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EMERGENCIES IN DENTAL MEDICINE**

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PhD THESIS

**DENTAL MANAGEMENT STRATEGIES FOR
DEMINERALIZATION AND MIH-HYPOMINERALIZATION
FOR TEMPORARY TEETH AND PERMANENT YOUNG ONES**

ABSTRACT

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**Timișoara
2024**



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INTRODUCTION

Motivation for choosing the theme

My interest in research began long before I embarked on my journey in dental school. From an early age, I was fascinated by the use of lasers and their impact on both hard and soft tissues. This curiosity led me to reach out to a university in Germany, expressing my desire to study lasers. Their response—that I first needed to pursue dental education before delving deeper into laser technology—set the course for my academic and professional path. Dentistry, as I have come to understand, is a field that thrives on interdisciplinary collaboration, requiring the integration of knowledge from various departments to deliver comprehensive and high-quality patient care.

This thesis focuses on the dental management of demineralization and hypomineralization, particularly Molar Incisor Hypomineralization (MIH), which poses significant challenges in pediatric dentistry. These conditions, affecting both temporary teeth and young permanent ones, demand a nuanced approach to ensure optimal oral health outcomes. The thesis explores various dental management strategies, with a particular focus on innovative laser treatments and diagnostic tools. By examining these strategies, I aim to contribute to the development of more effective and less invasive treatments for these common dental issues.

The motivation behind this thesis stems from the pressing need to enhance our understanding of how different dental management strategies can influence the treatment outcomes of demineralization and hypomineralization. These conditions, if left untreated or improperly managed, can lead to significant dental complications, affecting a child's quality of life and long-term oral health. The growing prevalence of MIH in young patients highlights the urgency of this research. My personal interest in this topic is driven by a desire to bridge the gap between conventional and emerging dental technologies, ultimately improving patient care.

As my studies progressed, I developed a keen interest in the challenges and intricacies of working with young patients. Regardless of one's level of experience, treating children is always a complex task. Emotions such as anxiety, fear of the unknown, and difficulties in expressing pain add layers of complexity to pediatric dental care. Understanding child psychology is crucial in approaching not just the dental issue, but also in effectively communicating with the young patient. Additionally, managing the concerns and anxieties of parents, who are often more nervous than their children, is an integral part of successful treatment.

The expertise of my thesis coordinator had a significant influence on the topic I chose. Her extensive knowledge of laser applications in dentistry, coupled with her substantial contributions to scientific research through numerous academic publications, profoundly shaped the direction of this thesis. Her guidance has been instrumental in ensuring that this research paper not only meets high academic standards but also contributes meaningfully to the field.

The doctoral thesis titled "Dental Management Strategies for Demineralization and MIH-Hypomineralization in Primary and Young Permanent Teeth," supervised by Prof. Univ. Dr. Carmen M. Todea at the University of Medicine and Pharmacy "Victor Babeș" Timișoara, within the Discipline of Oral and Emergency Rehabilitation in Dental Medicine, in collaboration with Moisa Dentistry SRL, the University of Life Sciences "King Mihai I," Faculty of Veterinary Medicine Timisoara, Department of Animal Production and Veterinary Public Health, the AMS 2000 Laboratory in Jebel, Timisoara, and the Research and Renewable Energies, Municipal Timișoara, undertakes a comprehensive investigation into innovative clinical approaches for the conservative and alternative treatment of Molar Incisor Hypomineralization (MIH) syndrome.

This research aimed to assess various dental management strategies for addressing demineralization and hypomineralization in both temporary and young permanent teeth. Our *in vitro* study found that laser treatments were more effective than traditional methods in reducing microinfiltration in temporary teeth.

Clinical evaluations using the DIAGNOdent® laser pen indicated that treatments with biodentine, along with glass ionomer and composite materials, were successful in managing hypomineralization in young molars and incisors. Additionally, our investigation into remineralization showed that diode lasers, especially when combined with CPP-ACP-fluoride varnish, significantly improved enamel remineralization in temporary teeth.

The significance of this research lies in its potential to address the growing clinical challenge posed by MIH, offering insights into more effective treatment strategies and ultimately contributing to the preservation of affected teeth, which are currently prone to rapid deterioration. The studies were conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of “Victor Babes” University of Medicine and Pharmacy, Timisoara, Romania (approval number 84 from 25 April 2022)

In the case of clinical studies after review of their written protocol, the patients or their legal representative signed the written agreement to participate in the study (Patient agreement regarding involvement in medical research)

The thesis is organized into two primary sections: a General Part and a Special Part. The General Part consists of four chapters that provide an overview of the current knowledge related to the topics addressed in this thesis. The Special Part is structured around three distinct studies, which explores the clinical and *in vitro* development of the main research themes.

The first study entitled „Evaluation of marginal percolation of the glass ionomer fillings at temporary teeth,, examines the effects of percolation on temporary teeth in an *in vitro* study, comparing conventional cavity preparation methods with Er: YAG laser treatment. The selected samples were freshly extracted temporary molars, removed due to the natural exfoliation process and orthodontic reasons. These sample teeth were randomly grouped into two categories: one receiving conventional treatment using high-speed instruments, and the other undergoing laser preparation intervention. Percolation, a critical

factor in restorative dentistry, directly influences the longevity and effectiveness of dental restorations. By contrasting traditional methods with advanced laser treatments, this chapter aims to highlight the potential benefits of integrating laser technology into routine dental procedures. The precision and minimal invasiveness of the Er: YAG laser could offer significant advantages in terms of patient comfort, preservation of tooth structure, and the durability of restorations.

