dentists from two French regions felt overstressed, and 41.2% of them considered that the dental office profitability represented the first cause of this phenomenon. Moreover, 48.1% declared that they had resorted to tranquilizers and alcohol in order to cope with the situation (Hautefeuille, 2013).
Professional and implicitly psychic exhaustion frequently leads to the appearance of depressions. Meral reached this result in a study carried out in 2015 in Turkey, Ankara, on a sample of 337 dentists. He showed that 22.2 % of the dentists had symptoms specific to depression, and that it was encountered more among women and among the dentists working in the public sector than to those working in the private environment (Meral *et al*., 2016).
Kaipa found that the professional relations and professional time is also an important factor career satisfcation and increased with age and was more in females, married dentists, and in those with postgraduate qualification (Kaipa *et al*., 2015). In this study, we found no statistical significance between satisfaction of male or female.
In China, for early and mid-career Chinese dentists working in a metropolitan public hospital, total career satisfaction was judged to be good overall. Professional relations, helpful staff, and respect were the most satisfied factors, whereas lack of personal time, low income, and heavy stress were the least satisfied factors (Cui *et al.,* 2017).

Conclusions

The results of the survey place financial security on the first place for job satisfaction and a monthly income of more than 1,000 euro is the best predictor for the motivation to practice the profession of a dentist. The monthly income is considered as the main cause for satisfaction or dissatisfaction, 62.9% dentists consider that need to earn more. Other predictors of job satisfaction refer to the level of autonomy, the private practice, the lack of fatigue and stress as well as the positive relationship with patients.
A negative aspect refers to the lack of motivation for the continuous medical education and ongoing professional training, aspects that some of the dentists consider as unimportant for a prosperous career.

CHAPTER 2

CLINICAL AND EXPERIMENTAL RESEARCH IN PREVENTIVE AND RESTORATIVE DENTISTRY

2.1. STUDIES ON PREVENTION OF THE TOXICITY OF DENTAL MATERIALS

State of art

In 1987, biocompatibility was defined as the ability of a material to perform with an appropriate host response when applied as intended (Williams, 2008). Later, this definition was considered to be too general. In 2008, Williams proposed that biocompatibility can be regarded as "the ability of a biomaterial to perform its desired function with respect to a medical therapy without eliciting any clinically significant adverse effects in the recipient of that therapy, generating the most appropriate beneficial cellular or tissue response to that specific situation, and optimizing the clinically relevant performance of the therapy"

(Williams, 2008). The biocompatibility of a material depends upon the type of material, where it is placed, and the function it is expected to perform. A few materials, if any, are completely inert from the physiological point of view since, most of the components with a variety of potential toxic or irritating (Schmalz and Galler, 2017).
The requirements of a biocompatible dental material refer to the following aspects (Freire *et al.,* 2017; de Souza Costa *et al.,* 2014):
- any dental materials used in the oral cavity should be harmless to all oral tissue: gingiva, mucosa, pulp, and bone;
-the dental material should contain no toxic, leachable, or diffusible substance that can be absorbed into the circulatory system, causing systemic toxic responses/toxicity (including teratogenic or carcinogenic effects) e.g.substances released intraorally from dental alloys and other dental materials;
-material should be free of agents that could elicit sensitization or an allergic response in a sensitized patient.
The intraoral tissues are modified by many structures or solutions which its use in dental medicine. In dentistry the following dental materials with *toxic potential* are frequently used:

Tooth whitening is a method used for the treatment of the dental discoloration by applying some substances that contain hydrogen peroxide or its precursor, carbamide peroxide, having a concentration ranging between 6% - 40%, depending on the application method. There are three fundamental approaches for bleaching vital teeth: in-office or power bleaching with 25-40% hydrogen peroxide, at-home, or dentist-supervised night-guard bleaching with 10-20% carbamide peroxide, and over-the-counter products with a low concentration of peroxide, 3-6%, self applied to the teeth via gum shields, strips, dentifrices (Alqahtani, 2014).
Although the manufacturers consider that the application of the hydrogen peroxide gel does not cause major side effects on the enamel's morphology, *in vitro* researches have shown the existence of some structural modifications: surface morphological changes, alteration of surface microhardness and mineral loss, chemical composition, when it using 30% hydrogen peroxide and more (Joshi, 2016). Clinical adverse effects of tooth bleaching are: cervical root resorption, crown fracture, tooth sensitivity, alteration in enamel surface, and mucosal irritations (Alotaibi, 2019). Most clinicians recommend applying *fluoride neutral gel* after tooth bleaching (Sulieman, 2005).

The mechanisms of *bleaching* involve the degradation of the extracellular matrix and oxidation of chromophores located within enamel and dentin. However, hydrogen peroxide produces also local undesirable effects on tooth structures and oral mucosa. In clinical conditions, the daily low-level doses used to produce tooth whitening never generate general acute and sub-acute toxic effects. Genotoxicity and carcinogenicity only occur at concentrations that are never reached during dental treatments. Some transient adverse effects have been reported on the oral mucosa and the digestive tract if the product is swallowed. Local effects may occur on the oral mucosa and dental tissues during whitening, namely, pulp sensitivity, cervical resorption, release of selected components of dental restorative materials, and alteration of the enamel surface (Alotaibi, 2019). Most of the local effects are dependent of the technique and concentration of the product so far used, but as the results of bleaching obtained are not stable, repeated treatments add to the adverse effects. The informed decision to administer or not and the control of bleaching effects should stand in the hand of dental surgeons and certainly not as it appears at present, as cosmetics sold without any restriction despite the potential health hazards of peroxides (Goldberg *et al*., 2010).

The ***acid etch procedure*** has been a usual clinical procedure to increase the bond strength between the composite resin and etched enamel. Adhesion at the level of dental enamel supposes the use of orthophosphoric acid 35-37% which by demineralization determines the appearance of microporosities increasing the retention of the composite material on the enamel tissue. Although enamel can be remineralized, it is known that this phenomenon is incomplete. For this reason, specialists recommend the use of fluoride, because fluoride treatment is effective in preventing enamel erosion/demineralization in enamel surface and improving the remineralization process (Choi *et al.*, 2010).
There are controversial discussions about the role of fluoride in enamel demineralization. Enamel structure consists of calcium phosphate and other ions: HPO_4^{2-}, CO_3^{2-}, K^+, Mg^{2+}, Na^+, Cl^- and HO^- (Xiaojie, 2008). HO^- anions are gradually substituted by Cl^- and F^- anions, so that hydroxyapatite converts in chloroapatite and fluoroapatite, respectively. Due to its small ionic radius, F^- has a higher affinity than $Cl^-$and HO^-, so that fluoroapatite is more stable than hydroxyapaptite and chloroapatite. This contributes significantly in decreasing the enamel erosion. On the other hand, the application of fluoride in the treatment of caries is well known in clinical practice (Fowler *et al.*, 2006; Nebu, 2019) although some studies highlighted its destructive effect on enamel structure (Wang *et al.*, 2008). Other studies revealed that fluoride alone is not enough to protect the enamel erosion, but the presence of calcium and phosphate ions is also essential for maintaining the structural integrity of enamel (Shahmoradi *et al*., 2017).
In general, the effect of additional demineralization with phosphoric acid is expected to be dependent on aspects such as functional monomer composition and adhesive generation, since the properties and interactions taking place in adhesive interfaces created differently are also expected to vary. However, since there is a high product-dependency aspect associated with the interactions taking place between the functional monomers and dental substrate, no definitive statements can be made as to effect of additional phosphoric acid etching on the dentin bond strength of different adhesive compositions. Most available studies have evaluated adhesives corresponding to a single class or generation. However, the adhesives tested were from different manufacturers and possessed different monomeric compositions (Sabatini, 2013; El-safty, 2017).

Other dental materials that are known to have toxic effects are the ***resin-based composites***. These have multiple applications in dental medicine, both as crown restoration materials, sealants for pitts and fissures, and as cementing materials for prosthetic restorations.
The history of resins started as early as 1960's, when Bowen developed the monomer, Bisphenol A-glycidyl methacrylate (bis-GMA), also used nowadays in the structure o many materials. In the 1970's, they developed another monomer with superior properties, namely urethane dimethacrylate (UDMA). Other composite materials contain 2-hydroxyethyl methacrylate (HEMA), triethylene glycol dimethacrylate (TEGDMA), and ethoxylated bisphenol A glycol dimethacrylate (Bis-EMA). There is currently a wide variety of state of the art composite materials such as polyacid-modified composites (compomers), organic resin-modified (ormocers), the ones having antibacterial properties or fluoride release ones (Leprince, 2012). This evolution of the composite materials aimed at improving certain properties such as the colour, translucidity, the resistance to wear and masticatory forces, the adherence to dental structures, the insolubility into the oral fluids (Schmalz, 2014).
Dental composites are composed of a wide variety of components with different chemical composition: organic composition (matrix material), made by dimethacrylate monomer, another inorganic material, (filler material) such as silica glass (SiO_2), alumina glass (Al_2O_3), and silane coupling agents ensures covalent coupling between filler and resin matrix. During

the curing process, polymerization, monomers are linked to each other forming long chains of polymers, cross-linked in a three- dimensional network (Wei *et al.*, 2018).
It is cited in the literature the toxic effect of these types of materials on the dental pulp, gingival fibroblasts, carcinogenic effects, teratogenic effects, genetic mutations or even system effects such as allergic reactions or anaphylactic shock (Schneider *et al.*, 2019).
Recently, *in vitro* and *in vivo* studies showed that monomers have been interrelated with genotoxicity, estrogenicity, immune system, hypersensitivity, cytotoxicity and the production of reactive oxygen species (Kamalak *et al.*, 2018; Shahriar *et al.*, 2019).
Current research on the compatibility of dental composites is focused on cytotoxicity, genotoxicity, carcinogenicity, hypersensitivity, and antibacterial effects of components (Mallineni *et al*., 2013; Lee *et al.*, 2017).
Manufacturers have tried to introduce improved and biocompatible materials and dentists have made effort to employ sufficient light curing intensity, reduce the curing tip distance, and increase the curing time, in order to increase the degree of conversion and minimize the release of uncured monomers. Further studies are needed to develop dental resin composites with less leachable components and to synthesize more biocompatible monomers and resin matrices (Kavuncu *et al*., 2020).

Another category of acrylic materials that may become toxic by the excess of monomer released into the oral cavity are the ones used to make conventional ***methyl methacrylate dentures***. Resin based materials made from liquid - methyl methacrylate mixed with polymethacrylate powder are the most commonly polymers used in prosthodontics**.** Experimental and clinical studies have documented that monomers may cause a wide range of adverse health effects such as irritation to skin, eyes, and mucous membranes, allergic dermatitis, stomatitis, asthma, neuropathy, disturbances of the central nervous system, liver toxicity, and fertility disturbances (Gupta *et al.*, 2012). The etiology of these lesions is often difficult to appreciate, a reason for which there are no concrete data regarding their prevalence among the population.
Self-curing resin used as a temporary crown induces allergic reactions such as a swelling and redness in the buccal and palatal mucosa. Dentures have also been reported to cause local mucosal irritation or even an allergic reaction. During orthodontic treatments, some resin-based adhesives cause allergic reactions such as gingival inflammation and lip edema and oral stomatitis (Yamashiro *et al.*, 2021).
In the dental practice of *prosthetic restoration* it uses metals and alloys for the making of crowns and acrylic resins for removable dentures. Just like in the case of crown restoration based on acrylic resins, the existence in excess of methyl methacrylate monomer in the basis of the prosthesis may cause stomatitis, irritations at the skin level and allergic dermatitis as well as the *burning mouse syndrome* (Rashid *et al.*, 2015).
The metal most frequently responsible for an allergic response is nickel, which is present in most stainless steels, most cobalt/chromium alloys, nickel-titanium alloys, and nickel-chromium alloys. If an adverse *allergic* response occurs, little can be done other than to exchange the metal component for one that does not contain nickel (Schmalz, 2014).
Dental alloys, such as chromium and cobalt, are commonly used for the fabrication of prosthesis and substructure of metalic crowns, and react easily with the biochemical medium in the oral cavity.
The specialized studies have shown that the *corrosion* products solubilized from dental alloys in the gum tissues depend on the alloy composition which influences the resistance to corrosion, the structure formed during casting and the subsequent processing protocols. The ions released from dental alloys can induce adverse biological reactions such as gingival swelling and erythema, mucosal pain, lichenoid reactions and allergic reactions (Renita *et al.*, 2016).

Publications on this topic:

1. **Murariu A,** Savin C, Feier R, Balan A. Study regarding the toxic effects of resin-based dental materials. *Revista de Chimie (Bucharest)*. 2016; 67(9): 1876-1878, FI=1,232.
2. **Murariu A**, Vasluianu R, Matricala L, Stoica I, Forna NC. *In vitro* evaluation of morphological integrity of dental enamel exposed to carbamide peroxide-based bleaching agent, *Revista de Chimie (Bucharest)*. 2016; 67(10): 2103-2105, FI=1,232.
3. **Murariu A**, Zaltariov M, Vasiliu L, Balan A, Savin C, Forna NC. The effect of ortho-phosphoric acid etching application on enamel surface: ATR-FTIR and SEM studies. *Revista de Chimie (Bucharest)*. 2017; 68(4):781-785, FI=1,412.
4. Vasluianu R, Forna NC, Baciu ER, Zaltariov M, Vasiliu L, **Murariu A**. *In vitro* evaluation of enamel surface treated with fluoride after bleaching and etching erosive processes. *Revista de Chimie (Bucharest)*. 2018; 69(7):1714-1717, FI=1,605.

2.1.1. Study regarding the toxic effects of resin-based dental materials

Introduction

The traditional concept of *biocompatibility* of dental materials is regarded as a lack of significant adverse reaction between the oral tissues (Murray *et al.*, 2007; Wataha, 2012).

The issue of biocompatibility of resin-based dental materials is still being discussed in the specialized literature. A material is biocompatible if it is not toxic and does not interfere with the oral tissue. In the case of *composite materials*, they may release unpolymerized monomers in the oral environment that may become toxic (Cramer *et al.*, 2011).

Since 1969, several authors have reported a correlation between increased plaque accumulation and gingival irritation adjacent to resin restorations and roughness and marginal adaptation of the filling In contrast to the local irritation caused by surface parameters, released substances can induce local effects in oral tissues (pulp, gingiva, oral mucosa) as well as adverse systemic reactions.

The nature of such responses is either allergic or toxic. Now it is recognized that resins used for dental procedures have local or sistemic toxic effects (Schmalz and Galler, 2017).

Despite the fact that dental resin composites have improved their physico-chemical properties, the concern for its intrinsic toxicity remains high. Some components of restorative composite resins are released in the oral environment initially during polymerization reaction and later due to degradation of the material. *In vitro* and *in vivo* studies have clearly identified that these components of restorative composite resins are toxic (Gupta *et al.*, 2012).

Systemic adverse reactions such as hypersensitivity and anaphylactic reactions associated with resin-based dental materials have been reported (Moharamzadeh *at al.*, 2009).

Side effects associated with acrylic materials are, in the majority of cases, of local nature and are manifested as cheilitis and stomatitis, annealing and burning mouth, painful sensations of different intensity and candidiasis. The allergic reaction to the presence of acrylates compensation can also occur in the form of extensive allergic reactions such as erythema multiforme. In clinical practice, contact stomatitis in children caused by wearing removable orthodontic appliances has been described (Kostic *et al.*, 2017).

The ***aim*** of this study was to highlight the frequency and type of oral lesion caused by the toxic components of the acrylic materials used in dentistry, namely resin-based

composites used to treat dental cavities and the acrylic materials entering the structure of dental prostheses.

Material and methods

The cross-sectional study was carried out by the use of our own questionnaire elaborated in order to find out the lesions at the level of the oral mucosa caused by the toxic effects of the acrylic products in the dental materials. This questionnaire was sent to 95 dentists of Iasi; the response rate being 85%. 29 of them (36%) are specialists in dental-alveolar and maxillofacial surgery, and 52 (64%) in general dentistry; as for the experience in the medical activity, most of them, namely 53 (65%) have more than 10 years of service, the rest of 28 (35%) having an experience below 10 years.

The questionnaire used in our study contains 11 questions referring to the following aspects: frequency, the clinical aspect and the morphological type of oral lesion, the time when toxic effects occurred, the type of allergen discovered and the dental material incriminated for the occurrence of phenomena.

Data were analyzed with the SPSS 18.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Statistical significance of the bivariate analysis was assessed by the Pearson chi-square at the 0.05 level.

Results

At the level of the oral cavity there is a series of physical and chemical aggressions triggering inflammatory, immunological and allergic reactions that vary depending on the toxic element incriminated: from stomatitis caused by incorrectly made prostheses to inflammatory lesions of the dental pulp and even lichenoid lesions of the oral mucosa.

The results of the study on the toxicity of acrylic materials show the existence of these phenomena at the level of the oral cavity (table XXVIII).

Table XXVIII: Toxic effect of resin-based dental materials

QUESTIONS	Yes		No		p value
	Nr	%	Nr	(%)	
Identification of toxic effects of the acrylic materials during the dental activity	61	75	20	25	*0.012**
Certainty of lesion etiology	57	70	24	30	*0.037**
Frequency of lesions reported in the past year	23	28	58	72	*0.033**
Moment of lesion occured: within 24 ore after 10 days	 45 16	 56 20	 36 65	 44 80	*0.024**

p<0.005*

During their activity, 61 dentists (75%) showed that they had diagnosed lesions caused by the toxic effects of the acrylic dental materials, and in the last year these have been signaled by only 23 dentists (28%) of the participants to the study. We may notice that 24 dentists (30%) cannot specify precisely the etiology of the disorder due to the fact that, besides the incriminated effects there may be other factors as well, and they are iatrogenic factors most of the time.

Depending on the moment of onset, 45 dentists (56%) mentioned a short period of time of up to 24 hours since the contact with the material, and 16 dentists (20%) encountered such phenomena after a longer period of more than 10 days.

Significant statistical differences were registered for all the questions, $p<0.05$.

The most frequent oral manifestations presented in table XXIX were the following: burning mouth syndrome was reported by 13 dentists with a frequency of 21.3%, followed by the pulp inflammatory lesions as a side effect to restoration composite resins, 19.6% and para-prosthetic stomatitis reported by 12.3% dentists;
Inflammation and ulceration were observed by 14.74%, especialy caused by conventional methyl methacrilate dentures. 13.10% of the dentists reported allergic reaction by resin composites used in restorative treatment (6.55%) and prosthetic treatment (6.55%).

Table XXIX. Oral manifestation of toxic effect of resin of resin-based dental materials

Oral manifestation	**Resin composite restorative materials**		**Conventional methyl methacrylate dentures**	
	Nr dentists	**%**	Nr dentists	**%**
Pulpal inflamation	12	19.67	0	0
Gingival inflamation	3	4.91	2	3.27
Prosthetic stomatitis	2	3.27	10	12.30
Burning mouth syndrome	2	3.27	13	21.30
Allergic reaction	4	6.55	4	6.55
Inflammation and ulceration	1	1.63	8	13.11
Total: 61	24	39.3%	37	60.6%

Discussions

In the case of resin-based composites, the cytotoxic mechanism is explained by the existence of the residual monomer remained after the curing, though the effect must be corroborated with other factors as well, such as the permeability of dentin, the saliva composition, the oral microorganisms, the mechanical factors, such as the short curing time (Ilie and Hickel, 2011)**.** Some authors consider that the degree of conversion of composite biomaterials is never complete and that it varies between 50 and 70% (Soanca *et al.,* 2015).
As for the *toxic effects* caused by methyl methacrylate monomer existing in the composition of dental prostheses, the cytotoxic mechanism is explained by the presence of monomer remained uncured, with differences depending on the type of resin used. Based on the polymerization method, acrylic resin can be classified as heat-polymerized, microwave-polymerized, light-polymerized and auto-polymerized, the latter being the most common in dental practice (Ata and Yavuzyilmaz, 2009).

