

Review Article

Current Concept of Caries Removal: A Brief Review

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ABSTRACT:

Dental caries has inflicted mankind from the very beginning and has encompassed every part of the globe thus justifying the widespread of this pandemic disease. Conventional caries removal and cavity preparation entail the use of high speed handpiece and burs which undoubtedly improved the speed and efficiency of cavity preparation but has many inevitable disadvantages. In quest to harness newer technologies for caries removal multifarious, new methods have been introduced. The aim of present review article is to discuss different methods of caries removal from past to the present.

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INTRODUCTION

Dental caries has inflicted mankind from the very beginning and has encompassed every part of the globe thus justifying the widespread of this pandemic disease. Once it affects the tooth structure, it is of fundamental importance to use conservative procedures that simultaneously prevent the progress of the lesion and minimize healthy tooth structure wear. Conventional caries removal and cavity preparation entail the use of high speed handpiece and burs which undoubtedly improved the speed and efficiency of cavity preparation but has many inevitable disadvantages, such as (i) perception of unpleasantness by the patients, (ii) use of local

anesthesia, (iii) deleterious thermal effects, (iv) pressure effects on the pulp and (v) may result in removal of healthy dentin, resulting in an excessive loss of sound tooth structure.

To overcome the disadvantages of conventional caries removal system, other procedures of caries removal have evolved. Moreover, with the advent of adhesive restorative materials and subsequent developments in cavity designs, the widely accepted principle of "Extension for Prevention" has been challenged and is now considered too destructive a method of caries removal.² This present review of literature aims to discuss the past, present and future of various caries removal methods.⁴

TISSUE REMOVAL TECHNIQUES³

There are a number of techniques available for caries removal

Category	Technique
Mechanical Rotary	Hand piece – Bur
Mechanical Non Rotary	Hand excavators, Air abrasion, Ultrasonics
Chemomechanical	Caridex, Carisolv, Enzyme, Papacarie
Photoablation	Laser

MECHANICAL METHOD OF CARIES REMOVAL

Conventional caries removal and cavity preparation entail the use of burs on a high-speed handpiece to gain access to the carious lesion, and a low-speed handpiece to remove carious dentine. Steel bur excavation and conventional rotary techniques removes largest amount of sound tissue (over-preparation) leaving behind some amount of carious tissues (under-preparation) with the possibility of overextending the cavity, healthy tissue removal, pressure and heat on the pulp, vibration, noise, pain stimulus and the need of local anaesthetic, a procedure that causes aversion in many patients, especially children.⁴

In the year 2003, Boston developed new polymer prototype burs as an alternative to conventional burs. It is the self-limiting polymer bur, which is the new version of SmartPrep, now called SmartBurs. It can be used with slow speed handpiece. It removes only infected dentin, and it does not remove healthy dentin. It is claimed to be disposable once the cutting portion of the bur wears off. Hence, these cannot be used repeatedly for tooth preparations. In recent years, polymer burs described as “dentin safe,” it means that it removes only carious dentine; the bur will be self-limiting when it reaches sound, healthy dentin. Its use has shown to be effective in caries removal. Polymer burs can remove softened dentin but cannot cut hard healthy dentin.⁵

The design of the polymer cutting instrument is based on the differential hardness of the tooth tissues. The knop hardness of enamel is approximately 380-400 and that of dentine is 66-80.⁶ The Knoop Hardness for carious dentine is 30 KHN⁷. In order to achieve effective removal of caries from enamel, dentine and to match KHN with sound teeth an instrument made of polymer which has KHN 50 was devised. Since this bur remove only carious part of the tooth, there are less chances that the odontoblasts are exposed which can minimize the pain and sensitivity while preparing the cavity or post-operative procedure. These burs rotate at a speed of 500-800 rpm. Prabhakar A et al. (2009) evaluated the efficacy of Polyamide Polymer Burs for selective carious dentin removal and found that the Polyamide burs were found to be self-limiting and lose their cutting efficiency on reaching affected dentin and do not cut sound dentin.⁸

AIR ABRASION

Air abrasion technology was initiated by Dr Robert Black in the 1940's was successfully introduced in 1951 with the Airdent air abrasion unit (S.S. White). Firstly, air abrasion was not able to prepare cavities with well-defined walls and margins, and the materials during that time (mostly amalgam and direct or indirect gold) demanded such preparations since the concept of bonding had not been introduced. Secondly, the introduction of the air turbine handpiece in the late 1950s made conventional cavity preparations less time consuming. Thirdly, as high-velocity suction had not been developed, evacuation of the powder was difficult.⁹

Though the basic concept of the air abrasion device has remained the same, it has experienced a rebirth not due to changes in the device per se, but due to improvements in bonding, restorative materials, isolation, and high volume suction.^{10,11}