Conclusions of first study

Marginal percolation can occur due to various factors, making it crucial to control those aspects within our reach, such as strictly adhering to the manufacturers' instructions and avoiding excessive drying of the surface to be sealed. It is also essential to recognize the inherent differences between *in vitro* and *in vivo* studies, each presenting its own set of advantages and limitations.

The current study highlights the accelerated occurrence of marginal percolation when the recommended procedural steps by material manufacturers are not meticulously followed. Specific factors contributing to this include improper filling of the material, the presence of thinner enamel layers, pre-existing microcracks in the dental tissue, and the omission of a protective varnish layer. Under such conditions, marginal percolation is more likely to occur.

The primary objective of this study was to observe and evaluate potential marginal percolation in temporary teeth following conventional versus laser preparation methods. The findings indicate that, regardless of the preparation technique employed, some degree of marginal surface percolation is inevitable. Notably, both conventionally and laser-prepared samples exhibited percolation at the interface between the protective varnish and glass ionomer cement. However, this percolation did not progress deeper in the samples where the manufacturer's instructions were carefully followed. In contrast, samples prepared without adhering to these guidelines demonstrated more significant percolation.

Glass ionomer cement emerges as one of the most suitable materials for restoring Class I cavities in temporary molars, particularly when addressing

concerns of microinfiltration. Future *in vivo* studies are necessary to evaluate percolation under the realistic conditions present in the oral cavity.

The second study entitled „A micro-invasive approach to treating posterior MIH lesions: a case report” presents an *in vivo* clinical case study that investigates various treatment approaches for Molar Incisor Hypomineralization. A number of patients were evaluated at the clinic to assess the stage of hypomineralization and its implications. The DIAGNOdent[®] pen was used to measure the extent of affected tissue, providing a quantitative assessment of enamel and dentin involvement. The diagnostic process was carried out in several steps: initially, a thorough examination and pain evaluation using the Wong-Baker FACES Pain Rating Scale were conducted. This was followed by pain management, and in subsequent appointments, final treatments were performed. These involved sealing the affected teeth with composite restorations after ensuring that the patients were pain-free. Each tooth was re-evaluated a few weeks later, and on the day of the final restoration, another Wong-Baker FACES assessment was performed to measure the effectiveness of the treatment in managing pain sensitivity.

Conclusions of second study

Children with MIH of systemic origin have a reduced quality of life and require effective treatment strategies. Combining various techniques to manage pain and hypersensitivity in MIH patients is encouraged. Recent studies suggest that longitudinal clinical studies are needed to understand the effects of Low-Level Laser Therapy (LLLT) on managing MIH hypersensitivity. There is a pressing need to develop and validate protocols for LLLT use in MIH management.

The third study entitled „Surface and mineral changes of primary enamel after laser diode irradiation and application of remineralization agents: a comparative *in vitro* study,” focuses on the surface morphology of temporary enamel, specifically evaluating the effects of different laser diodes operating at 450, 808, and 980 nm wavelengths. Various methods of evaluation were

employed, including Atomic Absorption Spectroscopy (AAS), to provide a detailed analysis of the enamel surface after laser treatment. The study investigates how these laser treatments alter the enamel's structure, potentially influencing its resistance to demineralization and its susceptibility to caries. The DIAGNOdent pen was again utilized to quantify the extent of enamel and dentin affection. By comparing different laser wavelengths, this research seeks to identify the most effective approach for preserving enamel integrity in pediatric dentistry.

Conclusions of third study

The research study investigated the impact of three types of low-lasers radiation treatments, namely at wavelengths of 980 nm and 808 nm, and 450nm on dental hard tissue. The study's findings revealed that all treatments had an influence on the surface morphological and chemical composition of the primary enamel hard tissue. The most significant enhancement in the chemical composition of enamel was achieved using laser diode irradiation, 980 nm and 808 nm, and varnish as looking to the changes of the morphological enamel surface by itself, and where all lasers in combination with MI-fluoride varnish had a great outcome regarding the smoothness of the enamel structure.

The EDX analysis, both 980 nm laser and 808 nm laser where both Calcium (Ca) and phosphorus (P) had an increase in the weight percentage, also when combining laser and MI- varnish fluoride together, for the 980 nm laser diode combined we had also the percentages of Ca and P increasing resulting in an increase in the enamel's resistance to acid.

Additionally, the low diode laser 450 nm radiation and 450 nm plus MI varnish fluoride and 808 nm plus the MI fluoride varnish even though the Ca percentage decreased, the P percentages increased significantly, also leaving a smooth enamel surface after irradiation with 450 nm and combined with MI f-fluoride varnish. Due to their minimal side effects, diode light lasers prove to be a great asset in pediatrics and preventive dentistry. Specialists should consider using low light diode lasers treatment to enhance the effectiveness of their dental



treatment. The best ways to strengthen the structural resistance against solubility processes require more research to confirm the functions of laser settings.

To identify the best circumstances for strengthening temporary enamel's resistance to solubility processes, more research *in vitro* and *in vivo* investigations of the new 808 nm and 450 nm diode lasers is required to confirm the functions of laser parameters.

In summary, this thesis provides a comprehensive examination of dental management strategies for demineralization and hypomineralization, with a focus on innovative laser treatments. The findings from this research offer valuable insights into the potential benefits of laser technology in pediatric dentistry, particularly in improving patient outcomes through less invasive and more effective treatments.