In a review regarding cytoxicity of acrylic resin for denture bases and its components, made on 19 studies, Goiato, concluded that auto-polymerized resin is more cytotoxic than heat-polymerized resin because of its higher quantity of residual monomers which cause cell and tissue changes in the oral mucosa (Goiato *et al.,* 2015).

In case of the materials used for the treatment of dental cavities, iatrogenies may occur through the inobservance of the rules for preparation of the dental cavities, the lack of the protective material for the dental pulp, the preparation of cavities at high speeds or the erroneous curing necessary to the hardening of the material. In case of the lesions caused by the monomer in the prosthesis structure, we may incriminate the traumatic and infectious factors.

As for the prevalence of *lesions caused by the toxic effects* of the dental materials, we may quote few studies in the literature. We mention the study carried out in Sweden where 36

out of 618 patients were found out to have possible reactions to resin-based dental materials, what represents a percentage of 5.9%. In this study, most problems were intraoral such as oral ulcers, burning mouth, followed by cutaneous disorders occurred within the first 24 hours after the dental treatment (Tillberg *et al.,* 2009).

Allergic reactions to dental materials especially resin-based dental materials have been reported since 1965 by Crissey. These reactions are mainly denture stomatitis due to allergy to polymethyl methacrylate denture base material dental materials have been reported since 1965 (Crissey, 1956).

According to the prevalence of this type of lesion, the studies performed in Romania by Scutariu reported a frequency of 14.5% (Scutariu *et al.,* 2015). The results of another study carried out in Norway for a 4-year period on a lot of 296 patients show a 8% frequency of allergic reactions to the resin-based dental materials (Vamnes *et al.,* 2004).

Reduction of acrylic material toxicity

The diversification of the dental materials for restoration having a more and more complex chemical composition also increases the risk of occurrence of diverse reactions. The dentist must know very well the structure of the dental materials used and to choose them not only for their esthetic and physical qualities, but also by biocompatibility, knowing that the level of cytotoxicity differs according to the existing monomer, the most incriminated ones being those having in their structure monomers like TEGDMA and HEMA (Ausiello *et al.,* 2013). The observance of the clinical protocol for the insertion and chemical initiation for material hardening may reduce the occurrence of the residual monomer responsible for the cytotoxic effects on the oral tissues.

In case of the acrylic dental prostheses, due to the toxicity of the residual monomer, there is currently the trend of using flexible prostheses made of thermoplastic materials that do not contain toxic monomers and which are better tolerated by the oral tissues as an alternative method (Guven, 2017).

In their practice, the dentist encounters every day the issue of biocompatibility of the materials used, which is why they must know and understand the reactions occurred at local and general level so as to carry out a high quality dental treatment in conditions for the patient.

Conclusions

Out of the 61 dentists that participated to the study, 28% of them diagnosed in the past year lesions caused by side effects to the dental materials. Their frequency ranges between 21.3% for *burning mouth syndrome* caused by methyl methacrylate monomer in conventional prostheses to 19.6% for the inflammations of the dental pulp, following the toxicity of composite resins up to much lower frequencies below 5% for other oral manifestations, such as gingival inflammation, mucosal inflammation and ulcers and allergic reaction.

2.1.2. *In vitro* evaluation of morphological integrity of dental enamel exposed to carbamide peroxide-based bleaching agent

Introduction

Tooth whitening is a method used for the treatment of the dental discoloration by applying some substances that contain hydrogen peroxide or its precursor, carbamide peroxide, having a concentration ranging between 6% - 40%, depending on the application method (Alqahtani, 2014; Tanaka *et al.*, 2010). Commonly known local risks associated with

tooth bleaching include tooth sensitivity, gingival irritation and adverse effects on enamel and restorative materials (Clifton and Carey, 2014).

The concerning adverse effects are due to the widespread acceptance between dentist and patients. There is no agreement about the effects of bleaching on enamel, since scanning electron microscopy investigations of bleached enamel surfaces have shown little or no topographic alterations while surface changes after carbamide peroxide bleaching have been reported. The alterations include increased porosity, pitting, erosion and demineralization of enamel prisms periphery. Moreover, chemical composition, mechanical and physical properties of bleached human enamel have also demonstrated conflicting evidences (Giannini, 2006; Tezel *et al.*, 2007).

Interaction of the bleaching agent and the oral tissue is critically important as the usage of the bleaching agent may negatively affect the oral structure. Altered enamel surface roughness has become a major problem in vital bleaching. A few researchers have found that there are increases in the enamel surface roughness after the bleaching procedure (Omar, 2019).This is due to the oxidizing process that occurs during bleaching treatment.

The ***aim*** of this study was the *in vitro* analysis of the morphological changes through Scanning Electron Microscope (SEM) and Atomic Force Microscopy (AFM). The purpose was to assess the effects of the carbamide peroxide on the structure of the tooth enamel at different concentrations and to check if the destructive effects are important at low concentrations.

Material and methods

We used sound teeth extracted for orthodontic and periodontal reason (incisor, premolar and molar). After the surfaces was cleaned under high pressure water to remove the white material, the teeth were stored in 0.1% thymol solution at 4°C until the preparation for testing. The teeth were treated with 10% (incisive), 16% (premolar) and 35% (molar) carbamide peroxide (44% Teeth Whitening Gel, WGS44-10, United States) solutions, respectively. The pH of the carbamide peroxide solutions was 7.4 (measured in laboratory). The bleaching treatments were performed for each tooth in two sessions, over a period of three months, at room temperature in closed dishes for 30 min/day over three months. The total treatment time was 90 minutes.

Measurements

The surface images were obtained with a Solver PRO-M scanning probe microscope (NT-MDT, Russia) in AFM configuration. Rectangular silicon cantilevers NSG10 (NT-MDT, Russia) with tips of high aspect ratio were used. All images were acquired in air, at room temperature (23 ^{o}C), in tapping mode, and at a scanning frequency of 1.56 Hz. The scan length ranged between 5 and 20 μm.

Each tooth was mounted on an aluminum stub for outer enamel structural defects examination by SEM (FEI Quanta 200, Eindhoven, the Netherlands) operating at 20 kV in low-vacuum mode for secondary electron imaging.

Results

Scanning Electron Microscopy (SEM)

As shown in Figure 2 the surface of the teeth is different from one another. The incisor's surface is rougher and has more sediments than the others, the premolar's surface is mostly smooth with scattered sediments and the molar's surface presents traces from mastication.

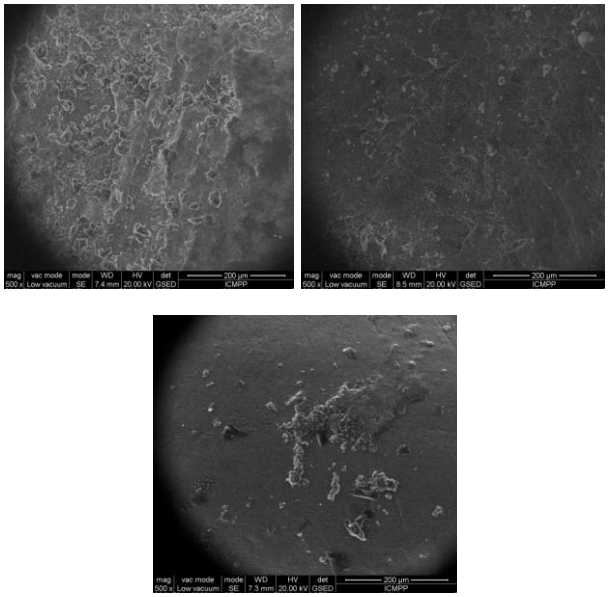


Figure 2: Initial SEM micrographs of incisor, molar and premolar

These micrographs show that there are morphological modifications of the surface after applying the lowest concentration of carbamide peroxide. In the case of the incisor, the initial sediments have been replaced by enamel fragments due to the demineralization of the incisor's surface. Also, due to the same process, narrow fractures appear on the surface. On the surface of the premolar, narrow and straight fractures appear, whilst the enamel is demineralized more severely, in certain regions. The molar's surface presents scattered demineralization holes in the enamel that might be due to the wider surface of the tooth. In figure 3 are shown the micrographs obtained after the first whitening treatment with 10% (incisor), 16% (premolar) and 35% (molar) carbamide peroxide solutions.

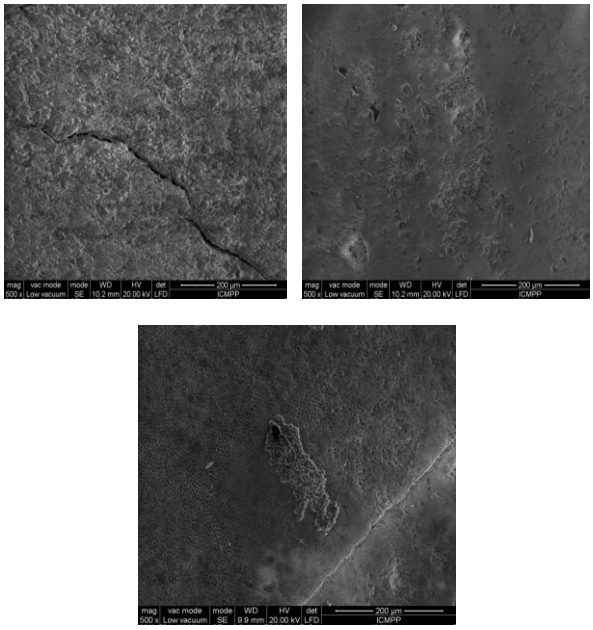


Figure 3. SEM micrographs of incisor, molar and premolar after the first whitening treatment

Figure 4 shows micrographs of the incisor, molar and premolar after the last bleaching exposure. The surface of the teeth is clearly different and more damaged compared to the initial micrographs. The incisor's enamel was severely deteriorated, hence the presence of microscopic fractures on the entire surface. In addition, there are areas where the enamel was completely destroyed and revealed the dentine underneath. In the case of the premolar, the fractures widened and deepened, whilst the enamel deteriorated in some regions, also revealing the dentine. The molar's surface, although rather smooth, has increased holes (up to 400 μm) and fractures. As shown in the micrograph, the fractures vary in depth and width, depending on the topography of the initial surface.
It is clear that the damage of the enamel increases with the concentration of carbamide peroxide and that the morphological changes differ from one tooth to another. The different modifications of the teeth may be due to the size and mechanical properties of each one, hence the more severe degradation of the enamel of the incisor compared to the molar.

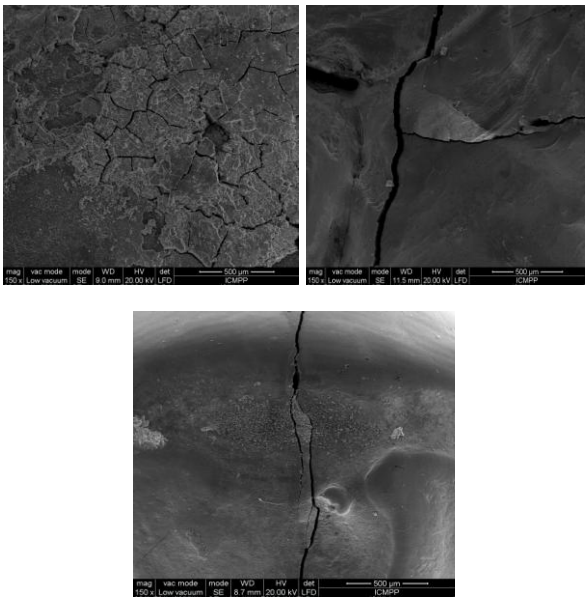


Figure 4. SEM micrographs of incisor, molar and premolar after the second whitening treatment

Atomic Force Microscopy (AFM)

More detailed morphological aspects of the samples before and after the whitening treatment were analysed using a SPM (Solver PRO-M, NTMDT, Russia) and a commercially available NSG10 cantilever (Solver PRO-M, NTMDT, Russia) with the resonant frequency of 297 kHz. Different squares of various side were scanned in the semi-contact mode, but the morphological features were easily observed when the scan length of 5 μm was used. The height AFM images collected in air, at room temperature (23 °C) and analysed using the software Nova v.1.26.0.1443 for Solver were clearly obtained for molar and premolar samples (figures 5 and 6).
Unfortunately the incisor's surface was very rough, especially after the whitening treatment, the maximum peak-to-valley distance (Sz) being higher than the limit allowed by our device. Thus, the samples in question were only the molar and premolar.

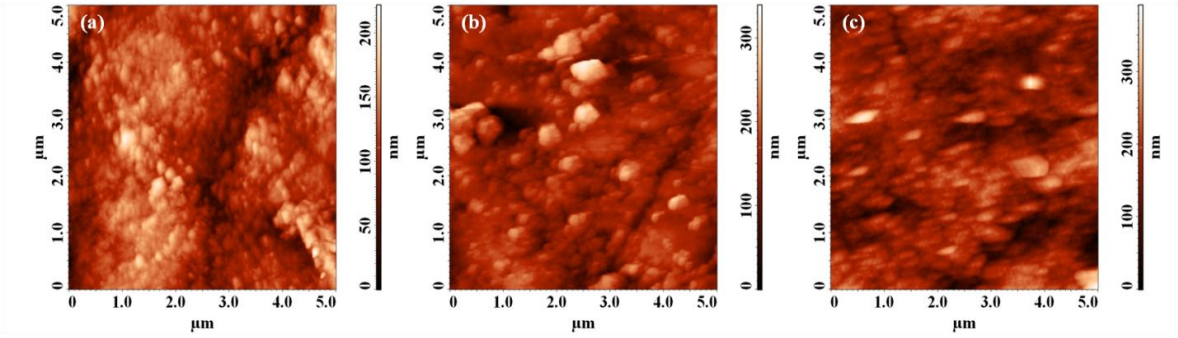


Figure 5. 2D topographical images of the molar surface before (a) and after the first (b) and the second whitening treatment (c).

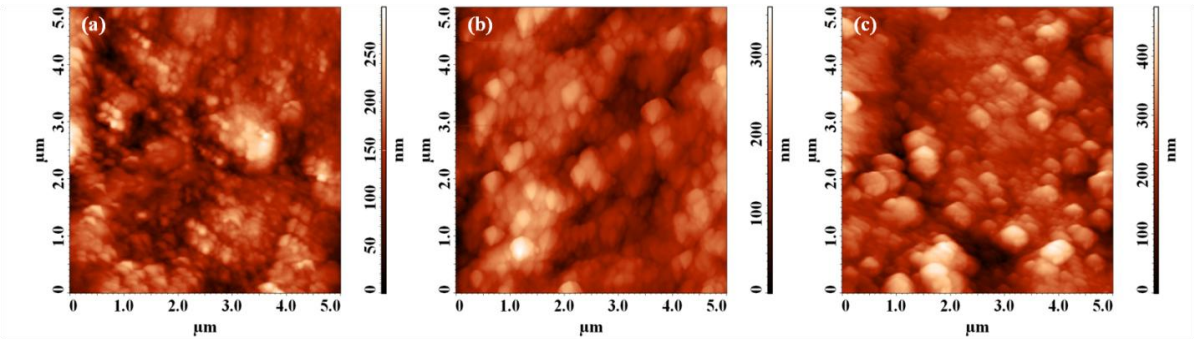


Figure 6. 2D topographical images of the premolar surface before (a) and after the first (b) and the second whitening treatment (c).

The surface topography of the molar and premolar samples, before and after the first and the second whitening treatment was evaluated by means of height AFM images, presented in figures 5 and 6 respectively. Using a specialized and standardized software, various tridimensional statistical parameters were calculated from the AFM measurements, among them being the maximum peak-to-valley distance (Sz) which is the mean distance from the highest peak to the lowest valley in the sampling area, the root mean square roughness (Sq) defined as the root mean square value of the surface departures within the sampling area and a quantification of the shape-size complexity, and the developed surface area ratio (Sdr) which is the percentage of additional surface area contributed by the texture as compared to an ideal plane the size of the measurement region. All these parameters shown in table XXX mediated from five different measurements, describe the relief structure quality and the complexity of the morphological features.

Table XXX

Changes Sz, root mean Sq, and developed Sdr of molar and premolar enamel before and after the first (W1) and the second whitening treatment (W2)

Sample	3D surface roughness parameters calculated on 5x5µm^2		
	Sz (nm)	Sq (nm)	Sdr (%)
molar	221.6±8.8	30.7±1.2	8.355±0.334
molar w1	338.9±13.5	36.6±1.5	14.872±0.595
molar w2	389.9±15.6	45.4±1.8	18.125±0.725
premolar	300.5±12.1	40.2±1.6	11.940±0.478
premolar w1	359.1±14.3	45.3±1.8	18.526±0.741
premolar w2	482.3±19.3	63.6±2.5	26.167±1.047

Discussions

The possible effects that peroxides can have on dental tissues have generated numerous clinical and experimental studies (Mondelli, 2015). The widespread use of bleaching techniques generates some concern about the effects promoted by these agents onto the bleached substrates. Some alterations in the enamel and dentin, such as an increase of roughness, porosity and diminished microhardness have also been observed (Attin *et al*., 2009).

In the literature there are some controversial aspects regarding beanching effects:

Götz *et al*. that analyzed the effects of hydrogen peroxide in low concentrations (13 and 16%) over the enamel surface and subsurface, found no changes in the microhardness (Götz *et al*., 2007). Sulieman *et al*. evaluated the effects of high concentrations of hydrogen peroxide and the results showed no change in abrasion, hardness and topography in the enamel and dentin (Sulieman *et al*., 2005).

It has been demonstrated that 10% carbamide peroxide bleaching gel caused low toxic effects to cultured pulp cells. Soares *et al.* reported that 16% gel resulted in a significantly higher cytotoxicity than 10% gel, which was probably caused by the intense diffusion of hydrogen peroxide across enamel and dentin. Therefore, in spite of the faster esthetic outcomes obtained when tooth bleaching therapy is performed with 16% carbamide peroxide gel compared with 10% gel, the higher concentration may be more toxic to pulp cells (Soares, 2013).

On the other hand, Mondelli showed that all bleaching procedures lead to a decrease in surface microhardness when compared with the control group after 24 h. The lowest change in surface microhardness was found in the specimens treated with 15% and 35% hydrogen peroxide induced the highest decrease in surface microhardness (Mondelli *et al.*, 2015).