Air abrasion for restoration preparation removes tooth structure using a stream of aluminium oxide particles generated from compressed air or bottled carbon dioxide or nitrogen gas. The abrasive particles strike the tooth with high velocity and remove small amounts of tooth structure.⁹

ULTRASONICS AND SONIC INSTRUMENT FOR CARIES REMOVAL

Sonic and ultrasonic devices are commonly used in dental practices such as, periodontology, oral surgery, endodontics and prosthetics. High-frequency ultrasonic devices have been used in conservative dentistry since the 1950s. Sonic and ultrasonic tips have been declared useful for precise and controlled removal of both caries and unsupported hard tissue free of caries. Sonic and ultrasonic instruments remove caries by abrading hard and soft dental tissues with oscillating diamond-coated tips. The ultrasonic tips carry out high-frequency linear oscillations, ranging from 6500 to 40 000 Hz, powered by piezo-driven inserts. Similarly, the sonic tips also execute low-frequency (6000 Hz) elliptic oscillations generated by an air scaler insert. Both oscillating abrasion systems are cooled with a water spray.¹²

These ultrasonic tips offer an innovative technique for the removal of caries as a result of several characteristics:^{13,14,15}

1. Minimally invasive cavity preparation
2. Ample visibility of caries during cavity preparation
3. Easy removal of caries located in hard-to-reach areas (ie, lingual or buccal surfaces of posterior

teeth) due to specific angulate shapes of oscillating tips

4. Low frequency of iatrogenic damage to neighbouring teeth when proximal caries are treated
5. Low noise level and
6. Low requirement of administration of anaesthesia during patient treatment

LASER

Laser technology has been in the scope of dentistry community since Stern & Sognnaes (1964) studied laser application on dental hard tissues.¹⁶ Lasers have become an attractive instrument for many dental procedures including soft tissues surgery, decontamination and for assuring anti-inflammatory effects. In restorative dentistry, laser has been used successfully for cavity preparation, caries prevention, caries decontamination and caries removal.¹⁷

The use of lasers for cavity preparation and caries removal is based on the ablation mechanism, in which dental hard tissue can be removed by thermal and/or mechanical effect during laser irradiation (Seka et al., 1996). This mechanism relies on the type of tissue to be irradiated, as well as the characteristics of laser equipments.¹⁸

The laser drill has been proven to be efficacious in substituting the conventional traditional bur for cavity preparation. Initially only low-energy settings of the laser were used to help in achieving an analgesic effect on the tooth which is involved. This was followed by the higher-power setting of the laser which was done to aid in removing of the enamel and exposing the infected dentin. Consequently, the low-power setting laser was used once for a second time for removing decayed dentin. There was difference in ablation rates for carious and sound tissue which led to selective elimination of carious lesions. There is a rise in bond strengths of tooth-coloured materials because smear layer does not form when the tissue is irradiated with laser.^{19,20} In cases of carious lesions which are limited proximally having intact occlusal surface, lasers could be used to preparing a box only preparation on the proximal surface without destructing the sound occlusal surface. In cases where the carious lesion extends deep within the tooth, lasers can be used to prepare the cavity, by restricting its initial depth of preparation and selective removal of the superficial layer of dentin without injuring the underlying pulp. The cases which require direct pulp capping treatment due to accidental pinpoint non-carious exposure, Er: YAG lasers can be used in a defocussed mode for partly necrotising the superficial tissue in order to create a defensive barrier surrounding the exposed pulp tissue.²¹

CHEMOMECHANICAL CARIES REMOVAL

Chemomechanical caries removal (CMCR) is a minimally invasive technique of eliminating infected dentin using specific chemical agents and hand

instruments. The method of caries removal is based on chemical dissolution. It is mainly indicated to overcome the use of burs and local anaesthesia, causing less discomfort to patients, preserving healthy dentin structure, thereby complying by the concept of minimal intervention dentistry (MID).²

The chemo-mechanical method is an effective alternative for caries removal because it brings together:²²

1. Atraumatic characteristics
2. Bactericide & bacteriostatic action
3. The active ingredient would soften the pre degraded collagen of the lesion without pain & undesirable effects to adjacent healthy tissues.

