

<https://doi.org/10.48047/AFJBS.6.15.2024.3595-3501>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Evaluation of the micromorphological changes in dentin after removal of caries with conventional rotary or enzyme-based chemomechanical caries removal agent.

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Volume 6, Issue 15, 2024

Received: 15 May 2024

Accepted: 18 Aug 2024

Published: 05 Sep 2024

[doi:10.48047/AFJBS.6.15.2024.3495-3501](https://doi.org/10.48047/AFJBS.6.15.2024.3495-3501)

Abstract

The current in vitro study's objective was to evaluate the micromorphological changes in dentin after removal of caries with conventional rotary or enzyme-based CMCR agent. Fourteen cavitated carious freshly extracted human permanent molars were collected for the study. The root of each molar was sectioned and discarded, while the crowns were fixed to resin blocks. The specimens were randomly divided into two groups, with 7 specimens in each group (n =7), group (1): conventional rotary method, group (2): enzyme-based CMCR agent. Each tooth was evaluated for micromorphological analysis under scanning electron microscopy (SEM). The SEM observations revealed presence of smear layer after rotary caries removal and showed little or no smear layer after enzyme-based caries removal. This means that Enzyme papain-based CMCR agent is a reliable alternative to conventional rotary method.

Key words: Chemomechanical caries removal, Papain, SEM.

Introduction

Dental caries is commonly known as tooth decay. In the minds of the lay person, and surprisingly even within dentistry, dental caries is often thought of as holes in the teeth rather than an entire disease process. However, it has been known for

over 100 years that dental decay is caused by bacteria fermenting foods, producing acids and dissolving tooth mineral. In recent decades the process has been much better defined from several aspects including microbiology, saliva, tooth mineral composition, tooth ultrastructure, diffusion processes, kinetics of demineralization, the reversal of demineralization that is known as remineralization, and factors that contribute to the reversal of the process.^{7,13} Now, we have a rather deep understanding of what goes on in the mouth, but this knowledge is far from being effectively utilized in dental practice.

The so-called cariogenic bacteria are essential to the disease process. At least two major groups of bacteria, namely the mutans streptococci and the lactobacilli species, are able to produce organic acids during metabolism of fermentable carbohydrates by these bacteria.^{13,14} The acids produced include lactic, acetic, formic and propionic, all of which have been shown to readily dissolve the mineral of the enamel and dentin.⁸

Dental caries cannot be completely cured by only eliminating the causative microorganisms. Instead, it can also be treated by behavioral management. It includes reduction in consumption of fermentable dietary carbohydrates and frequent disruption of bacterial biofilm from the tooth surface. Bacterial penetration cannot be prevented if such management is not being practiced by the patients which can result in irreversible inflammatory damage to the pulp.⁴

Conventional cavity preparation and caries removal methods use mechanical means, mostly burs, and are often associated with pain and fear, especially for children.⁶ Although the pain can be managed through local anesthesia, fear of the needle, noise, and vibration of mechanical preparation remains a cause of discomfort for the patient. Moreover, these techniques present the risk of easily

removing healthy dental tissues or damaging the pulp through temperature rise, which may be in the origin of discomfort (thermal stimulation).^{6,19}

Until today, different therapeutic approaches regarding dental cavities have been discussed and reconsidered in order to be as conservative as possible and to preserve tooth structure by only removing the irreversibly damaged dental tissues. This leads to increased tooth longevity and prevents the repetitive restorative cycle.^{2,3} Although mechanical methods for caries removal are widely accepted quick techniques, various alternative therapeutic approaches have been demonstrated to be promising, such as chemo-mechanical methods, lasers, or sono/air abrasion.^{3,19}

Today's focus in dentistry is more on prevention and detection of caries at an early stage. This has created the concept of minimally invasive dentistry (MID).²² The term MID is a relatively new concept for the dental profession that suggests a change in the principles of operative dentistry, as it has been proven that the invasive approach is destructive, ineffective and maximally interventionist.¹⁷

The concept of MID is based on caries risk assessment, prevention and control of further disease by reducing the cariogenic bacteria, early caries detection, remineralisation of early carious lesions, repair of defective restorations rather than replacement, and minimum intervention and cavity design when restoration is necessary.²¹ One of the most common MID modalities over the last 10 years has been the use of CMCR agents.¹⁶ CMCR involves the decayed dentin being chemically softened and then gently removed using hand instruments.⁹ It differs from the conventional surgical procedure in that it selectively removes infected dentin while preserving affected dentin that possesses the potential to remineralize; thus, it is considered less destructive.²⁰ Several CMCR agents have been developed

since 1975. They can be generally categorized as either sodium hypochlorite (NaOCl)-based agents or enzyme-based agents.¹

Papain-based enzymatic CMCR used in this study was introduced in 2003 has claimed to preserve healthy dental tissue with benefits of minimal discomfort, antibacterial, and anti-inflammatory effects.¹⁸ It was first marketed in Brazil in 2003. This product is a gel based on the combination of papain and chloramine for the removal of carious tissue, uniting the cleaning and healing properties of papain with the disinfecting characteristics of chloramine.¹¹ Papain interacts with the collagen exposed by the dissolution of minerals in the dentin due to the action of bacteria, softening the infected tissue and allowing its removal with blunt instruments; hence, there is no need for anesthesia or drills.^{5,15}

Micromorphological analysis by Scanning Electron Microscope (SEM)

SEM analysis that was used is considered the most efficient method for determination of surface changes of dentin and the presence of smear layer.¹⁰ It is one of the common methods for imaging the microstructure and morphology of the materials. In SEM, an electron beam with low energy is radiated to the material and scans the surface of the sample. Several different interactions occur as the beam reaches and enters the material, which lead to the emission of photons and electrons from or near the sample surface. In order to form an image the receiving signals produced from the electron-sample interactions are detected with different types of detectors depending on the mode of SEM being used. Different modes of SEM exist for characterization of materials (including biomaterials) such as the X-ray mapping, secondary electrons imaging, backscattered electrons imaging, electron channeling, and Auger electron microscopy.¹²

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