In this study, initially, according to figures 5 and 6 and table 30, the enamel of the pristine molar sample was smoother compared to the enamel of the pristine premolar sample. Further, depending on the bleaching protocol, different effects on dental enamel structure and topography were observed. First the morphology for both samples was strongly influenced by the whitening process with 16% and 35% carbamide peroxide solutions, respectively (figures 5 (b) and 6 (b)). Significantly higher 3D roughness parameters obtained for these samples compared to the unmodified ones indicate that the surfaces were more irregular, due to the demineralization process of the enamel, exhibiting numerous and deeper peaks and valleys (see the values for Sz). The application of the second whitening treatment with 16% (premolar) and 35% (molar) carbamide peroxide solutions revealed more intense morphological changes on enamel surfaces influenced by previously created porosity, allowing the penetration of the high-concentrated bleaching agent on deep enamel. The significant deep alterations of the dental structure were reflected also by the increased values of the Sz, Sq and Sdr.

Conclusions

Summarizing the results of the effect of three bleaching concentrations (carbamide peroxide solutions) and their application on the morphological modifications of enamel, the following conclusions can be gained: The investigation of carbamide peroxide bleaching agent in three different concentrations, two times over a period of three months, showed that surface morphology of the enamel are affected, causing enamel erosion, as SEM and AFM techniques have revealed. According to the results of this study it is recommended to perform tooth whitening using only low concentration of carbamide peroxide (10%), and shorten treatment time (<30 min) to reduce the possible destructions in enamel structure

2.1.3. The effect of orthophosphoric acid etching application on enamel surface: ATR- FTIR and SEM studies

Introduction

The acid etch procedure, a concept first proposed by Buonocore in1955, has been a usual clinical procedure to increase the bond strength between the composite resin and etched enamel (Shinohara *et al.*, 2006). Adhesion at the level of dental enamel supposes the use of *ortho*-phosphoric acid 35-37% which by demineralization determines the appearance of microporosities increasing the retention of the composite material on the enamel tissue (Gateva *et al.*, 2016).

Since its introduction to the dental profession, there has been a controversy regarding the type and concentration of etchant, length of etching and rinsing time. In the past, some author's recommended 50% (w/w) orthophosphoric acid buffered with 7% zinc oxide. Later study in 1987 reported that phosphoric acid concentrations of 30 - 40% with a 60 s etching time produced a highly retentive enamel surface topography. Now it is recomanded the 37% phosphoric acid with an application time of 60 s, followed by copious rinsing with water for 15 - 60s (El-safty, 2017).

Independent of the type and concentration of the acid used and the etching time, all the acid etchants affected the enamel surface morphology, creating microporosity by selective removal of the prism material (El-safty, 2017).

The ***aim*** of this study *in vitro* was to evaluate the morphological effects of phosphoric acid 37% concentration on dental enamel surfaces using Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) and Scanning Electron Microscope (SEM) techniques.

Material and methods

Materials consisted of sound maxillary incisors and premolars extracted for orthodontic and periodontal reasons and were stored in ethanol 35%. Before the strat of the experiments the teeth were analyzed by Attenuated Total Reflectance Spectroscopy and Scanning Electronic Microscopy. The orthophosphoric acid 37% was applied on enamel surface for 15 seconds. Then the surface as continously washed with distilled water for 30 seconds. The teeth were dried in vacuum and analyzed by the above mentioned methods.

Measurements:

The differences in composition of the analyzed teeth (incisors and premolars) before and after etching of dental enamel surface with orthophosphoric acid 37% were highlighted by using the method of IR spectral subtraction of the samples. The morphology of the teeth before and after etching procedure was investigated with the Scanning Electron Microscope type Quanta 200 (FEI Company), in low vacuum mode, at 20 kV. The samples were uncoated in order to conduct the treatment.

Results

In this study, the effects of etching of dental enamel surface with orthophosphoric acid 37% were investigated on four teeth extracted for orthodontic and periodontal reasons.

ATR-IR spectroscopy

The advantage of ATR-FTIR spectroscopy as an analytical method for dental materials research is its ability to probe the structure of the tooth tissues and to establish the

changes in composition after application of various treatments (bleaching, etching). ATR-FTIR supplies complete information of the enamel structure and its evolution during different treatments.

In figure 7 the subtracted IR spectra of the incisors and premolars before and after etching procedure are shown. It can be seen that initially composition of the enamel (96 % minerals-hydroxyapatite, water and organic proteins) is changed, with a significant lose of specific vibrations bands for inorganic matrix at 600-700 cm^{-1} assigned to the bending mode of PO4 tetrahedral, 833-845 cm^{-1} attributed to the bending mode of $CO3^{2-}$ in the structure of apatite and 900-1200 cm^{-1} characteristic for stretching modes of $PO4^{3-}$ .Beside these, the IR subtracted spectra revealed a major demineralization process involving the organic protein matrix. The presence of the specific bands for amide I, II and III at 1728-1740 cm^{-1}, 1643-1550 cm^{-1} and 1230-1260 cm^{-1}, respectively clear indicates the collagen structure in the composition of dentin.

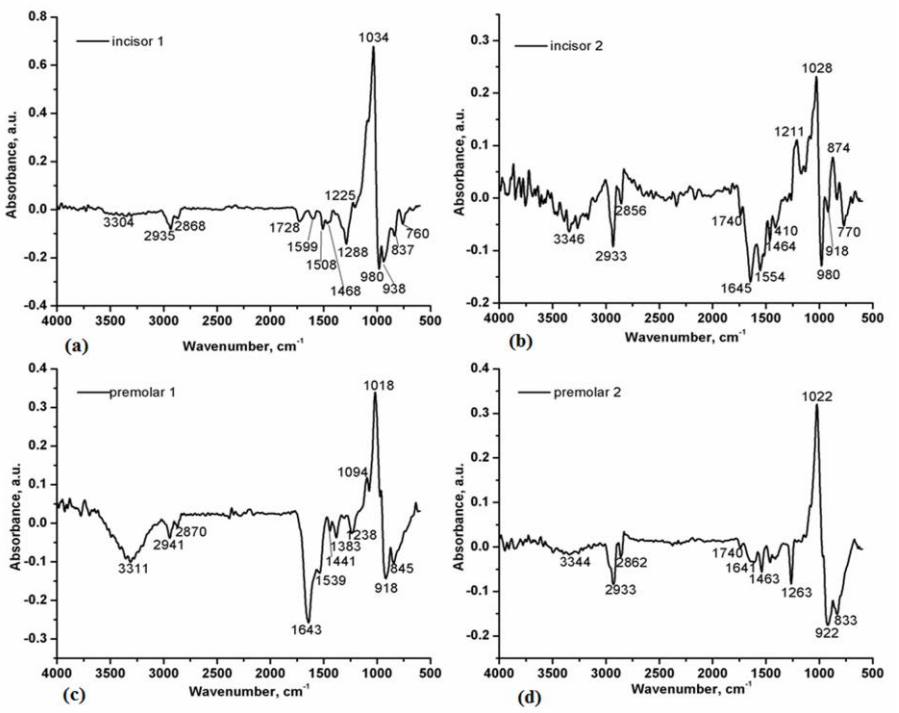


Figure 7. Subtracted IR spectra of the incisors (a, b) and premolars (c, d) samples before and after etching procedure with *ortho*-phosphoric acid 37%

The spectral differences between the treated and untreated teeth with orthophosphoric acid were studied by deconvolution of the IR spectra in the 1800-1200 cm^{-1} and 1200-600 cm^{-1} spectral region. The main changes in the IR spectra of the samples before and after etching procedure with *ortho*-phosphoric acid can be seen in figures 8 and 9.

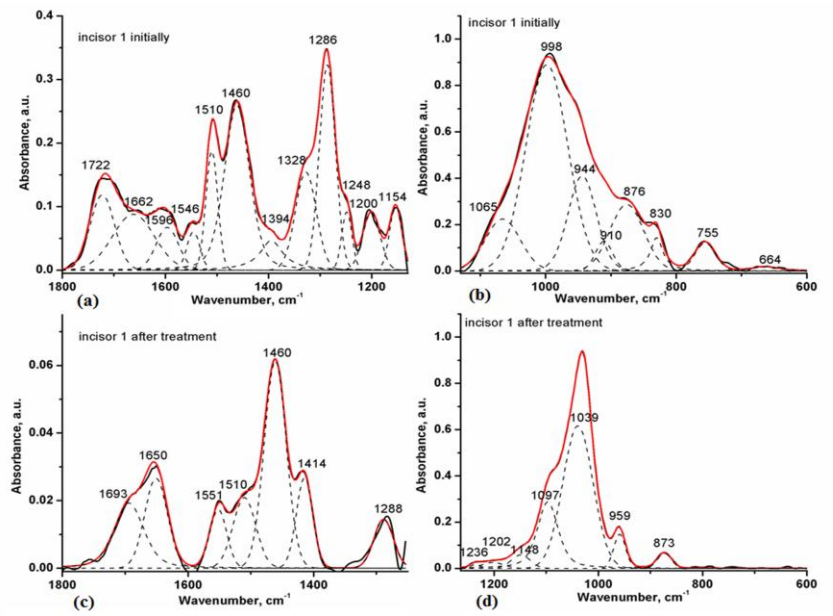


Figure 8. ATR-IR deconvoluted spectra of the incisor 1 before (a, b) and after (c, d) treatment with etching agent

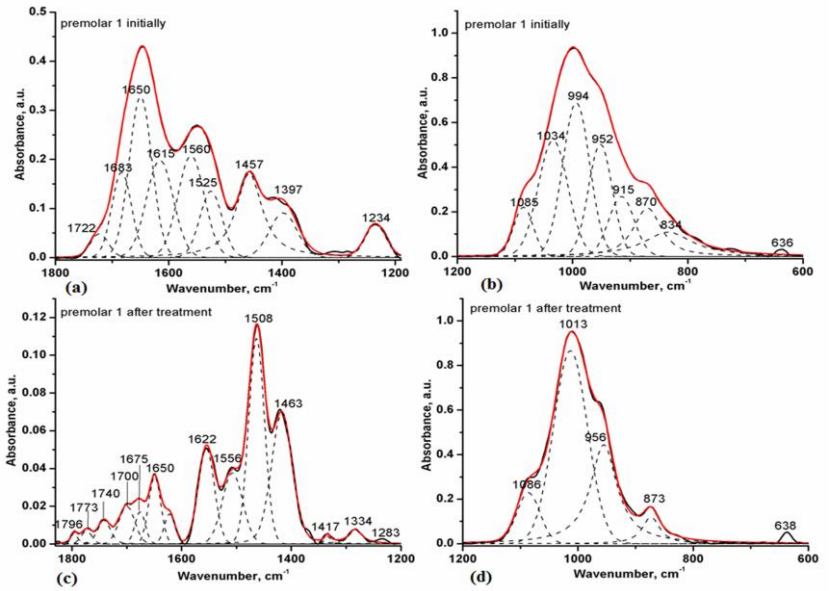


Figure 9. ATR-IR deconvoluted spectra of the premolar 1 before (a, b) and after (c, d) treatment with etching agent

The specific peak position and the corresponding area were compared and the results are indicated in table XXX.

Table XXXI

Results of the deconvolution of FTIR spectra and the area for the characteristic peaks of the analyzed teeth

Sample	1800-1200 cm^{-1} / Area		1200-600 cm^{-1} / Area	
	Initially	**After etching**	**Initially**	**After etching**
Incisor 1	1722 / 6.99	-	-	1236/0.39
	1662 / 8.98	1693/1.34	-	1202/1.34
	1596 / 3.66	1650/1.20	-	1148/2.62
	1546 / 1.91	1551/0.59	1065/15.01	1097/17.87
	1510/5.38	1510/0.95	998/71.72	1027/60.75
	1461/18.07	1461/2.69	944/23.29	959/4.19
	1394/3.89	1414/0.87	910/4.25	-
	1328/7.84	-	876/18.76	873/2.16
	1286/12.61	1288/0.56	830/5.18	-
	1248/2.28	-	755/4.82	-
	1200/3.83	-	664/1.46	-
	1153/3.02	-		
Incisor 2	1738/1.23	1772/0.59	1091/5.32	1088/11.20
	1691/4.48	1713/0.81	1032/35.65	1018/65.80
	1651/11.12	1669/3.38	994/37.34	-
	1614/6.46	1627/1.60	949/31.36	948/43.12
	1557/6.65	1575/0.13	914/36.82	-
	1530/4.47	1551/0.15	870/1.37	877/32.27
	1509/3.11	1527/1.24	842/18.18	814/10.19
	1463/7.45	1478/2.42	766/4.87	-
	1418/6.54	1447/3.78	636/0.70	635/0.37
	1408/2.69	1415/1.81		
	1286/2.29	1281/0.34		
	1255/0.27	1239/1.33		
Premolar 1	-	1796/0.13	1085/9.43	1086/11.62
	-	1773/0.17	1034/33.79	1013/64.39
	-	1741/0.42	994/40.38	-
	1722/1.93	1700/0.72	952/26.19	956/38.79
	1683/7.53	1675/0.41	915/15.05	-
	1650/16.50	1650/0.99	870/18.32	873/6.63
	1615/11.85	1622/0.38	834/17.72	-
	1560/12.20	1555/1.87		
	1525/6.67	1507/1.75		
	1457/14.29	1463/3.94		
	1397/5.54	1417/3.60		
	1234/3.08	1283/0.33		
Premolar 2	1732/0.76	1780/0.27	1087/10.92	1089/10.64
	1655/4.65	1664/0.29	998/82.05	1012/75.65
	1604/3.06	1629/0.46	933/38.73	950/32.86
	-	1606/0.20	866/20.08	875/14.60
	1546/3.93	1571/0.51	826/3.72	-
	1466/1.13	1552/0.38	793/12.66	-
	1463/10.66	1491/1.15		
	1415/7.40	1418/4.29		
	1264/3.76	1272/0.59		
	-	1247/0.10		

SEM technique

Figure 10 shows the initial surface of the incisor 1 in comparison with its surface after the etching treatment with orthophosphoric acid. The changes in morphology of premolar 1 can be seen in figure 11.

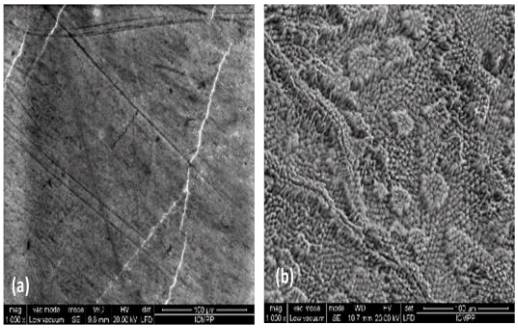


Figure 10. Initial SEM micrographs of incisor 1 before (a) and after (b) treatment with the etching agent

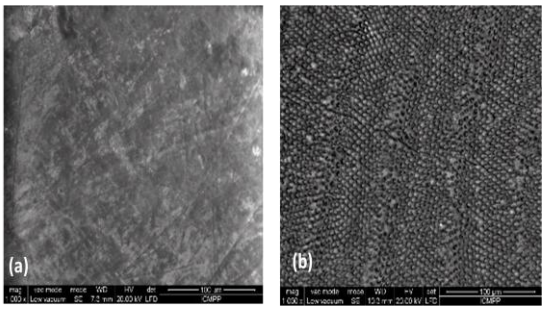


Figure 11. SEM micrographs of premolar 1 before (a) and after (b) treatment with etching agent

Discussions

The structural changes in the surface of the teeth are highlighted by the disappearance of the specific vibration bands of enamel: inorganic carbonates at 1495-1410 cm^{-1}, 1090-1080 cm^{-1}, 885-870 cm^{-1}, 860-845 cm^{-1}, 715-695 cm^{-1}, $PO4^{3-}$ stretches at 1200-900 cm^{-1} and the appearance of those characteristic for protein matrix in the structure of dentine: amide I at 1700-1780 cm^{-1}, amide II at 1550 cm^{-1}, amide III at 1250 cm^{-1}. It can be seen a drastically decrease of the area specific for the stretching modes of phosphate and carbonate groups and an increase of the area specific for protein matrix. These modifications are associated with the demineralization process which occurs by application of the etching agent on the enamel surface of teeth. By etching procedure the degree of demineralization is higher than that resulting from bleaching treatments of teeth, as other studies revealed (Vasluianu *et al.*, 2016).

Results reveal that within the sensitivity of the applied method the investigated etching procedure significantly affected dental enamel as compared with the bleaching method using different concentrations of carbamide peroxide (Lührs *et al.*, 2008). On the other hand, studies have demonstrated that enamel surface is significantly affected by orthophosphoric acid, even for a short period of time (Uysal *et al.*, 2010). Enamel is a heterogeneous material and it varies in mineral content, amount of organic matrix and chemical construction.

Another study with the same conclusion was made by Sabatini in 2013. She concluded that an acid-etching step with 37.5% phosphoric acid prior to the application of the self-etch adhesives tested had a significant adverse effect on dentin (Sabatini, 2013).

As it can be seen from the SEM micrographs, in our study the surface of the teeth changed completely after treatment, due to the demineralization of the enamel. The initial surface of the teeth was smooth, containing small defects due to mastication. As the demineralization process occurs, the enamel is destroyed, leaving a rough surface and

revealing the dentine underneath. In the case of the premolar, the demineralization is homogenous whilst the incisor's enamel is heterogeneously demineralized, exhibiting an uneven pattern. It is clear that in both cases the demineralization is severe, as we had expected.

In comparison with the bleaching treatments on the teeth surface where holes and fractures varying in depth and width were observed, the demineralization process by application of orthophosphoric acid is total, the SEM images revealing the characteristic regular structure of dentin (Vasluianu *et al.*, 2016).

For these reasons, the latest researches in the field focused on the obtaining of some high performance adhesive systems (the 7th generation) with the increase of biocompatibility through the elimination of the acid impairment.

Conclusions

The etching treatments with orthophosphoric acid caused structural and morphological changes to the dental surface as SEM and ATR-FTIR methods revealed. Orthophosphoric acid 37% was applied to evaluate its influence on enamel structure. ATR-FTIR spectra revealed that the inorganic and organic components of dental enamel were removed from superficial and deeper enamel layers leading to a severe demineralization.

2.1.4. *In vitro* evaluation of enamel surface treated with fluoride after bleaching and etching erosive processes

Introduction

The investigation of carbamide peroxide bleaching agent showed that surface morphology, structure of the enamel and dentine are affected, causing enamel erosion and lost in inorganic and organic matrix of the tissues (Murariu *et al.*, 2017). The effect of fluoride treatment on enamel structure was seriously investigated, being accepted two concepts: first of one its role on the erosion of enamel, and secondly its role in the inhibition of dental caries (Ghiorghe *et al*., 2013). There are no many studies to analyze the fluoride effect after the bleaching (with carbamide peroxide) and etching (with orthophosphoric acid) treatment of the enamel surface (Kemaloğlu, *et al.*, 2014).

The possibility of remineralizing bleached enamel has been investigated, however, the results are conflicting. The addition of fluoride and calcium in the bleaching agent did not result in higher means of enamel microhardness.In a study by Borgers and others, the authors did not observe any improvement in fluoride uptake in bleached enamel. On the other hand, the use of fluoride following bleaching has been shown to restore microhardness and prevent mineral loss of bleached enamel (Borges *at al.*, 2010).

This study ***aimed*** to evaluate the structural and morphological aspects of fluoride gel application on enamel subjected to 10%, 16% and 35% carbamide peroxide for 90 min and then to 37% orthophosphoric acid solution for 15 seconds.