CARIDEX AND CARISOLV

In 1976, Goldman & Kronman, reported an alternative to tooth tissue removal – the possibility of removing carious material chemically using N-monochloroglycine (NMG, GK-101). After subsequent modifications the caridex system, containing N-monochloro D, L-2-aminobutyrate (NMAB, GK-101E), was introduced. This system was developed as a chemo-mechanical method for caries removal. Carious dentine, softened further by NMAB (GK-101E), should have been readily removed by lightly abrading its surface with the applicator tip. Many studies have indicated that in permanent teeth, the ability of carious dentine removal using NMAB was no greater than using a control of isotonic solution. In deciduous teeth, however, addition of urea to the solution significantly improved carious dentine excavation compared with the some control solution without urea.²³ Carisolv™ reached the market promising to be more effective and easy to manipulate. The key difference to other products already in the market was the use of three amino acids- lysine, leucine and glutamic acid.²

NEW CARISOLV SYSTEM (2013)

It was introduced by Rubicon Life Science and includes an advanced gel, a new excavation technique and a new patented caries detector. Special hand excavators with blunt cutting angles and the Komet Bur Technology have been incorporated in this kit. The tissue preserving burs comprise of the ceramic bur CeraBur K1SM and the round polymer bur PolyBur P1. By means of a unique patented technology, the burs offer a considerably more minimally invasive treatment than traditional techniques. The CeraBur helps the dentist to distinguish between healthy and carious tissue in a tactile manner, which is reinforced when used with Carisolv Gel. The disposable PolyBur is softer than healthy dentin and is therefore self-limiting, and can thus be used in treatments close to the pulp. This new system provides an excellent bonding surface for bonded restorations.²⁴

PAPACARIE®

With the intension of presenting a chemomechanical caries removal product that cost less than Carisolv® in 2003 Papacarie® a material was launched which consists of papain enzyme (extracted from the latex of leaves and fruits of the green adult Carica papaya tree, chloramine, toluidine blue, salts, preservatives, a thickener, stabilizers and deionized water. The main action depends on the presence of the papain enzyme which is a proteolytic enzyme that causes degradation of proteoglycans in the dentinal matrix.²⁵

BIOSOLV

It is an experimental enzymatic chemomechanical caries removal agent which is not commercially available (coded SFC-V and SFC-VIII). Based on the manufacturer’s information, it consists of pepsin enzyme in a phosphoric acid/sodium biphosphate buffer. It is claimed that the phosphoric acid can dissolve the inorganic components of caries-infected dentine, while permitting the pepsin to selectively disrupt the denatured collagen fibres. Meanwhile, this softened mass can then be easily removed by the specially designed plastics instruments (Star V1.3) without affecting sound tissue.²⁶

Review of literature	
Author	Observation
Kumar J et al. (2012) ²⁷	Author compared the clinical efficiency of chemomechanical caries removal using Carisolv® and Papacarie® - a papain gel. He observed that the Carisolv® and Papacarie® have similar clinically efficiency as chemomechanical agents for dentinal caries removal.
Nagaveni NB et al. (2016) ²⁸	The study was conducted to evaluate clinically the effectiveness, total working time and pain reaction following treatment with a new chemomechanical caries removal gel (Carie-Care™) compared to conventional drilling method in primary teeth. It was found that Carie-Care™, a new chemomechanical caries removal agent could be an effective caries removal method for the treatment of patients seeking an alternative to conventional methods.
Anwar AS et al. (2017) ²⁹	Study was conducted to compare the microhardness of sound dentin before and after carious removal using a chemomechanical method and a conventional method. In accordance with the results obtained in this study, it may be concluded that: The rotary instrument group showed a consistent microhardness value with not much difference according to depth. The chemomechanical group showed a lesser microhardness value closer to the cavity floor than away from it.
Pandit IK et al. (2007) ³⁰	Author conducted an in vivo study comparing the different methods of caries removal were done in children of age group 6-9 years. Among these patients a total number of 150 carious deciduous teeth were selected. Caries removal was done by hand instruments, airtor and carisolv. The efficacy, time taken and pain experienced by the patient during caries removal was evaluated. Result of the study showed; <ul style="list-style-type: none"> • All the three methods removed caries effectively; however, the efficacy of caries removal determined using Ericson et al. scale was the highest with airtor, followed by almost comparable effectiveness by carisolv method and the least by hand instruments. • The time taken to remove caries by carisolv method was observed to be maximum, followed by hand instrument method and the minimum time was taken by airtor method. • The pain experienced by the patients during caries removal was found to be maximum with airtor method, followed by hand excavation and the least by carisolv method.

CONCLUSION

With the increasing trend and need for preserving natural tooth structure while providing a patient friendly environment, Minimal Intervention Dentistry is of great eminence in today’s scenario. Chemomechanical caries removal is a minimally invasive technique of eliminating infected dentin using specific chemical agents and hand instruments. The method of caries removal is based on chemical

dissolution. It is mainly indicated to overcome the use of burs and local anaesthesia, causing less discomfort to patients, preserving healthy dentin structure, thereby complying by the concept of minimal intervention dentistry. Papacarie and Carisolv removed caries effectively and with high patient acceptance and, therefore, they can be considered as viable alternatives to painful caries removal technique

like airotor in the management of dental caries, especially in pediatric patients.

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