Material and methods

Experimental part

The material used is from sound maxillary incisors and premolars extraced for orthodontic and periodontal reasons, with a completely preserved structure of enamel. The teeth were disinfected, cleaned and stored in ethanol 35%. Before all experiments the teeth were analyzed by Attenuated Total Reflectance Spectroscopy and Scanning Electronic

Microscopy in order to establish the structural and morphological characteristics. The composition of teeth before and after application of the fluoride gel was evaluated by Energy-Dispersive X-ray Spectroscopy. The commercial fluoride gel (*Fluor Protector*) was applied on enamel surface for 1-2 min. The teeth were left at room temperature for 30 min, and then washed with distilled water, dried in vacuum at 37 ^{o}C and studied by the above mentioned methods.

Measurements

Fourier transform infrared (FTIR) spectra were recorded using a Bruker Vertex 70 FTIR spectrometer equipped with a ZnSe crystal, in ATR (Attenuated Total Reflectance) mode in the range 600-4000 cm^{-1} at room temperature with a resolution of 4 cm^{-1} and accumulation of 32 scans. For both SEM and EDX analyses, all data were collected on a FEI Quanta 200(Eindhoven, the Netherlands) operating at 20 kV in low-vacuum mode for secondary electron imaging. The Quanta 200 SEM was equipped with an EDX system for qualitative and quantitative analyses and elemental mapping. Through EDX analysis, the relative amounts of C, N, O, F, Na, P, Cl, Ca were calculated before and after fluoride gel application.

Results

SEM and EDX analyses

SEM images of the incisors and premolar enamel before bleaching, etching and fluoride treatments showed homogeneous and regular surface, mostly smooth with scattered sediments from mastication, with several defects: irregular scratched pattern or isolated enamel loss (figure12a). After bleaching and etching procedures we found demineralized areas in all teeth enamel, with a rough surface and revealing the dentine underneath (figure 12b). The most severe microstructural changes in teeth enamel were found after the etching treatment using orthophosphoric acid, when a total demineralization was observed (figure 12c). After fluoride gel application one can observe the appearance of some crystals, which are fluoroapatite or fluorohydroxyapatite gradually connect, growing and forming a mineral structure and filling the microscopic defects and pores from demineralization of the enamel surface (figure 12d). The presence of fluoride decreases non-apatite impurities observed initially by stimulation of the crystal growth. In vitro model mimics the conditions of the oral environment for the deciduous teeth enamel, revealing a simple and facile method for remineralization of the enamel structure.

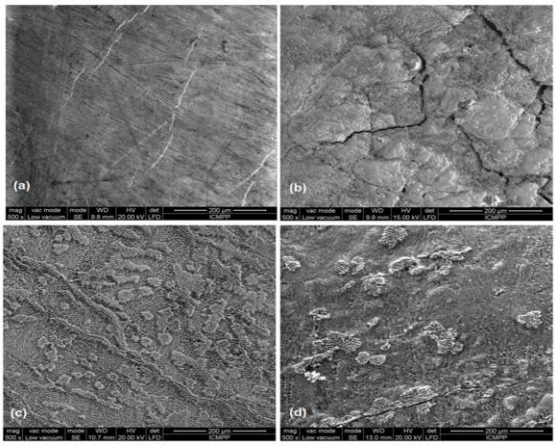


Figure 12. SEM images of incisor:
a. initially, b. after bleaching, c. after etching, d. after fluoride procedures

The same process was observed in the case of premolar enamel (figure 13). The SEM images indicated that the application of fluoride gel significantly protected the enamel and decreased the erosion process when compared to the untreated teeth. The fluoride application reduced the lesions after etching procedure leading to an increasing of mineral density.

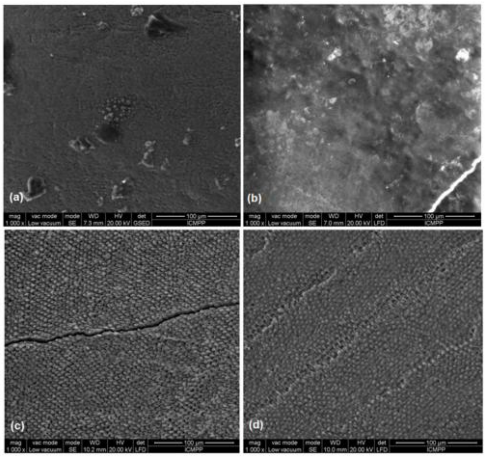


Figure 13. SEM images of premolar:
a. initially, b. after bleaching, c. after etching, d. after fluoride procedures

The higher mineral density observed after fluoride treatment could be assigned to the formation of calcium fluoride adsorbed on the enamel surface and of the role of fluoride anion as an inhibitor for enamel loss. One can observe that fluoride ions occupies the free spaces remained by demineralization with orthophosphoric acid and renders the fluorinated crystals better observed in the figure 12d. Thus, SEM analysis demonstrated the protective role of the fluoride in restoring the enamel structure.

EDX analysis

Energy dispersive spectroscopy (EDX) is a micro-analytical technique conventionally used in scanning electron microscopy (SEM) for the local determination of chemical elements in solid samples.
In our research, we evaluated the mineral change in the enamel structure before and after the etching procedure and fluoride treatment.

According to our EDX analysis one can observe a decrease in cation content by etching process and an increase in anion content, especially the F^- and Cl^-anions (figures 14 and 15). Moreover, increased levels of fluoride after application of fluoride gel indicated the remineralization process. Also, the Ca/P ratios after fluoride treatment are similar with those of untreated teeth proving that calcium phosphate was a greater part of enamel inorganic content, and the fluoride application procedure on the enamel surface contributes to a complete remineralization process.

These findings show that the fluoride treatment significantly protect enamel and prevent the loss of its structural integrity.

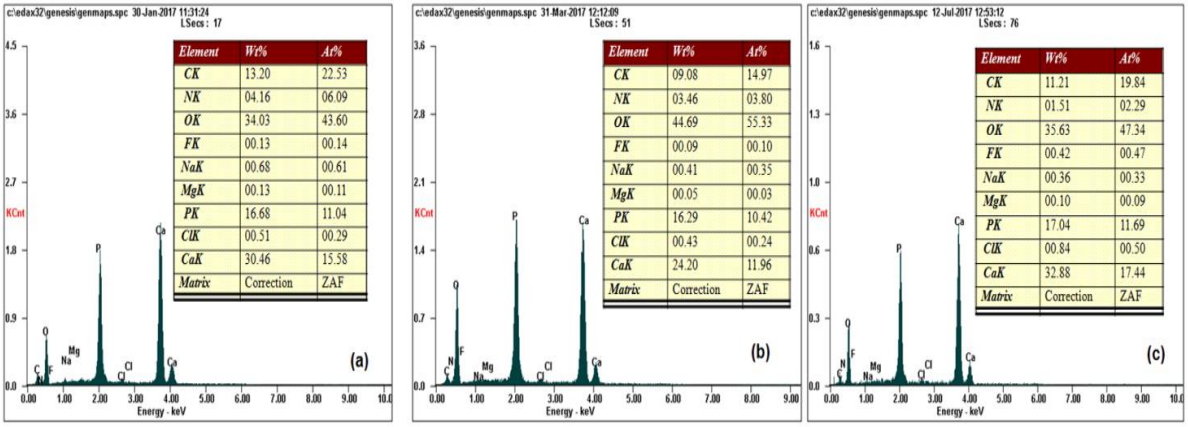


Figure 14. EDX composition of incisor: a. initially, b. after etching, c. after fluoride procedures

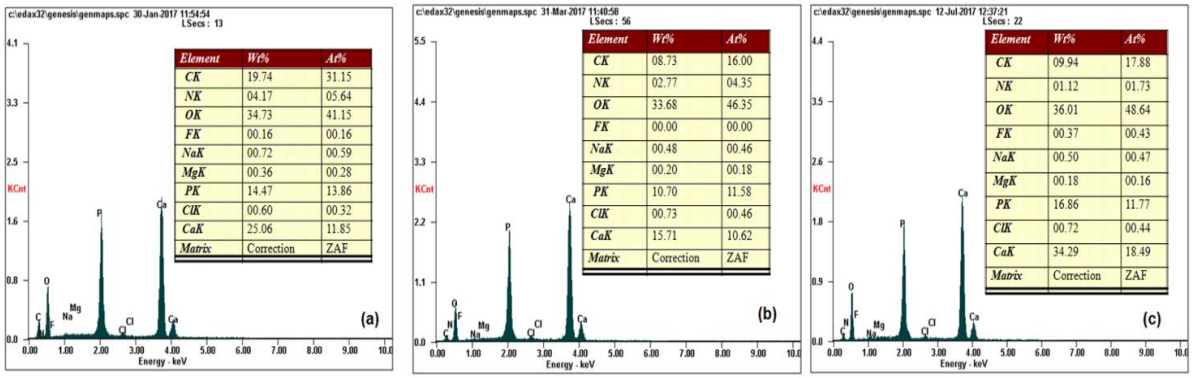


Figure 15. EDX composition of premolar: a. initially, b.after etching, c. after fluoride procedures

ATR-IR spectroscopy

In figure 16 the ATR-IR and the subtracted spectra of the incisors and premolars after etching procedure and after fluoride treatment are shown. It can be seen that the composition of the enamel after the etching procedure characterized by a significant lose of specific bands assigned to inorganic matrix at 600-700 cm^{-1} (PO_4^{3-} tetrahedral), 833-845 cm^{-1} (bending mode of CO_3^{2-}) and 900-1200 cm^{-1} (stretching modes of $PO4^{3-}$) is changed by the presence of the specific bands of fluoride ions. These can be observed at 717-679 cm^{-1} partially overlap with those of PO_4^{3-} anions. Beside these, the IR subtracted spectra revealed a major remineralization process involving the enamel surface. The presence of the specific bands of inorganic carbonates in the structure of enamel at 1581-1485 cm^{-1} and 1340-1298 cm^{-1} in the IR spectra of incisor (figure 16 a, b) and premolar (figure 16 c, d), respectively clear indicates the remineralization process by fluoride treatment.

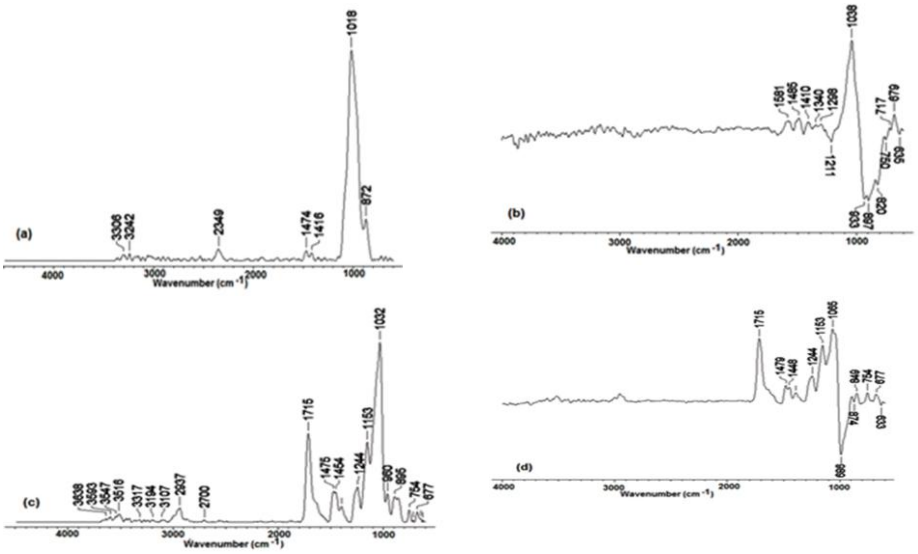


Figure 16. ATR-FTIR spectra:
a. incisor, b. IR subtracted spectra of the incisorafter fluoride treatment and etching procedure, c. premolar, d.IR subtracted spesctra of the premolar after fluoride treatment and etching procedure

Discussions

Effects of bleaching agents on the enamel surface have been a clinical concern as they can lead to dentinal sensitivity, enamel demineralization and surface morphological changes (Lago *et al.*, 2017). Ather studies have shown that enamel alterations are not limited only to the surface and they are also associated with loss of microhardness and strength, inorganic and organic changes (Omar *et al*., 2019).

Some strategies have been proposed to prevent changes in the enamel surface, such as topical fluoride application, phosphoprotein casein and calcium phosphate (CPP-ACP) and, more recently, the use of high power lasers, such as the Nd:YAG laser (Omar *et al*., 2019).

The addition of calcium or fluoride in the composition of whitening materials is an alternative to reduce the adverse effects promoted by peroxides during bleaching.

Although the mechanism of action of fluoride in preventing caries is well known in the literature, its effect on preventing demineralization caused by bleaching agents is still controversial.

Our results of experimental tehniques (SEM and EDX analysis) indicated that after fluoride gel aplication can observed the appearance of some crystals of fluorapatite or fluorhydroxyapatite. The images made by SEM analysis demonstrated the protective role of the fluoride in remineralising the enamel.

More, Sabatini showed that the use of 37% phosphoric acid following bleaching can significantly increase the decalcifying effect of the acid on the enamel surface, creating an uneven etched surface, and this greater susceptibility to the action of the acid persisted for at least 1 week after bleaching (Sabatini, 2013).

In stead, a study made by Giannini evaluating bleached enamel with carbamide peroxide solution followed by fluoride treatment and enamel did not show resistance to demineralization. However, if ions were added during bleaching and ionic exchange, maybe they could be uptaken and increase enamel resistance to demineralization. As both fluoride and calcium ions would increase the saturation of bleaching agent gel, a lower mineral loss

would occur during bleaching. Thus, bleaching gel compositions with addition of fluoride or calcium could reduce or overcome the bleaching adverse effects (Giannini *et al.*, 2006).
Soares demonstrated that even when applied onto remineralized enamel by fluoride, the 16% carbamide peroxide gel was still toxic to the odontoblast-like cells, with no significant difference from the non-fluoride treated enamel (Soares *et al.*, 2013).
According to our results are those of Lago.The authors showed that a reduction of enamel microhardness occurred immediately after bleaching, even with fluoride tratement. Immediately after bleaching, there was a decrease on enamel microhardness. However, after 7 days, some of those specimens previously treated before bleaching significantly recovered their initial microhardness without influencing the esthetic results of bleaching (Lago *et al*, 2016).

Conclusions

The application of fluoride gel after bleaching and etching procedures increased the enamel bond strengths and the remineralization process. SEM images and EDX composition revealed a higher mineral density in the enamel structure. The ATR-IR subtracted spectra highlighted the differences between the enamel composition after demineralization process and fluoride application. Fluoride treatment is effective in preventing enamel erosion/demineralization in enamel surface and improving the remineralization process.

2.2. MODERN APPROACHES IN THE FIELD OF RESIN –BASED DENTAL MATERIALS

State of art

As one of the most common dental filling materials, composites have been widely used in clinical application for nearly 50 years. Their development and evolution are based on acrylate, and their first introduction into dentistry was dated back to the late 1950s and early 1960s. Bowen first reported on amonomer named bisphenol-A diglycidyl methacrylate (bis-GMA;(2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl] propane)) and the successful synthesis of composite by adding inorganic fillers. Composites have been gradually improved in their formulations, properties, esthetics and become increasingly popular in dentistry (Zhou *et al.*, 2019).

In daily practice, composite resins offer special benefits. They allow clinicians to follow a predictable, conservative and safe chair protocol to improve patients' smiles and restore worn or decayed dental structures. Combined with the best adhesive protocols, these procedures can be used successfully to achieve beautiful results (Pratap *et al.*, 2019).

CHARACTERISTICS OF PRESENT COMPOSITES

There are many advantages of adhesive restorations such as the protection of healthy tooth structure, reduced microleakage and prevention of postoperative sensitivity, marginal discolouration and the formation of secondary decay (Cangul and Adiguzel, 2017).
Basically, dental composites are composed of three chemically-different materials: the organic matrix or organic phase; the inorganic matrix, filler or disperse phase; and an organosilane or coupling agent to bond the filler to the organic resin. This agent is a molecule with silane groups at one end (ion bond to SiO_2) and methacrylate groups at the other (covalent bond with the resin) (Hervás-García *et al.*, 2006)
The light cured composite resins used today are composed of an organic matrix, inorganic filler particles and an intermediate linker connecting the two components. In addition to these 3 components, activators which increase polymerisation of the composites to the structure

and colour molecules which form colour compatibility with the dental hard tissues have been added (Cangul and Adiguzel, 2017).
In essence, composite resins consist of a continuous polymeric or resin matrix, in which the inorganic filler is dispersed. The addition of fillers to dental composite resins significantly strengthens their physical properties by increasing the strength and strengthening the matrix, reducing the coefficient of termic expansion. There are many fillers for composite resins. These materials include quartz, alumina, zinc, zirconium, to name a few. Fillers may vary in size, depending on the manufacturing process (Ferracane, 2011).
A classification with proven current validity is the Lutz and Philips classification which is based on the inorganic filling size and amount (table XXXII).

Table XXXII: Classification according to the inorganic filling particle size and percentage (Cangul and Adiguzel, 2017)

Composite resin type	Particle size	Particle percentage
Megafill	50-100 μm	-
Macrofill	10-100 μm	70-80%
Midifill	1-10 μm	70-80%
Minifill	0.1-1 μm	75-85%
Microfill	0.01-0.1 μm	35-60%
Hybrid	0.04-1 μm	75-80%
Nanofill	0.005-0.001 μm	-

Hybrid composite resins are the composites currently used in dentistry (Cangul and Adiguzel 2017).
These composites are so called because they are made up of polymer groups (organic phase) reinforced by an inorganic phase, comprising 60% or more of the total content, composed of glasses of different compositions and sizes, with particle sizes ranging from 0.6 to 1 micrometers, and containing 0,04 micrometer sized colloidal silica.
Composite laboratory resins respond very well as a restorative multifunctional material without a limitation in terms of aesthetics without strain on the financial point of view. This materials are available to clinicians and do not require much effort on the part of either the technician or the dentist. Thus, photopolymerizable composite resins can be a very good indication where the technical conditions of the clinic or the material condition of the patient exclude the use of porcelain.
Flowable composites. These are low-viscosity composite resins, making them more fluid than conventional composite resins.
Their main advantages are: high wettability of the tooth surface, ensuring penetration into every irregularity; ability to form layers of minimum thickness, so improving or eliminating air inclusion or entrapment; high flexibility, so less likely to be displaced in stress concentration areas (cervical wear processes and cavitated dentine areas); radio-opaqueness and availability in different colours (Hervás-García *et al.*, 2006; Cangul and Adiguzel, 2017).

The most important disadvantages of composite resins can be said to be microleakage and postoperative sensitivity which cause low resistance to tensile stress and abrasion and discolouration. The latest developments in restorative composites have focussed on reducing polymerisation shrinkage, increasing the aesthetic appearance and polishability and resistance to wear and breakage and providing colour compatibility (Fugolin and Pfeifer, 2017).
Manufacturers are constantly striving to improve the physical properties and ease of use of these materials. New nanomaterials are welcome supplements to the already refined range of

composite resins available for clinical use.Composites have been gradually improved in their formulations, properties, esthetics and become increasingly popular in dentistry (Cangul and Adiguzel, 2017).

NEW RESINS FOR DENTAL COMPOSITES

A lot of factors contribute the composite failure, such as poor oral hygiene, incorrect design of cavity preparation, imperfect manipulation of the composites, composites materials performance and so forth (Makvandi *et al.,* 2018).

More recently, the focus in resin development has shifted to improving the overall resistance of the restoration to degradation in the oral environment, including the actual hydrolysis of ester bonds present in methacrylates by salivary and bacterial enzymes, as well as by preventing biofilm formation on the surface and interface of composite restorations (Wu *et al*., 2015).

In addition to lower stress generating/high-strength materials, researchers in academics and industry have also focused on developing materials with *bioactive characteristics*. The ideal restorative material of the future will not only be able to withstand occlusal loads and develop low polymerization stress but also be antifouling, antibacterial, and remineralizing, in addition to being biocompatible (Fugolin and Pfeifer, 2017).

Antimicrobial composites

Antimicrobial materials, therefore, have long been sought to either kill the bacteria on contact (bactericidal effect) or prevent bacterial adhesion (antifouling effect), and many strategies have been pursued. Quaternary ammonium methacrylates are being extensively studied and have been introduced in resin composites since they show bactericidal effects and are able to reduce bacterial adhesion (Cheng *et al*., 2015; Zhang *et al*., 2016)

One aspect that cannot be ignored, despite the clear and encouraging evidence to support the use of antimicrobial materials, is the fact that for any agent to be effective in the long term, there needs to be substantial and prolonged activity at the surface, as well as in the bulk of the biofilm layer (Takenaka *et al.,* 2008).

a) Releasing type antibacterial composites

Composites containing releasing antibacterial ingredients can exert a strong antibacterial effect. Research studies on releasing antibacterial ingredients in recent years mainly include fluoride, chlorhexidine, nanosilver, and so forth. However, with the release of antimicrobial agents, the antibacterial effect will reduce gradually, and voids/porosity will appear in the composite which will negatively influence the mechanical properties of the composite.

Calcium fluoride (CaF2) nanoparticles have been incorporated into composite as inorganic fillers. Nano-CaF2 composites can exert long-term releasing of fluoride and calcium ions, which are advantageous to inhibit tooth demineralization, promote mineralization.

The *fluoride ions* not only adjust the balance of mineralization of tooth hard tissues, but also possess bacteriostasis to combat secondary caries (Zhou *et al.,* 2019). Another study demonstrated the application of *chlorhexidine* in dental composite to inhibit both planktonic bacterial growth and biofilm formation (Zhang *et al.* 2014).

Silver nanoparticle-induced oxidative stress, genotoxicity and apoptosis in cultured cells and animal tissues. Composites containing silver nanoparticles which was considered to be a broadspectrum antibacterial agent, exhibited a potent antibacterial activity. Silver nanoparticles will contact with the cell membrane of bacteria and form obvious irregular perforation on the cell membrane, resulting in changes and degradation of themembrane system structure, leading to bacteria death (Zhang *et al.* 2014).

b) Nonreleasing antibacterial composites

Quaternary ammonium compounds have broad-spectrum antimicrobial properties against bacteria, fungi, and viruses. Novel polymerizable quaternary ammonium monomers (QAMs) were synthesized and copolymerized in dental resins to offer nonreleasing and long-lasting antibacterial activity (Makvandi *et al.,* 2018).

Remineralizing Materials

The rationale for the development of remineralizing dental materials is to replenish the lost mineral content from early disease to prevent cavitation of the lesion (Zhang *et al*., 2016). Calcium fluoride, amorphous calcium phosphate, nanohydroxyapatite and nanofluorohydroxyapatite nanoparticles have been widely studied as remineralizing agents, with studies predominantly focusing on repairing relatively small defects (Li *et al.*, 2014).

Nanoparticle characteristics such as surface charge, degree of hydrophobicity, ratio of surface area to biofilm mass, and the ability to adsorb or be collected on the surface of the biofilm can all be tailored (Melo *et al*., 2014).

To overcome demineralization leading to secondary caries, calcium fluoride and nanoparticles of dicalcium phosphate anhydrous have been added into composites. The addition and release of calcium phosphate ions may help remineralize the surrounding dentin to help inhibit secondary caries. These therapeutic composites with calcium and phosphate ions have been shown to effectively remineralize enamel and dentin lesions in vitro (Zhou *et al.,* 2019).

Stress-Reducing Materials

Stress-reducing materials continue to be the focus of investigations due to their utility in preventing gap formation at the tooth-restorative material interface. However, rather than concentrating on shrinkage reduction, most current strategies propose some type of modification to the polymer network that can simultaneously decrease stress and either maintain or enhance mechanical properties and monomer conversion. One example is the development of thiourethane oligomers. When used in highly filled composites, thiourethanes have been shown to reduce polymerization stress by up to 50% (Bacchi and Pfeifer, 2016).

Degradation-Resistant Materials

Methacrylamide monomers have been demonstrated to be more stable in aqueous environments, including acidic conditions. Specifically for dental uses, they have been proposed as monofunctional monomers for adhesives and as multifunctional monomers for composites. Several bisacrylamides have been evaluated as crosslinkers for dental composites with physical properties comparable to methacrylates and greater stability in an aqueous environment. Vinyl ethers have also been shown to be very stable, even after enzymatic challenge, and novel multifunctional monomers have shown mechanical properties comparable to methacrylate controls (Gonzalez-Bonet *et al*., 2015).

Reinforcing and Self-Healing Materials

Self-healing materials are capable of restoring mechanical integrity after damage has occurred. The recovery is not always complete but allows for extension of the materials' survival. Self-healing materials are classified as either intrinsic or extrinsic, according to whether the reparative, highly reactive molecules are produced only when the damage occurs (intrinsic) or if they are somehow stored within the material (extrinsic) (Diesendruck *et al*., 2015).

Several recent studies using microcapsules loaded with different healing agents have demonstrated at least 65% recovery of the virgin fracture toughness with minimal cytotoxicity. In at least 1 study, the self-healing efficacy was kept even after 6 month of water

storage, leading to the conclusion that the specific composition tested was promising for healing cracks, resisting fracture, and increasing the durability and longevity of dental restorations (Wu *et al.,* 2016).
Ideally, directly placed esthetic dental restorations should: withstand occlusal loading, be stable in the harsh oral environment, minimize or prevent stress development and avoid gap formation, prevent biofilm attachment/growth, present remineralizing capabilities, be able to self-repair, and be easy to use.
By any engineering measure, this is a very challenging list of prerequisites. To date, no material commercially available or under development is able to fulfill all of them. Resistance to wear and strength of composites in general have significantly increased over the years, and materials with low stress generation have been developed and commercialized. However, no currently available material has substantial antibacterial, remineralizing, or general bioactive/biomimetic capabilities (Fugolin and Pfeifer, 2017).

In conclusion, there is vast space for further research in terms of appropriate resin material, filler particles and their surface modifications, wear behaviour in varying oral environment and specific functionality of dental materials such as antimicrobial properties, self-heling properties, remineralization properties (Pratap *et al.,* 2019).

Publications of this topic:

1.Alice Murariu, Ciprian Dinu, Doriana Agop Forna, Victorita Stefanescu, Gabi Topor, Norina Consuela Forna, Silvia Fotea, Gabriela Gurău, Cristina Iordache. Composite resins – multifunctional restorative material and practical approaches in dental field, *Materiale Plastice*. 2020; 57 (2): 276-284, FI=1,517.
2. Simona Stoleriu, Sorin Andrian, Irina Nica, Andrei Victor Sandu, Galina Pancu, **Alice Murariu***, Gianina Iovan. Evaluation of adhesive capacity of universal bonding agents used in direct composite resins repair. *Materiale Plastice*. 2017; 54 (3): 574-577, FI=1,248.
3. Catalina Iulia Săveanu, **Alice Murariu***, Onuță Constantin, Oana Dragoș, Loredana Golovcencu. Resin composite sealant with Bis-GMA, *in vitro* and *in vivo* study. *Materiale Plastice*.2018; 55 (4): 669-671, FI=1,393.

2.2.1. Composite Resins – multifunctional restorative material and practical approaches in dental field

Introduction

Resin composite materials are considered the first choice for direct restorations in anterior and posterior teeth, mainly due to their aesthetic appearance, conservative preparations, low cost, and satisfactory clinical behavior.
In prosthodontic treatment with resin composite materials is used for dentures. Denture base resins are extensively used in dentistry for a variety of purposes. Their applications include use during denture base construction, relining existing dentures, and for fabrication of orthodontic removable appliances (Rashid *et al.,* 2015).
Mechanical and other physical properties of resin composite might influence the restoration longevity and the stress generated due to volumetric polymerization shrinkage and shrinkage-induced stress of these materials remains an actual concern, whereas the

inadequate integrity of the restoration-tooth margins, cracks, and postoperative sensitive are consequences of polymerization shrinkage stress (Tribst *et al.*, 2017).
For direct compsite restorations, especially for posterior teeth, the biomechanical characteristics of composite resins and conservative preparation of tooth structure are among the most important advantages of composite resins in dental treatments (Tabatabaei *et al*., 2016).
The biomechanical study of the dental resins, implying different technologies, is necessary to understand the causes of the prosthetic failures. These failures are given not only by the material defects, which appear in all dentures-dependent on the material structure (with or without the presence of reinforcing filler); they can also appear follow-up the technological procedures for achievment of the prosthetic pieces, their processing and solubility (Bortun *et al.*, 2012).

The ***aim*** of this study is to analyze the biomechanical behavior of four types of composite resins, two of them used in direct restorations and the other two for prosthetic restorations created in the lab.

Material and methods

The deformations, hardness and elasticity were analyzed under the same conditions, namely at 200 Mpa, as these are very important parameters for the biomechanical behavior of the analyzed biomaterials, the specificity elements being correlated with the biomaterial structure, polymerization time and polymerization modality (Ilie *et al.*, 2017).

In the category of composites used for direct crown restoration, the materials under analysis were represented by Gradia anterior (GC), a hybrid composite material designed for esthetic restorations, prevalent in the anterior area and by Gradia posterior (GC), a hybrid resin composite with micro-filling for posterior crown restorations.

From the category of lab composites we selected Gradia Plus (GC), a photopolymerizable micro-ceramic composite, whose internal structure consists in improved bonds between the organic-inorganic filling and the resin matrix and the Solidex composite(Shofu), a micro-hybrid photo composite with a filling of over 53% of ceramic particles.4 test samples were created using the analyzed materials, with the same dimensions (250x25x5 mm), being subject to traction forces on the universal testing machine (Textenser). Polymerization of cabinet composites *(Gradia anterior, Gradia posterior*) was made with a Woodpecker LED.B Photopolymerization lamp**,** Voltage: 110-240V, AC, 50-60Hz, wavelength: 420-480nm and luminous power: 1000-max 1200 mW/cm2 and the working time was 20s. The polymerization of laboratory composites was achieved at 90s with the means of the polymerization oven (Laborlux 3), with following characteristics 310-500nm, 300W.
The operation regime of the Textenser universal trial machine for variable forces was determined through the 27 (FATIGUE) switch in ON position (when it is in OFF position, the machine only executes trials at unique traction). Lamp 28, located under switch 27, is lit when the switch is moved to ON.

The cycle counter 29 needs to be set so that the indication of the cycle limit number (30.a) exceeds the indication of the performed cycles number (30.b), which is usually brought to zero by pressing the black button near the lower window (performed cycle counter). During the trials, in the lower counter the number of performed cycles is summed up and the upper counter shows the number of cycles to be performed. The strain limits (movement of the mobile beam) were chosen with an accuracy of 0.1 mm with the device 24, (marked with *STRAIN LIMIT*): low value (*LOW*) and high value (*HIGH*) were chosen by rotating the

selectors. As a synthesis of the biomechanical behavior outcome related to the used resins versus the resins used in the lab of dental technique using indirect means, a relatively wide range of higher value parameters stands out with regard to resistance for the lab composites compared to those used in direct restorations (table XXXIII).

Table XXXIII. Physical properties of composite resins for the clinic compared to laboratory ones

	LABORATORY	CLINICAL
Voltage resistance(N / mm $^{2)}$	80-120	70-80
Deformation at 200MPa	3.5-4.5	8-9
Hardness N / mm ^{2}	500-600	360-410
Elastic modulus N / mm ^{2}	7000-10000	4000-5500

Results

Regarding the stress resistance, the superiority of Gradia Plus lab composite stands out, followed by Solidex, with a much lower stress resistance for the composites used in the direct restorations, a better resistance being displayed by the Gradia composite for the posterior area and the Gradia composite for the anterior area. A deformation risk was recorded for the composites used for direct restorations, a higher risk in case of Gradia composite used for esthetic restorations, followed by gradia posterior, whose higher hardness recommends it in the areas of greater masticatory forces (figure 17, figure 18).

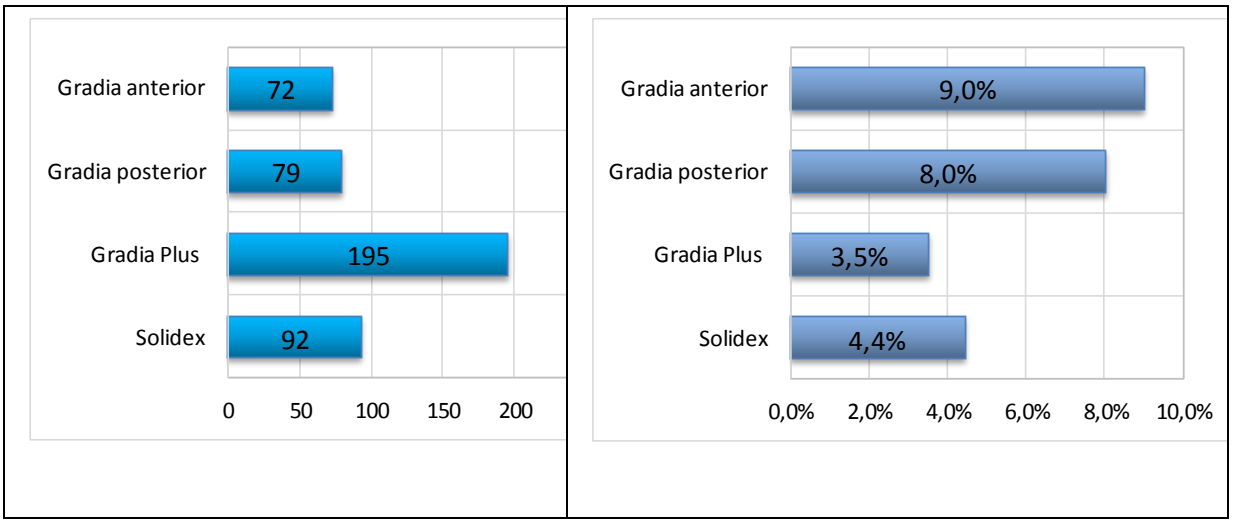


Figure 17, Figure 18. Aspect of resistence risk and stress resistence at analysed materials

Very good deformation resistance was obtained for lab composites, the first place being taken by Gradia Plus, which through the chemical bonds established between the organic-inorganic filling and the resin matrix reached a hardness of 9.9350, the following position in terms of hardness being taken by Solidex, and for the lab composites higher values were recorded, 598 for Gradia plus and 512 for Solidex, while for the direct restoration composites, the elasticity module reached was 398 for Gradia posterior and 368 for Gradia anterior, a property that influences their selection in relation to the particularity of the clinical case (figure19, figure 20).

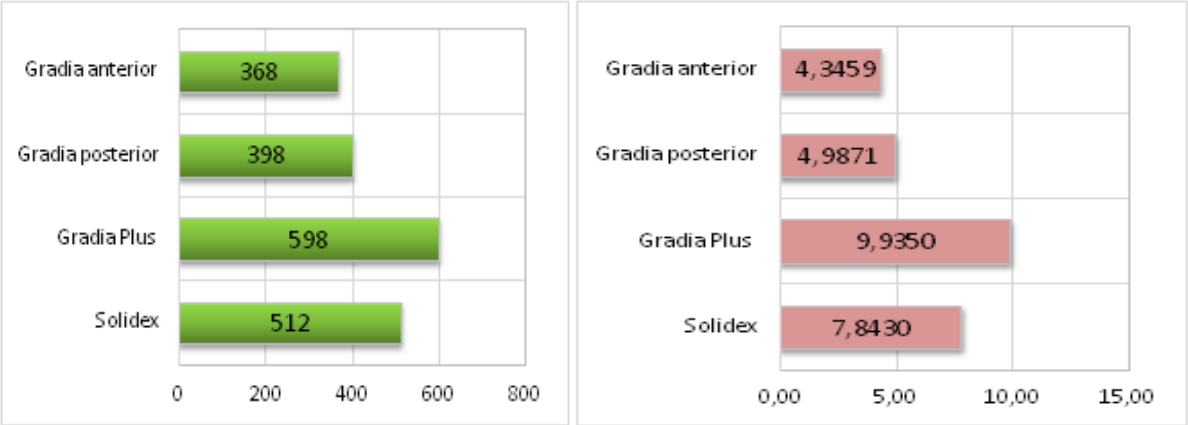


Figure 19, Figure 20. Aspect of hardness and elasticity moduls at biomaterials analysed

In order to try and to give strength and polishability both in a single composite, manufacteres have introduced resin composite hybrid with smaller particles, the size of the average of the particles at about 0.02 μm to 1 μm. This allows the clinician to deploy a single restoring material, with all the properties of mechanical and physical improvement of the prior resins. The major disadvantage of these types of composites is in need of maintaining the gloss. The gloss is satisfactory at first, but tends to be lost over time (table XXXIV).

Table XXXIV. Comparison between the clinical problems raised by the composite resins used in the clinic and those used in the laboratory

CLINICAL	LABORATORY
Contraction during polymerization leads to open contacts. The risk of porosity leads to gaps in the material.	The laboratory ensures dimensional stability and eliminates any porosity.
The variable rate of wear leads to restrictions on the application in the posterior area of the oral cavity.	The surfaces have a hardness with a wear rate compatible with that of the substance of the natural tooth.
The micro-sites created around the edges of the recovery lead to problems such as soft deposits, secondary caries and adverse pulp response.	Significant reduction of micro-places.
Polymerization can cause stress.	Minimal reactions only if bonding is used.
Load particles can generate rough surfaces (not when using microfilament resins).	The homogeneity of the microphilic structure does not allow obtaining such an effect.
Difficulties in creating morphology with the free hand.	Any required design will be manufactured in the laboratory and returned ready for fixing.
The change in color during polymerization causes difficulties in choosing the shade.	The laboratory has materials that ensure color stability. Subsequent modifications can be made if another shade is obtained. They can be easily re-polished in the oral cavity and can be repaired just as easily with composite resins used in the clinic.

Discussions

Compared with the acrylates these composite resins are much more resistant to wear during a good color stabilization assured by the acrylate. It is also worth noting the high degree of polishing that can be used clinically. These materials can be repolished after their period of alteration and used again with the same glow which is a very important technical detail for clinicians and patient. Another important aspect is the one that most clinicians seem to accept, namely that these glossy surfaces are accepted by the gingival tissues with a minimal inflammatory response. Composite resins have a wear rate very close to that of natural teeth. This aspect of the problem puts them in a favorable light in terms of clinical use. Many researchers made are aimed to calculating the resistance of their composite photo polimerizable in time (Mangani *et al*., 2007). The study also stopped comparatively on the different types of light - curable composite resins.

Thus, a study conducted by David James, following for a period of 3 years a composite resin for laboratory use, was followed by another study carried out by Mitchen on several composite resins for clinical use over a period of more than 5 years. A clinical study conducted by Bishop over a period of over 4 years showed that using laboratory composite resins, 91 clinically satisfactory inlays were obtained from 92 follow-up inlays. The only unsatisfactory inlay was the first one made, which leads to the idea that it could be an error due to lack of experience. Another study, conducted this time by the University of Alabama, reveals its strength in time of the crowns of the shell/coating made of this material. The results demonstrate an average annual wear of 7 μm /year. This value approaches the laboratory composite resins abrasion to that of the structure of the natural tooth. It worth remember the fact that the rate of abrasion decreased during the study, that can make us to believe that timefor use of this material in the oral cavity may be extended. Comparison of a number of other materials and laboratory resins makes us realize the clinical importance of them (de Munck *et al*., 2005).

The composite resin is one of the most versatile dental materials and when it is used correctly, with peculiar attention, can provide restorations comparable with ceramics. The appropriate usage often requires a further training further to get a level of master skill. When used in appropriatsituations, these materials have to last many years, the strength and maintenance of gloss being a significant gain. The ability to be minimally invasive and to preserve the structure of the tooth is another significant benefit. Composite resins are used in a regular manner to restore cavities, closing spaces, lengthening teeth, covering dark teeth or colored and for tooth fracture (Raj, 2007; Ilie *et al*., 2017). Selecting thetype of material suitable for certain clinicalsituations, such as mentioned above, it is a matter open to debate. Hybrid and microfilled composites are often used in combination to achieve a restorative result that provides optimal physical and mechanical properties. The hybrid material provides strength and opacity, and the microfill provides the ultimate shine and shine durability. This incremental layering technique with composite resins leads to an optimal polymerization depth, with the reduction of shrinkage effects or stress forces during the polymerization. In addition, the polychromatic effect can be observed when layering different restorative components with various refractory indices, different shades and opacities. By using anatomical layering by successfully overlapping the dentin, enamel and incisal composite, a more realistic color can be obtained, similar to the surface and optical characteristics that mimic nature.

Laboratory composite resins offer two distinct advantages that can reduce the risk of periodontal reactions. Second, the edge of the work should be extended subgingivally where the dental structure is deficient. Coronary restorations of this type appear to be associated with excellent tolerance on the part of the gingival tissues.Depending on the qualities of the

composite resins produced, each manufacturer gives certain indications that he considers valid. Taking into account both the multitude of producers and the variety of types of composite resins, it is very difficult to give general indications of this type of biomaterials. However, some of the basic indications of these materials could be: inlays, onlays; shell crowns; bridges; vestibular facets; restorations following endodontic treatments; There are no specific contraindications to this type of material.

Conclusions

Composite resins offer a conservative and cost effective solution for much clinical situ ations. The use of laboratory composite resins appears as a natural necessity in joint prostheses. This conclusion is based on the increase in the level of aesthetic demand from patients from all walks of life.Light-curable composite resins are a very good solution in the case of aesthetic restorations, where for various reasons; the use of porcelain is not indicated.

2.2.2. Evaluation of adhesive capacity of universal bonding agents used in direct composite resins repair

Introduction

Oral cavity is a complex environment, were restorative materials are exposed to various challenges and prone to degradation. Erosion, abrasion, termal variation, acidic attacks, salivary enzymes and hydrolysis are some of the factors implicated in composite resin failure. Clinical studies claimed that the composite resin failure varied between 5 and 45% over a period of 5–17 years (Altinci *et al.*, 2018). Generally, two different procedures are used in dental office for failed restoration treatment: repair or replacement. Unfortunately total replacement of the restoration lead most of the time to excessive removal of sound enamel and dentine, bigger cavity preparation, pulp harm and weaker remaining tooth structure (Gordan *et al*., 2012; Özcan and Koc-Dundar, 2014). Partial replacement of the restoration or the repair has the advantages of being minimally invasive, less time consuming and increasing the longevity of the restoration. The bond between the existing composite resin and the new one used for repair represent a major issue (Shahdad and Kennedy, 2008).

Universal or multi-mode bonding agents are the newest type of dental adhesives which consist in a mixture of etching agent, primer and bonding agent in the same bottle. The producers claimed that they can be applied either in etch-and-rinse and in self-etch procedure. The *aims* of present study were to characterise the resin-resin interface when a universal bonding agent was used in two different strategies in direct composite repair and to evaluate the bonding interface by microleakage assessment.

Material and method

1. Composite resin specimen preparation and aging

Two different composite resins were used in this study: a micro-filled hybrid (Zmack, Zhermack Sp.A, Germany) (MH) and a nano-filled hybrid (Premise, Kerr Co) (NH). Data regarding the chemical characteristics (matrix type, filler type and filler content) are presented in table XXXV.

Table XXXV. Chemical characteristics of composite resins

Product	Filler type	Filler content in weight	Filler content in volume	Matrix type
Z-mack	Barium glass, silica	77%	57%	Bis-GMA, Bis-EMA TEGDMA
Premise	Barium alumino borosilicate glass, silica, PPF, barium glass	84%	69%	Bis-GMA Bis-EMA TEGDMA

From each material forty specimens were obtained by placing the composite resin into the moulds having an intern diameter of 5 mm and a height of 6 mm. The materials were applied in two layers using incremental technique. Each layer of 1.5 mm has being polymerized for 40 seconds using a LED unit (LED B, Guilin Woodpwcker Medical Instrument Co., Ltd, China). The moulds were placed in direct contact with a translucent Mylar strip, on a glass slab to flatten the surface and to prevent the formation of the oxygen inhibited layer. Half specimens of each material were used to obtain control samples and the other half was aged by storing in artificial saliva (AFNOR NF S90-701) for four months.

2. Simulation of repair procedure and preparation of the samples

In order to simulate the repair procedure, the same micro-filled hybrid composite resin used for specimens preparation (Z-mack, Zermack Sp.A.) was placed in direct contact with the non-aged and aged NH and MH composite resin specimens. As an intermediate layer, a universal bonding agent (G Premio Bond, GC Corporation) (UBA) was applied between the composite resins used in dental repair in two different strategies: etch-and-rinse (strategy 1), and self-etch (strategy 2). The protocol of samples distribution in groups and groups setup are listed in table XXXVI.

Table XXXVI. Control and study groups setup

Group	**Initial composite resin**				**UBA**		**Composite resin for repair**
	non-aged MH	aged MH	non-aged NH	aged NH	strategy 1	strategy 2	MH
1	X					X-	X
2	X				X-		X
3		X			-	X-	X
4		X			X		X
5			X			X	X
6			X		X		X
7				X		X	X
8				X	X		X

In etch-and-rinse strategy, the surface of the resin specimens were etched using 35% phosphoric acid gel (3M-ESPE, St. Paul, MN, USA) for 30 seconds, then removed with water and gently dry using the dental unit air spray. The application of UBA followed the producer instructions: scrubbing the sample surface for 20 second, gently air drying for 5 seconds and lightcure for 20 seconds. In self-etch strategy the same steps were followed, except the

etchant application.The repair composite was applied in two increments of 1.5 mm each. In order to identify the two different materials used in restoration repair, different shades were chosen for composite resins.
The samples considered as control (groups 1, 2, 5, 6) were removed from the moulds.
The samples included in the study groups (3, 4, 7, 8) were immersed in artificial saliva for 2 months and then removed from the moulds.

3. Microleakage evaluation by dye penetration and interface characterisation using SEM evaluation

The extern surfaces of the samples were coated with two layers of water resistant nail varnish, except a 10 mm x5 mm surface. The samples were immersed in 2% methylene blue buffered dye solution (pH=7) for 4 hours. Then the samples were transversely sectioned using diamond discs (Komet Dental, Brasseler GmbH&Co, Germany) at low speed, under cooling water. The sample sections were examined using an optical microscope (Carl-Zeiss AXIO Imager A1m) at 50x magnification. The dye penetration was evaluated according to four scores: 0- no dye penetration, 1- dye penetration less than a quarter of the interface, 2- dye penetration more than a quarter, but less than a half of the interface, 3- dye penetration more than a half, but less than a three quarter of the interface, 4-complete dye penetration of the interface (Table XXXV). The characterisation of the repaired composite resins interface was performed on the images recorded using a scanning electron microscope (VEGA II LSH, Czech Republic). The morphology of UBA layer and the micro-gaps formation between UBA and composite resins were evaluated at 500 x magnification.

Results

SEM aspects of some samples included in groups 1-8 are showed in figure 21. In groups 1, 2, 5 and 6 a very tight adaptation of the two composite resins placed in contact was observed. There were no gaps or defects at resin-resin interface. In groups 3, 4, 7 and 8 a slightly enlargement of the resin-resin junction was recorded and in some samples little gaps and defects were visible (Fig.21-groups 3, 7).
Optical images of the resin-resin junction and examples of dye penetration scored as 0 and 1 in groups1-8 are presented in figure 22.
The scores for dye penetration recorded for the samples in all the groups and the mean score values are presented in table XXXVII.
In groups 1, 2, 5 and 6 all the samples were scored as 0 for dye penetration. Higher scores were registered in groups 3, 4, 7 and 8 when compare to 1, 2, 5 and 6. The lower mean value of dye penetration was recorded in group 3 and the highest in group 8.

Table XXXVII. Dye penetration scores in control and study groups

Group	No of samples					Mean score value
	score 0	score 1	score 2	score 3	score 4	
1	10	-	-	-	-	0
2	10	-	-	-	-	0
3	2	4	3-	1	-	1.3
4	1	5	3	1	-	1.4
5	10	-	-	-	-	0
6	10	-	-	-	-	0
7	1	4	4	1	-	1.5
8	1	3	4	2	-	1.7

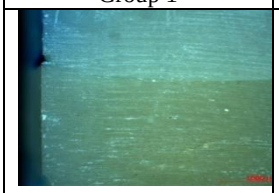
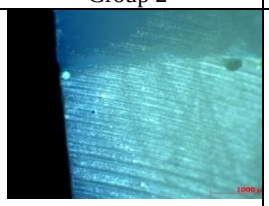
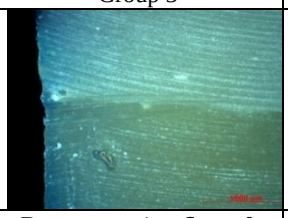
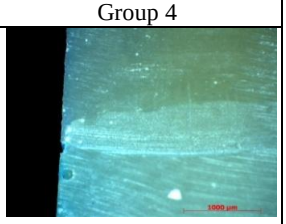
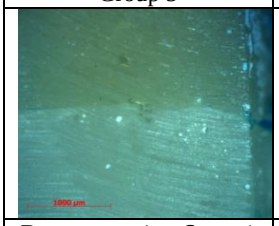
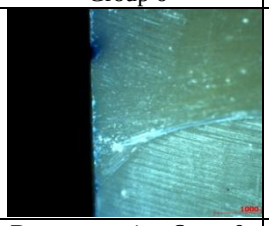
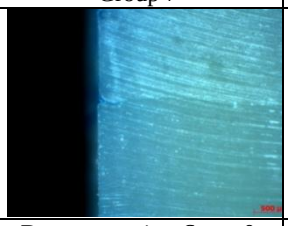
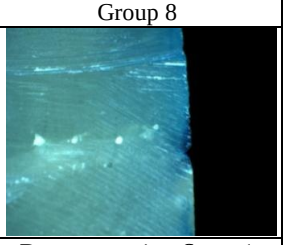
Group 1	Group 2	Group 3	Group 4
			
Dye penetration-Score 0	Dye penetration-Score 0	Dye penetration-Score 0	Dye penetration-Score 0
Group 5	Group 6	Group 7	Group 8
			
Dye penetration-Score 1	Dye penetration-Score 0	Dye penetration-Score 0	Dye penetration-Score 1

Figure 21. Cross sections of the adhesive joint created using the universal bonding system

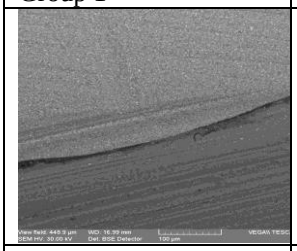
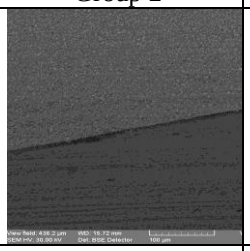
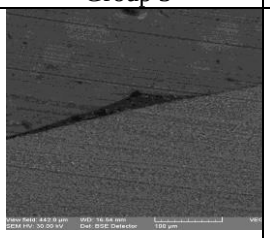
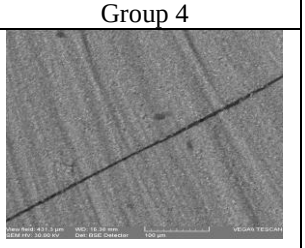
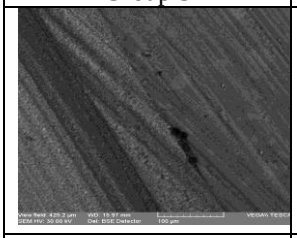
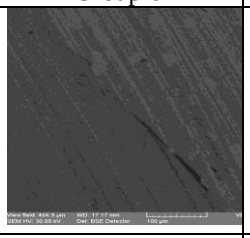
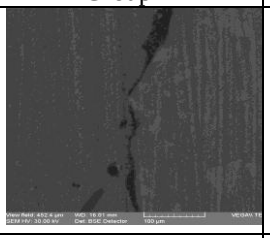
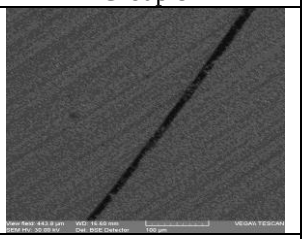
Group 1	Group 2	Group 3	Group 4
			
SEM X 500	SEM X 500	SEM X 500	SEM X 500
Group 5	Group 6	Group 7	Group 8
			
SEM X 500	SEM X 500	SEM X 500	SEM X 500

Figure 22. Aspects of dye penetration at the resin-resin interface in control and study groups

Discussions

The degradation of composite resins in oral cavity might be due to fatigue, enzymatic activity, chemical agents, termal variation, wear, hydrolytic action (Cavalcanti *et al.*, 2007). Restoration failure is often a result of the degradation process which leads to microleakage, discoloration, marginal ditching, delamination or fracture. In case of failed restoration there are two different clinical approaches: repair or replacement. In repair procedure a freshly new material is placed in direct contact with an old material, aged and mostly unknown. In our study using the same material for repair as it was applied before leaded to better results regarding the microleakage when compared to the use of dissimilar composite resins in repair procedure.

Generally, the adhesion between two composite layers is obtained by oxygen-inhibited layer of unpolymerized resin due to covalent bonds formation. After polymerization, 40–50% of the unreactive methacrylate groups is present and lead to the adhesion of a new composite layer. In time the percent of these groups decrease and the bonding potential become lower. This can be the explanation the lower microleakage registered in control groups when compare to study groups.

Different methods of surface treatment were recommended during time in order to improve the resin-resin adhesion. For both similar and dissimilar combination of composite resins, using universal adhesive system in etch-and-rinse strategy showed lower microleakage when compared to self-etch strategy. This finding is in contrast with the results of previous studies which demonstrated that the use of phosphoric acid in etch-and-rinse bonding systems, did not leaded to significantly improved effect on repair bonding (Papacchini *et al.*, 2007).

In the present study saliva storage was chosen as aging regimen. Water storage simulates aging by water uptake and the level of water-sorbtion of composite resins is correlated to matrix type (Özcan *et.al*, 2005). After a specific point it is expected the saturation to appear. In our study both types of composite resins that were aged presented increased microleakage at the interface with the resin used for repair when compared to non-aged specimens.

Conclusions

Universal bonding agent used in direct composite resins repair showed a very good adaptation to non-aged micro-filled hybrid and nano-filled hybrid composite resins. Aging by saliva storage of repaired composite resins leaded to an enlargement of resin-resin junction and a increased microleakage irrespective of the strategy (etch-and-rinse or self -etch) used for bonding agent application. Etch-and-rinse strategy for universal bonging agent application determined a better interface bonding when compared to self –etch strategy.

2.2.3. Resin composite sealant with Bis-GMA, in vitro and in vivo study

Introduction

Dental caries prevention is a desideratum that belongs to both dentists and patients and is represented by a complex of methods including, in addition to general or local fluoridation, buccal dental hygiene and diet hygiene, dental sealing. Sealing is a method of immunising dental hard surfaces with increased reliefs in patients with high carious risk. The primary objective of the seal is to close the coronary retention shields to newly erupted teeth to prevent the bacterial plate stagnation areas from turning into ecological niches of caries, favoring the cleaning and

self-cleaning of retaining surfaces. Selection of sealant material is dependent on the patient's age, child's behavior, and the time of teeth eruption (Naaman *et al*., 2017). Dental sealants reduce the incidence of caries after some studies by 76% on sound occlusal surfaces, compared to the non-use of sealants during the two to three year follow-up period (Jumanca *et al.*, 2016). As a result of these the aim of the study, we have been investigating the in vitro structure and in vivo retention of sealings made with a composite resin sealant: DEFENSE CHROMA (ANGELUS®, Brasil).

The ***aims*** of this study are assessing the degree of oro-dental hygiene by analyzing the Oral Health Index (OHI), caries risk assessment; the assessment of Index of orthodontic treatment need (IOTN) and seal integrity assessment 6 months after application.

Material and method

A composite resin sealing material was used in the study: DEFENSE CHROMA (ANGELUS®, Brasil). The reasons for selection of this material were based on the properties of its composition and results obtained in the in vitro pre-study, namely: the degree of surface roughness assessed by AFM analysis, material shade: thermochromic sealant, changing color to temperatures lower than 37 degrees C (favoring clinical evaluation of sealant presence), fluoride content, filling degree - 50%, showing wear resistance.
A number of 17 patients were selected for 80 seals and then we evaluated the retention of preventive sealing material over time, 6 months after application.
The *criteria* for selecting the observation sheets were as follows: clinical data on odontal status - permanent molars I and II, without cavitary carious processes; patients evaluated within 6 months of application of the sealant to the occlusal surface of the permanent receiving molars. The parameters selected from the clinical exam were as follows: the patient's caries risk; OHI index; IOTN index; absence of carious lesions at first and second permanent molars; the initial sealing requirement; the presence / absence of the sealant at the evaluation made 6 months after the maneuver.
Evaluation of the sealants: is very important in the correct identification of the sealant and the diagnosis of the caries / in the incipient carious lesions. It is recommended to use a transparent sealing material to allow for the visualization of possible changes), the area covered by the sealant (because it indicates the degree of efficiency of the sealant) of the carious lesions on the tooth surface.
The database was made using the software package for Windows, version PSS 16.0. Tooth sealing was performed according to the sealing protocol indicated by the manufacturer. After sealing, the patient reassessment was done every 6 months according to the CCS-SES System (Color Coverage Caries - System Evaluation Sealants).

Results

Concerning the caries risk of the selected patients, the highest percentage is given by an increased caries risk of 76.47%; the same frequency of caries for the patients with small and medium risk with 11.76%. Bi-dimensional and three-dimensional analysis by AFM highlights a homogeneous structure with no structural retaining areas of the material (figure 23, 24).

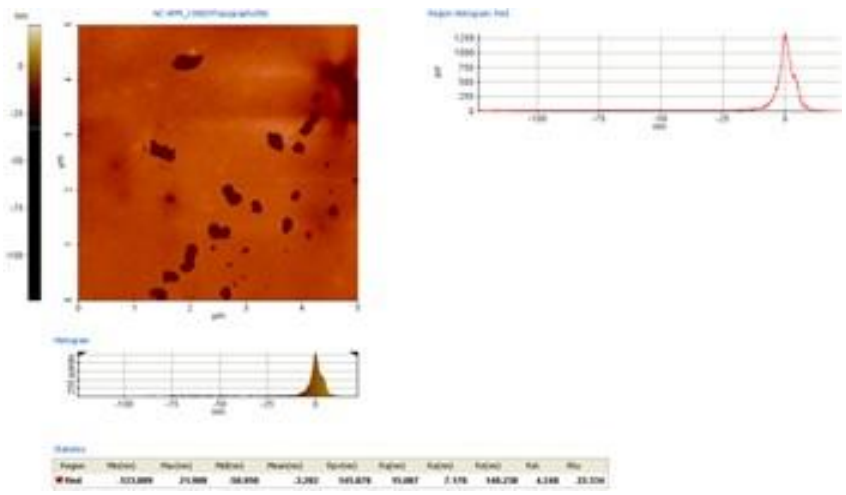


Figure 23. Imagine 2D (XEI-Image Processing and Analysis software) AFM - 5µm analysis of a composite resin sample - DEFENSE CHROMA (ANGELUS®, Br)

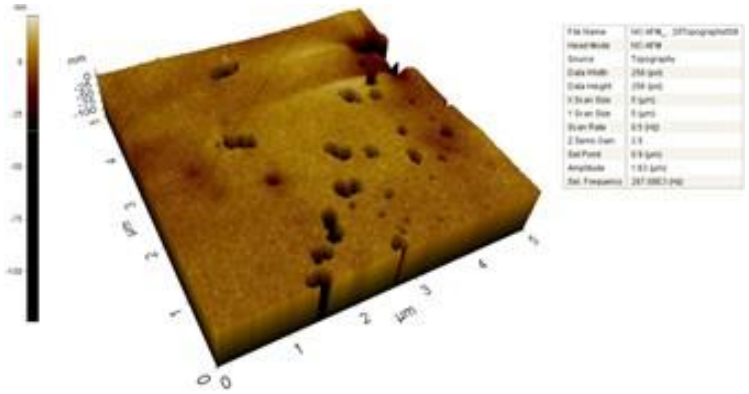


Figure 24. Imagine 3D (XEI-Image Processing and Analysis software) AFM - 5 µm - analysis of a composite resin sample - DEFENSE CHROMA (ANGELUS®, Brasil)

Discussions

OHI oral hygiene index is made up of the following percentages: 5.88% of subjects have a proper hygiene (OHI-0), 29.41% have a mean oral hygiene (OHI-1), 64.71% of subjects have improper oral hygiene (OHI-2). Although the IOTN (Index of Orthodontic Treatment Need) index may interfere with good retention of the sealing material, and sealing is contraindicated in patients with occlusive disorders present in patients with dento-maxillary abnormalities, these have been performed to minimize RC patients.

The calculated percentages are as follows: 11.76% of patients show normal oclusion with IOTN=0, 23.53% of patients have minor changes in IOTN=1, for 35.29% of patients have changes in oclusion reports of up to 2 mm with IOTN= 2, and 5.88% of patients show changes in oclusion reports up to 4 mm with IOTN=3, 23.53% of subjects have an IOTN=4 -

changes in oclusion reports greater than 4 mm.

In the clinical examination of patients after 6 months of application of the sealant, sealing of the sealant in the permanent molars I was as follows: 92.65% (63) of the seals performed had a 100% sealing material retention and 7.35% (5) of the seals performed a 50% - 100%. In the case of second permanent molars, the retention of sealing material is 100% 6 months after application. Of the total number of seals made with DEFENSE CHROMA composite resin based on the clinical examination of patients 6 months after application, the retention of sealant from permanent molars I and II was as follows; 94% (75) of the total seals performed had a 100% sealing capacity and 6% (5) of the total seals performed had a retention of sealing material between 50% and 100%.

In this *in vivo* clinical study, sealing was performed with DEFENSE CHROMA (ANGELUS®, Brasil) composite resin sealing material on retention 6 months after application. The selection of the material was based on the sealant characteristics exhibited by the manufacturer and on the results of the in vitro in vitro study, where the characteristics of 4 composite resin based sealants used in dental practice were evaluated: Fissurit® FX (VOCO, Germany) - without filler; DEFENSE CHROMA (ANGELUS®, Brasil) - 50% filler; WAVE (SDI, Australia) - 63% nanofilles; PermaFlo ™ (Ultradent, USA) - 68% nanofiller.

The analysis of the roughness of the material as well as its complication in the enamel substructure were analyzed by AFM and SEM images. According to other studies, preparation of the tooth surface is not necessary for our study by making only a seal application according to the protocol (Dhar and Chen, 2012). Although the nanotechnology in dentistry is developing very fast (Kanuga, 2014) the toxicity of Bis-GMA material is questionable, being studies that agree and disagree with this (Maserejian *et al.*, 2016). It is known that the viscosity of the composite materials is influenced by the percentage of inorganic particles contained therein. The filler particles increase the wear resistance of the material, reduce the coefficient of contraction of the socket and the linear thermal expansion and ensure the physionomic appearance. The nuances of composite resins influence polymerization but also clinical evaluation after application. A darker / opaque shade will result in a diminution of light beam penetration and cohesiveness of the material, inhibiting polymerization in deep layers, persistence of unreacted monomer, and impairment of mechanical properties. Also, the darker/opaque shades do not allow the surface to be evaluated under seal (Santini *et al.*, 2012). Therefore, by analyzing these characteristics DEFENSE CHROMA (ANGELUS®, Brasil) proved to be the best option by summing up the characteristics: satisfactory degree of roughness, low percolation degree, thermochromatic character - translucent at the temperature of the oral and bluish cavities at lower temperatures, content of 50% inorganic charge and fluorine content. Seals partially present at the 6-month evaluation were recorded in the 5 patients with IOTN of 4, which could suggest an interference with sealing material adhesion. Simonsen evaluated the retention rate according with other studies into intact sealant, partial loss, and complete loss (Simonsen, 2011). However, Mickenautsch and Yengopal do not support the use of sealant retention as a valid predictor for caries manifestation (Mickenautsch and Syengopal, 2013). Other factors that could have contributed to the partial loss of the sealant are linked to the sealing protocol, eg salivary enamel etching, incorrect application of the material, or overfilled of premature contacts. Adequate moisture isolation is the most critical step in sealant application and the etching also. The results of this study were optimal at the 6-month evaluation, with 94% seals being present at a rate of 100%. However, the evaluation period was only 6 months to follow up the results of the six-monthly 6-month evaluations to allow us to express our long-term efficacy.

These results may be comparable to the results of other studies (Muntean *et al.*, 2016). Other study which evaluated the retention of resin-based filled sealant is higher than resin-based unfilled sealant at the 12-month follow-up but the difference was notstatistically significant (Reddy *et al.*, 2015).

Conclusions

Dental seals showed a 100% retention for 94% of seals proven to be effective in the primary prevention of dental caries. Although 50% of the inorganic particulate matter has been sealed with sealant resistance, the sealant being lost only partially between 50% -100% for 6% of the seals, increased attention should be paid to removing existing premature contacts which may interfere with retention and finally the success of seals.Composite resin materials differ in composition and characteristics. Assessment of their characteristics, before choosing a sealant and careful observation of the instructions and application steps, improve the final seal.

SECTION II

FUTURE PLANS OF DEVELOPMENT ON SCIENTIFIC AND ACADEMIC CAREER

The strategy I am considering for the future is focused on the permanent connection between the didactic and research activities through the provision of some competitive educational and scientific offer at national and European level.

II.1. FUTURE DIRECTIONS IN RESEARCH ACTIVITY

I will continue to stay involved into the research activity relating to Community Dentistry field while following both the issues detailed in my doctoral thesis and the new ones.
The research will rely on team work through collaborations and projects with national and international institutions on research topics that may involve the future PhD candidates. The following topics will represent research domains specific to Community Dentistry carefully selected to answer the current exactness requirements of the Doctoral School within "Grigore T. Popa" University of Medicine and Pharmacy of Iasi.

II.1.1. Research in the preventive domain of oral health

a. CLINICAL RESEARCH

In the primary prevention of dental caries, the role of sealing the occlusal surfaces of recently erupted permanent molars is well known, by forming a barrier against the acid attack produced by the decrease of the salivary pH. Occlusal surfaces are much more susceptible to acid attack than lateral, smooth dental surfaces. Many studies in the literature have demonstrated the effectiveness of this method, the results showing a decrease in caries risk in children who have been applied sealants, compared to those in the control group, to which sealants were not applied.
According to the literature, materials fall into two broad categories: resin-based and glass ionomer sealants, which can be further split into four subclasses (Colombo *et al*., 2018):

1. resin-based sealants-placement procedure starts with pits and fissures cleaning, acid etching and maintaining a dry field until the sealant is placed and cured
2. glass ionomer sealants- are generally easier to place than resin-based ones, as they do not need tooth processing before application (enamel and dentin are bond through a chemical reaction) and are not susceptible to moisture. Moreover, they continuously release fluoride (until the material remains on the tooth), although the clinical effect is not well established. The main liability of this material is retention: glass ionomer sealants have lower retention rates compared to resin-based ones
3. resin-modified GI sealants- sealants resin is incorporated with glass ionomer, in order to improve physical characteristics of the material, which shows less sensitivity to water and a longer working time than conventional glass ionomer.

4. polyacid-modified resin sealants- combine resin-based material in traditional resin-based sealants with the fluoride-release and adhesive properties of glass ionomer sealants.

The implication of this research direction refers to the conduct of clinical trial research studies to compare the effectiveness of some sealing materials currently used in the primary prevention of dental caries in children aged 6 to 12 years.

The objective of this intervention is to compare for two years, two or more types of sealing materials from the above mentioned categories, in terms of retention, marginal integrity and the existence of secondary caries. Such studies are needed to clarify the effectiveness of these types of sealants that have different chemical composition.

The studies may have as practical purpose, the development of a guide for the use of different types of sealing materials, presenting each material in terms of properties, advantages and limitations of application, insertion technique and longevity.

Another research direction aims to establish the effectiveness of sealing in population groups with various caries risk.

In this sense, the efficiency of sealing can be pursued by reducing the risk of caries in two or more groups of children with different caries risk, in correlation with behavioral (poor oral hygiene) and food (excessive consumption of carbohydrates and sour juices) risk factors.

b. **EXPERIMENTAL RESEARCH**

***In vitro* study of sealing materials on enamel surface**

In this research field I will continue the studies focused on experimental research in the field of caries prevention using different types of sealants, in particular, new and not yet tested materials, in collaboration with the specialists from "Petru Poni" Institute of Macromolecular Chemistry of Iasi and Faculty of Materials Science and Engineering, "Gh. Asachi" Technical University.

According to the clinical research, the experimental one can highlight through in vitro studies the effects of the sealing material on the filling margins, on the depth of penetration of the material in pits and fissures, on the occlusal surface, instrumented or not before applying the sealant.

It is well known that dental materials, restorative or fissure sealants, are directly affected by oral cavity conditions, such as saliva, foods, tooth brushing and chewing forces. The development of an optimal surface polish reduces stain and plaque accumulation and minimizes wear.

Another experimental research on sealing materials may *aim to study the wear and roughness of different types of sealing materials using scanning electron microscopy technique.*

One of the most cited methods to evaluate the efficacy of sealants is microleakage assessment at the tooth-sealant interface (Arastoo *et al.,* 2019).

One of the latest innovations in the field of composite resins is the use of *nanotechnology*. Adding nanoparticles to composite resins could allow for production of flowable materials with better mechanical properties and flowability than previous sealants.

New types of nanofilled composites have a filler content of more than 70% and despite this high filler content, they have good flowability. In this respect, *in vitro* research with Scanning electron microscopy can be used to compare the microleakage of flowable nanocomposites and conventional materials used as pit and fissure sealants.

The goal of these in vitro researches is to highlight the surface changes of enamel and sealing material while testing several materials with different composition as well as the failures that may occur through fissures.

In vitro study of novel dental materials used in remineralization

Recently, some novel biomaterials have been developed in caries prevention and treatment and showed broad prospects of application (Cheng *et al*., 2017):
a. Nanoparticles of amorphous calcium phosphate and CaF_2 were synthesized and could release calcium/phosphate and fl uoride ions, contributing to remineralize tooth lesions and neutralize acids.
b. Biomineralization agents could mimic the natural mineralization process of dental hard tissues.
c. Quaternary ammonium methacrylates were identified to be effective against dental biofi lms. These biomaterials are promising for incorporation into dental composite in preventive and restorative dentistry, thus improving the efficacy and success rate in caries prevention and treatment.

a. Composites/Sealants containing calcium phosphate were could release supersaturating levels of calcium and phosphate ions and achieve remineralization of tooth lesions in vitro. More recently, nanoparticles of amorphous calcium phosphate of about 100 nm in size were firstly synthesized via a spray-drying technique.
Owing to the small size and high surface area effects, the "smart" nanoparticles exhibit excellent characteristics, dramatically increasing the calcium and phosphate ions released at a cariogenic low pH while possessing mechanical properties nearly twofold of abovementioned CaP composite. In addition, nanoparticles could neutralize a lactic acid solution of pH 4 by increasing the pH rapidly to nearly 6, which could avoid caries formation. Although employed widely in the remineralization of carious dentin, such an ion-based strategy cannot be effective in locations where the crystallites are totally destroyed.

Other novel material used in preventive dentistry is sealant with particles *with amorphous calcium phosphate (ACP)* that improve the preventive properties of sealants by increasing enamel remineralization and decreasing subsequent demineralization and secondary caries (Mermarpour *et al.,* 2020).
Amorphous calcium phosphate (ACP) acts as an important intermediate product for in vitro and in vivo apatite formation, and was the first product to be used as artificial hydroxyapatite. Its unstable and reactive nature in aqueous media causes the release of calcium and phosphate ions and their transformation into crystalline phases due to microcrystalline growth. This makes it a candidate for tissue repair, remineralization and regeneration. The combination of ACP with restorative materials leads to enhanced remineralization of tooth structures, and provides anticariogenic properties. Amorphous calcium phosphate can be added to restorative materials such as adhesives, resin composites and fissure sealants.

b.Another promising class of mineralization materials is the *biomineralization agents*. Inspired from the function of non-collagenous proteins in the biomineralization process of natural teeth, using biomimetic templates to remineralize the demineralized dentin is of great interest in recent years as non-collagenous proteins, the natural nucleation templates, lose their abilities to induce in situ remineralization in the mature dentin.

c. Quaternary ammonium salts, widely used in water treatment, food industry, textiles, and surface coating because of their low toxicity and broad spectrum of antimicrobial activity, are

some ionic compounds which can be regarded as derived from ammonium compounds by replacing the hydrogen atoms with alkyl groups of different chain lengths. They were first introduced to dental material industry in the 1970s as mouth rinses.
Since then numerous researchers have devoted to exploring novel quaternary ammonium salts to meet the "immobilized bactericide" concept in dental materials and have been proven to be efficient in killing bacteria or inhibiting biofilms.
Recently, it has been revealed that glass ionomer cements containing different concentrations of a novel material belongs to this family, have antibacterial effects to different extents as well**.**
The research studies aim to evaluate the effect of novel composites/glass ionomer cements and sealing material on remineralization of enamel lesions and compare it with conventional resin-based sealant (control group).The samples are artificially demineralized using 50 mMol/l lactic acid solution at pH.5.0 for 4 days; as a second step the remineralization potential of sealants is evaluated using the Scanning Electron Microscopy.

II.1.2. Oral health related quality of life for children with special needs

The Word Health Organisation defines quality of life as "individual's perception of their position in life in the context of culture value system, in which they live and in relation to their goal, standards, and concerns.
Oral-health-related quality of life (OHRQoL) is defined as: "the impact of oral diseases and disorders on aspects of everyday life that a patient or person values, that are of sufficient magnitude, in terms of frequency, severity or duration to affect their experience and perception of their life overall" (Locker and Allen, 2007).
Oral health related quality of life plays an important role in understanding subjective patient evaluations of and experience with oral healthcare. The subjective evaluation of OHRQoL "reflects people's comfort when eating, sleeping and engaging in social interaction; their self-esteem; and their satisfaction with respect to their oral health". Consonant with the biopsychosocial model of health, OHRQoL is the result of an interaction between oral health conditions, social and contextual factors, and the rest of the body.
OHRQoL is important for both theoretical and practical reasons. OHRQoL research has shown its utility in the study of diverse populations including patients with oral cancer, children with craniofacial anomalies, patients with visual and hearing disabilities.
OHRQoL is utilized in health services research to examine trends in oral health and population-based needs assessment. Epidemiological survey research has examined trends in OHRQoL, identified individual and environmental characteristics that affect OHRQoL (*e.g.*, income, education, etc.), and aided in needs assessment and health planning for population-based policy initiatives.
Research has found that certain groups are at greater risk for low OHRQoL and has revealed that certain medical, dental and emotional conditions are also associated with low OHRQoL compared with the general population: women with HIV, individuals with dental anxiety and individuals with special needs.
The number of **people with disabilities** is increasing in the world, mainly because of their higher survival rates through advances in medical and social care services. Rates of acquired disability are also increasing due to population ageing and increases in chronic health conditions. One potential consequence of that is as the number of people with disability increases, the need for health and social care also increases. Research has shown that compared to the general population, people with disabilities experience poorer health and inferior access to high quality health services.
Children with special needs are the neglected segment of the population in terms of access to services like education and health. Limitations such as motor, sensory and intellectual

disabilities lead to children with special needs having difficulties in maintaining oral health and communicating their oral health needs.
Children's oral conditions not only impacted on their own quality of life, but also affected the quality of life of the wider family. The family is affected in three main areas: their emotional state, restriction to family activities, and conflict within the family.
The family's quality of life could be affected directly by the child's oral health or indirectly through the negative impacts of oral health on the child's Oral Health Related quality of life.
Oral Health Related Quality of Life has a multitude of substantive applications for the field of dentistry, healthcare, dental research and can be used to inform public policy and help eradicate oral health disparities.
Few studies have been conducted to assess oral health related quality of life of this special population. The OHRQoL measure was developed with several components including a Parental Perceptions Questionnaire, a Family Impact Scale, and three age-specific Child Perception Questionnaires (Ansari *et al*., 2016; Nqcobo *et al.,* 2019). In Romania, there is currently no questionnaire addressed to this category of people.
In this situation, the future research has the purpose to asses the oral health quality of life of children with special health care using the ***Parental Perceptions Questionnaire*** *and* ***Child Perception Questionnair****e for assesing the effects of oral health conditions on general well-being and family life of these children.*
A secondary research aims to investigate correlations between specific health care conditions, gender, and age of these children and global ratings of oral health and wellbeing.

II.1.3. Oral health screening programmes

Screening is a method used for the detection of a disease at a point in its natural history when it is not yet symptomatic.
The logic of screening rests upon the assumption that early detection of disease may allow for interventions that alter its natural course, thereby halting disease progress and preventing the onset of adverse outcomes. In this sense, the aim of screening is generally secondary prevention.
Beyond altering the course of disease, there are additional considerations that must be addressed whenever a screening strategy is proposed. The benefits that may be obtained in terms of improved health must be balanced against a variety of other factors, including cost (e.g. equipment, manpower), ethical issues (e.g. labelling of individuals who screen positive), the efficacy of interventions (e.g. effect on quality of life), and side effects (e.g. does early detection do more harm than good?).
The advantages of implementing generalized screening programs for human diseases are numerous and often self-evident. Beyond the primary benefit of improving the overall health of the population, early detection in the pre-clinical phase followed by preventative measures to arrest disease progress should yield several secondary benefits, including less patient time spent with the health care professional, more time for the health care professional to treat other patients, and cost savings for patients and third-party providers.
Early detection would likely reduce the morbidity associated with dental caries and periodontal disease, and the mortality associated with oral cancer.
The priciples of screening are:

- The condition sought should pose an important health problem.
- The natural history of the disease should be well-understood.
- There should be a recognizable early stage.
- Treatment of the disease at an early stage should be of more benefit than treatment started at a later stage.

- There should be a suitable test.
- The test should be acceptable to the population.
- There should be adequate facilities for the diagnosis and treatment of abnormalities detected.
- For diseases of insidious onset, screening should be repeated at intervals determined by the natural history of the disease.
- The chance of physical or psychological harm to those screened should be less than the chance of benefit.
- The cost of a screening program should be balanced against the benefit it provides.

Screening for oral cancer

There are about 657,000 new cases of oral and throat cancer worldwide each year, resulting in more than 330,000 deaths, most of them are Squamous cell carcinoma. Oral cancer is largely related to lifestyle, with major risk factors being tobacco and alcohol misuse. In addition to smoking, the use of smokeless tobacco has been strongly linked to oral cancer.
Unfortunately, the diagnosis continues to rely on patient presentation and physical examination with biopsy confirmation. This may result in delay in diagnosis accounting for the fact that the majority of these cancers are diagnosed at a late stage. Studies confirm that survival does correlate with stage, making early diagnosis and treatment optimal for this disease.
Despite advances in surgical techniques, radiation therapy technology, and the addition of combined chemotherapy and radiation therapy to the treatment regimen, survival data has not shown appreciable change in decades. Five-year survival data reveal overall disease specific survival rates of less than 60% although those that do survive often endure major functional, cosmetic, and psychological burden due to dysfunction of the ability to speak, swallow, breathe, and chew. Seventy-five percent of all head and neck cancers begin in the oral cavity. According to the National Cancer Institute's Surveillance, Epidemiology, and Ends Results (SEER) program, 30 percent of oral cancers originate in the tongue, 17 percent in the lip, and 14 percent in the floor of the mouth . Many other studies support this finding that oral cancers appear most often on the tongue, and floor of the mouth. New data related to the HPV16 virus may indicate that these trends are changing with the poster mouth including the tonsils, tonsillar pillar and crypt, the base of the tongue, and the oropharynx increasing rapidly in incidence rates. A thorough, systematic examination of the mouth and neck need only take a few minutes and can detect these cancers at an early and curable, stage.
It is well established that virtually all oral squamous cell carcinomas are preceded by visible changes in the oral mucosa, usually by way of white (leukoplakia) and red patches (erythroplakia). In addition, there are other inflammatory disorders of the oral mucosa such as lichen planus, submucous fibrosis and perhaps oral fibrosis due to systemic sclerosis that have been associated with an increased risk of squamous cell carcinomas development. It is believed that identification and monitoring of these potentially malignant lesions and conditions allows clinicians to detect and treat early intraepithelial stages of oral carcinogenesis, for example mild, moderate or severe dysplasia and carcinoma in situ, all of which generally precede the development of invasive squamous cell carcinomas .
Currently, screening of oral cancer is largely based on visual examination. Various evidence strongly suggests the validity of visual inspection in reducing mortality in patients at risk for oral cancer. Simple visual examination is accompanied with **adjunctive techniques** for subjective interpretation of dysplastic changes. These include toluidine blue staining, brush biopsy, chemiluminescence and tissue autofluorescence.

Population screening programmes are of three main types. Mass screening describes a process whereby the whole populations are screened, but this type of programme is rarely

used. Most programmes are selective and target a subset of the population who are felt to be at highest risk, the third type is opportunistic screening, where individuals are examined when they attend a healthcare professional for some other, often unrelated, purpose.

For this purpose, *I propose the conduct of some screening campaigns for the population groups at risk of oral cancer* where the criteria for subject selection should, in accordance with the risk factors for oral cancer, be:
-the institutionalized old people aged over 65
-male individuals aged between 50 and 65 who smoke and drink alcohol and have a low social-economic status.
The clinical examination and use of additional tests for the identification of malignant oral lesions might be carried out in the dental office existing in the institutions for old people, in dentists' private dental offices (in the case of rural areas) as well as in the outpatient service of the faculties of Dental Medicine. Examiners must be dentists, doctoral students, and medical residents.

Other future directions for research activity:

- rendering the research team made up of colleagues and researchers efficient, and their activity must result in at least three ISI articles per academic year;
- publication of ISI articles in magazines having a high impact;
- establishing new research directions;
- diversification of the research methods;
- coordination of a research project and participation to the national grant contest;
- dissemination of results of the conducted researches at national and international congresses;
- publication of the research results in chapters of monographs at prestigious publishing houses;
- partnerships with colleagues from diverse universities from the country and abroad for the implementation of common projects;
- participation at national research programmes specific to this field.

II.2. FUTURE DIRECTIONS IN ACADEMIC ACTIVITY

II.2.1. Academic activities regarding students and residents

The mission of the discipline of Community Dentistry is to promote critical analysis of social, behavioral, and policy-influenced factors that affect oral health outcomes in both individual patients and the entire population.

A graduate is expected to be competent in the following areas of knowledge, as relevant to the specialty:

a. the epidemiology of oral health and disease;
b. the principles of oral health promotion;
c. the principles of public health research oral disease prevention at a population level;
d. the analysis of oral health needs and services in community.

In this field, I will continue to lay focus on the **oral health promotion**, the diversification of interactive didactic methods, the support of students' academic, post-academic and master activity, the involvement of students in oral health promotion activities in different communities, in particular, for children and adults with disabilities.

a. Oral health promotion for children with special needs

Promoting oral health includes, but goes beyond, health education for individual patients and their parents/carers. The Ottawa Charter principles for Oral Health Promotion (World Health Organization, 1986) are fundamental pillars in underpinning oral health promotion. They emphasise the importance of a population approach to health rather than just an individual approach which includes:

1. building healthy public policy
2. creating supportive environments
3. strengthening community action
4. developing personal skills and
5. re-orientating health services

The WHO International Classification of Functioning describes disability as an umbrella term, covering impairments, activity limitations, and participation restrictions. Disability is diverse, including those who have a range of impairments with or without additional needs. However, not everyone who is disabled will have complex needs. The scope is broad, covering people with physical, sensory, intellectual, medical, emotional or social impairments; or more often a combination of these factors. These groups are sometimes referred to as 'people with special needs', people with 'special healthcare needs', or people requiring 'special care dentistry'.

Global oral health goals of International Dental Federation emphasized the importance of promoting oral health within groups and populations with the greatest disease burden. This is especially important for people with disabilities as they typically experience greater levels of oral disease. These groups are often under-served and experience high levels of unmet need for dental care, with the oral disease they experience often remaining untreated. Most dental care for people with disabilities is not complex and can be provided in primary care and community settings, by a dental workforce with the relevant attitudes and competencies.

It is harder for people with special needs to find sources of dental care, and once a source of care is located, it can be more difficult to render dental treatment. Deciding on adequate treatment may require balancing complex medical and social factors and may sometimes require the use of sedative medications or even hospital treatment under general anesthesia. Many people with special needs are dependent on others to locate and arrange for dental treatment. Some caregivers are not themselves aware of the consequences of untreated dental disease and may not be aware of or use procedures known to prevent dental diseases. These factors can result in pain, suffering, and social stigma in these populations beyond that found in other segments of our society.

Barriers to oral healthcare include the following:

- Inadequate public awareness of the need for dental care for these children;
- Poor accessibility to dental care due to ignorance or difficulty in obtaining care;
- Financial problems – many children are from socially-deprived families and not able to afford treatment or expenses incurred to obtain treatment (e.g. transport);

- Poor communication – many of these children are unable to convey their dental needs adequately.
- Treatment is only sought when there are obvious signs e.g. swellings;
- Associated medical problems - many of these children have associated medical problems, which can complicate their dental management;
- Lack of training and understanding among dental personnel.

Strong evidence exists for the effectiveness of targeted school-based toothbrushing programmes and targeted chewing gum programmes.
The conditions for successful school-based toothbrushing programs include:
• high tooth decay rates in non-fluoridated areas
• links with parents
• programs commencing with five year olds
• children not brushing at least twice a day with a fluoride
toothpaste (at home and/or school)
• support for teachers/caregivers or use of non-teacher supervisors.

In this perspective, I propose ***the oral health promotion programme for children with special needs****. This progam is related to clinical examination and developed educational programmes according to maintining a good oral hygiene with toothbrushing programs: lectures and hands-on education for children, parents, caregivers and teachers*.
Clinical oral examinations will be performed according to the following criteria:
- Caries experiences were assessed by the International Caries Detection and Assessment System(ICDAS);
- Oral hygiene status by Simplified oral hygiene index of Greene and Vermilion (OHI-S);
- Gingival health status by Modified Gingival Index (MGI).

Dental examination will be performed at special school/special care centers by residents in General Dentistry and students in the 5th year of study with a disposable mouth-mirror attached to an LED light.
After dental examination and tooth-brushing assessment, a standard hands-on tooth-brushing training will be provided immediately to each child and his/her parent. Oral health instruction will also be illustrated to the participants. Questionnaires regarding children's oral health related behaviours and family demographic information will be completed by parents. Children' oral health status and expected behaviours (tooth brushing, healthy eating habits and dental-visit experience) will be assessed at 6-month, 12-month and 24-month intervals.

b. The oral health promotion programme for older adults and people with disabilities

Older adults and adults with disabilities experience a high prevalence of tooth decay, periodontal disease, edentulism, unmet oral health treatment needs, xerostomia and impaired oral health quality of life.
Appropriate prevention and promotion such as behavioral interventions among the elderly should be implemented to restrict oral health problems and possibly increase their quality of life.
Applying the *Health Belief Model* in oral health promotion is expected to improve the effectiveness of prevention and promotion that restricts oral health problems.

I propose this research to determine the effectiveness of an oral health promotion programme on oral health behavior and oral status among the institutionalized older and persons with disabilities.

The *Health Belief Model* is a framework of health promotion that is expected to promote clients' perceptions in health risk, disease severity, and benefits of behavior change. Therefore, applying this model in oral health promotion could lead the elderly to avoid consequent oral disease. It is believed that soon after the elderly have perceived susceptibility and severity of their oral health problem, a healthier behavior will occur.

This research study aims to:

a. Conducting a clinical examination performed in institutionalized centre in Iasi; Indexes used in this study are: Gingival index, Simplified oral hygiene index and tooth loss.
b. Developing a questionnaire to assess oral health perception based on the Health Belief Model theory, including perception in disease susceptibility, severity, benefits, barriers, and self-efficacy;
c. Conducting an intervention procedure for two groups: experimental and control group:
   -Intervention in the control group-they receive only regular oral health promotion, including oral health education, demonstrations on oral hygiene care, and denture cleaning.
   -Intervention in the experimental group-they receive not only oral health education and demonstration, but information regarding their oral health risk, disease severity, and benefit of behavior changes according to the *Health Belief Model*.
d. After 3 months, both groups will be interviewed and oral health examined to collect oral health perception data and oral health status using the same diagnostic criteria as those used at baseline.

Future directions regarding teaching activity for students:

- Diversification of the instructive-educational methods;
- Use of some instructive-educational methods based on putting students' creative potential to good use;
- Customization and differentiation of course syllabus according to the requirements of each educational context;
- Increased use of the information technology in the teaching activity ;
- Involvement in international mobility programmes such as Erasmus+ programme.

Future directions regarding teaching activity for residents

- provision of updated information in the educational process through the consultation of existing databases, websites and specialized magazines;
- conduct of post-academic refresher courses adapted to the curriculum for General Dentistry residency**;**
- involvement of residents in the organization of sanitary education campaigns for the public.

***Other strategies in the teaching field I intend to focus on*:**

- participation to courses in the fields related to Community Dentistry subject such as medical biostatistics, clinical epidemiology, informatics;
- students' active involvement in the carrying out of courses and internships;
- proposal of new post-university courses in interdisciplinary fields;

- adaptation of study programmes so they may concord with the particularities appeared in the process of European curricula;
- constant collaboration with colleagues from other universities that are specialists in Community Dentistry;
- permanent collaboration with students and their encouragement to participate to research, humanitarian and volunteer activities;
- my involvement in students' practical activities by supporting them to organize professional visits at diverse faculties in our country and abroad, scientific manifestations to which they may invite different famous personalities and specialists in their field of activity;
- my voluntary involvement together with my students at different actions for the promotion of oral health among the disfavored population and informing the population about the prevention of oral diseases;
- my involvement in the training of students/graduates/residents as entrepreneurs so that their business might be successful with results and motivations both for their career as dentists and for patients.

II.2.2. Academic activities regarding future doctoral students

The activity of a doctoral thesis supervisor implies a series of obligations assumed at the time of acceptance of the PhD candidate whose activity I will coordinate, supervise and finalize successfully.

I would like to mention that I am fully aware of the responsibility incumbent upon a doctoral thesis supervisor since it is decisive in the carrying out of a successful research activity.

Other research topics specific to the field of oral public health can be concretized by the following aspects:

- *socio-economic disparities in oral health*: research studies in different communities area; oral health status in relation with ethnicity; oral health and access to dental care among disadvantaged people;
- *psychological determinants of oral health* : assessment of the dental anxiety of young adults in different communities; programs to prevent oral disease related to changing behaviors;
- assessment the oral health status in children with different socio-economic backgrounds;
- inequalities in oral health and oral health promotion;
- the impact of oral health on quality of life in working population in rural areas.

The directions related to PhD candidates' activity focus on:

-the selection of the most capable students who wish to enroll on the doctoral programme;
-the support and guidance of PhD candidates in:

- drafting the research study protocol;
- choosing the pertinent scientific methods necessary to conduct the research;
- establishing partnerships with specialists in the field of medical biostatistics, epidemiology, and researchers of prestigious national institutions;
- guidance for the publication of research results in ISI magazines having a high impact

- encouraging PhD candidates to take part to multidisciplinary teams

- training and encouraging PhD candidates to take part to sessions for the dissemination of scientific research within the academic community
- supporting mobility for PhD candidates.

I am aware that the activity of coordination of PhD candidates is a tireless team work with supplementary attributions as compared to mu current academic position, but I am convinced that the experience acquired during my teaching and research career started in 1992 will lead to success in this field.

II.2.3. OTHER PERSPECTIVE IN PROFESSIONAL ACTIVITY

Another challenge comes from my position of president of the Disciplinary Committee of Dentists' College of Iasi by which I get information about the professional conducts errors and the medical deontology of some colleagues. From this perspective, *I want to elaborate an interactive course for students in their final year of study or residents in first year that may underline the importance of knowing legislation and preventing the malpractice cases.*

Ethical issues in dentistry-courses for students, residents and doctoral students

Ethical principles are the inspirational goals of the profession, which provide guidance and offer justification for the Code of professional conduct and the advisory opinions.

Ethical codes vary from one country to another and even within countries, but they have many common features, including commitments that dentists will consider the interests of their patients above their own, will not discriminate against patients on the basis of race, religion or other human rights grounds and will protect the confidentiality of patient information.

Individual dentists have the responsibility to act in the patient's best interes and to provide the highest standards of clinical care. An important component of clinical care is the informed consent, which corresponds to the basic principle of patient autonomy and respect. The process of informe consent is also helpful in improving the dentist-patient relationship. There is the need for maintaining the record officially and professionally to protect against any commercial, legal and medico-legal litigation.

Medical malpractice is an act of a medical professional deviating from the set regulations and standards that result in injury or damage to a patient.

Dental malpractice *is very similar to medical malpractice, where a dental professional fails to follow the required standards of practicing dentistry, thereby harming the patient.To avoid the incidences of oral malpractice and minimize the risks of procedural errors, the operator must consider ethical principles of clinical practice and adhere strictly to the standards of healthcare while performing the diagnosis and treatment.*

There are three basic types of dental malpractice:

-*Medication errors* in which either too little or too much anesthesia (local or general) is administered, or in which the dentist fails to consider all possible medication interactions

-*Procedural errors* which occur during implant, endodontic or surgical errors; negligent dental work

-*Diagnostic errors* which typically involve failure to diagnose of oral disease

Others examples include: lack of informed consent, unnecessary examinations or procedures and any intentional misconduct on the part of the dentist.

Dental practice requires from the dentist a behaviour and an attitude based on ethical principles. A change in terms of correctness and ethical considerations has been noticed lately

in the conduct of dentists in relation to their skills. Such situations are encountered when the dentist thinks they can carry out a procedure that exceeds their practical skills while having another motivation than the successful completion of the intervention thus breaching the golden rule – *primum non-nocere*. Examples of this type are numerous and they include surgical treatments, mainly those related to oral implantology when these require complex and high risk supplementary measures.

This is only one example of malpractice encountered during my activity carried out in the discipline committee of Dentists' College of Iasi. Other examples refer to:

-patient's lack of informed consent;

-inobservance of the professional guides;

-dentist's non-cooperating attitude and lack of empathy;

- deficient communication, and the lack of recognition of one's own limits;

-lack of confidentiality and of the right to have access to one's own medical documents.

Other problem also encountered lately refers to the publicity that the dentist might make. There are many obvious cases of publicity made in an abusive manner in mass media in order to attract patients for abusive maneuvers, most of the time esthetic ones, or to provide an unjustified warranty for the medical procedure.

In the 21st century where rapid technological changes have also taken place in dentistry through the appearance of new state-of-the-art equipment, technologies and materials, it is mandatory that every professional should develop their career in concordance with these requirements. They may do that by taking part to courses, workshops and hands-on which offer skills and competences necessary to conduct new procedures or use vanguard technologies.

Although there are Medical bioethics courses in the faculty curriculum, I consider a post-academic course that might present, via real and concrete examples, the malpractice risk to future dentists or to those who are at the beginning of their professional career as opportune.

Other activities relating to professional development

Educational projects will represent another part of my academic preoccupations since I have already participated as a member in two educational projects dedicated to 1st year students of the Faculty of Dental Medicine being in unfavorable situations, ROSE type projects meant to prevent school dropout.

To **increase academic prestige,** I will participate to international research teams; I will get involved into the presentation of research results to famous congresses in the field of oral public health where I can also engage future PhD candidates.

In conclusion, the success of the academic profession is given by perseverance, an open mind to innovating ideas, the capacity to communicate within work teams, and the permanent improvement of teaching and professional performances.

I consider that my professional reputation and future academic career will result in the increase of visibility of the department, faculty and university where I currently work.

SECTION III

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