www.jmscr.igmpublication.org
Impact Factor (SJIF): 6.379
Index Copernicus Value: 71.58
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v6i6.55

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

No Drill Dentistry: A Review of Advances in Non-Rotary Methods of Caries Removal

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Abstract
A surgical approach to the elimination of a carious lesion was developed a century ago, this approach was necessary at that time because there was no valid alternative. But nowadays New caries excavation techniques have been introduced .Non-rotary methods are 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). This paper reviews the newest developments in non-rotary caries excavation techniques and their mechanism of action.
Keywords: *Air abrasion, Chemomechanical caries removal, Lasers,No drill, Prevention of extension.*

Introduction

Minimal intervention is a new concept introduced by Mount and Hume in 1997[1]. This approach to treating dental caries includes many nonsurgical modalities, as well as the key concept that dental caries should be treated as an infectious disease. The main goal of minimal intervention is to increase the life of the teeth, which was restored with less intervention. Now the concept is "prevention of extension" rather than "extension for prevention. "The new non-rotary caries excavation techniques have been introduced, such as the use of improved caries-disclosing dyes, enzymatic caries-dissolving agents, caries-selective sono/air abrasion and laser ablation. They all aim to remove or help remove caries-infected tissue as selectively as possible, while being minimally invasive through maximum preservation of caries-affected tissue. At the beginning of the past century, when the first operative dentistry guidelines were established, the term "caries excavation" was defined as a synonym for "cavity preparation", which in turn consisted of "mechanical treatment of the injuries to the teeth produced by dental caries, as would best fit the remaining part of the tooth to receive a filling" From this definition, it appears that caries excavation procedures were regarded as one of the many mandatory steps to prepare a tooth to receive the filling material.[2]

Non–Rotary Caries Excavation Procedures

Air-abrasion excavation

The father of the concept of the air abrasive microdentistry is an American Dentist, Dr. J. Tim

Rainey, from Refugio, Texas, USA.[3] Air-abrasion systems for cavity preparation use the kinetic energy of abrasive particles to cut tooth structure in a less invasive way, while rounding off internal and cavosurface angles to the direct benefit of the subsequent adhesive restoration.[4] A powerful narrow stream of moving aluminum oxide particles is directed against the surface to be cut. When these particles hit the tooth surface, they abrade it,without heat, vibration or noise.[5]

The instrument was first developed in the 1940's by Dr. Robert Black. In 1951- S.S. White Technology introduced Air-Dent the first commercially available unit for preparing cavities in teeth air abrasion.[6] Although 27-µm alumina particles have proven to remove more carious dentin than particles with larger dimensions (50- and 125-µm diameter), cavities produced in sound dentin were still considerably deeper than in carious dentin.[7]

Other types of particles were tested in order to improve the effectiveness of caries removal with air-abrasion systems like spherical glass beads with different diameters, Polycarbonate resin-crushed powder but further clinical investigations with these particles are still lacking[2]. A mixture of alumina and hydroxyapatite in a volume ratio of 3:1, with particle sizes ranging from 3 to 60 µm, was shown to be as efficient as conventional hand excavation with dental spoons, and was positively rated when related to the auto-fluorescence signature of the lesion[8].

An air-abrasion system that makes use of a bioactive glass powder (Bioglass, Novamin Technology; Alachua, USA) with a particle diameter between 25 and 32 µm was also explored. Although still removing sound dentin, the risk of unnecessary sound dentin removal was reduced because of the difference in cutting rate between sound and carious dentin[9]. It should be avoided in cases involving severe dust allergy, asthma, chronic obstructive lung disease, recent extraction or other oral surgery, open wounds, advanced periodontal disease, recent placement of orthodontic appliances and oral abrasions, or subgingival caries removal. Many of these conditions increase the risk of air embolism in the oral soft tissues.[10]

Ultrasonics

1950s.Nielsen et al designed Magnetostrictive instrument With 25kHz oscillating frequency in Conjunction with thick aluminum oxide and water slurry[13,14].The kinetic energy of water molecules being transferred to the tooth surface via the abrasive through the high speed oscillations of the cutting tip. It was found that harder the tissue, the easier it was to cut. However the results were inconclusive due to erratic and unpredictable performance of the instrument[14].

Sonic oscillation (SONO-Abrasion)

"A recent development from the original ultrasonics is the use of high frequency, sonic air-scalers with modified abrasive tips a technique known as SONO-ABRASION." The handpiece oscillates in the sonic region (<6.5 kHz), & tips describe an elliptical motion with a transverse distance of between 0.08 and 0.15 mm and a longitudinal movement of between 0.055 and 0.135 mm. They are diamond coated on one side using 40 µm grit diamond and are cooled using water irrigant at a flow rate between 20 and 30 ml/min. The operational air pressure for cavity finishing should be around 3.5 bar[13]. A maximum 2-N torque force should be applied, otherwise the cutting efficiency is reduced due to damping of the oscillations[9]. Regarding caries removal, the effectiveness of sono-abrasion based on its auto-fluorescence signature has shown a tendency to underprepare carious cavities[8].

The surface topography of dentin after sono-abrasion excavation with diamond-coated tips revealed relatively little or even no evidence of smear layer formation,[14] which may be advantageous for the bonding effectiveness of so-called mild self-etching adhesives in particular.

More recently, the Cariex system (Kavo Dental; Biberach, Germany) was launched, including two sets of cutting tips: two diamond-coated tips with different diameters for enamel preparation and two

tungsten-carbide tips with different diameters for dentin excavation (Fig 1). The effectiveness and efficacy of these new tungsten carbide tips in removing carious dentin have, however, not yet been explored.

Hydrokinetic technique – LASER Excavation

The word "laser" is an acronym for "Light Amplification by Stimulated Emission of Radiation", which means that laser devices produce beams of coherent and high -intensity light.[15]. Early use of infrared lasers, such as carbon dioxide (10.6μm wavelength) and ruby lasers, to remove carious dentin results in a slow removal of tissue and excessive heat transfer to the dental pulp. The erbium-loaded yttrium-aluminum-garnet (Er:YAG) and the erbium,chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) lasers are the two types of erbium-based devices currently available on the market. Both devices present very similar wavelengths (2.78 μm for Er, Cr:YSGG and 2.94 μm for Er:YAG), although the Er,Cr:YSGG laser is discretely more absorbed by hydroxyapatite than Er:YAG[15].

Several advantages have been related to the use of laser irradiation in operative dentistry, such as a more conservative cavity design, an alleged antibacterial activity,[16] and a significant decrease of enamel solubility, therefore also possibly playing a role in the prevention of recurrent caries.[17] Moreover, laser ablation apparently provides more comfort to the patient due to the absence of vibration[18] and a lower pain sensation. In fact, the need for local anaesthesia is reported to be lower when compared to the use of conventional rotary instruments.[19] Absence of smear layer is very often mentioned as an advantage of laser irradiation of tooth surfaces, in particular for bonding procedures.[20.21] However, while relatively high bond strengths have been reported with either an etch-and rinse or a self-etching adhesive after caries removal with an Er:YAG laser,[22] other authors found lower bond strengths to laser-irradiated dentin when compared to a conventionally bur-cut substrate.[23,24,25]

On the other hand, the major drawback related to their use in operative dentistry is the relatively long time needed for cavity preparation. Although Er:YAG laser ablation is not selective for carious dentin, it has been described that the popping sound emitted by these lasers when operating in dental hard tissues changes according to the presence or absence of caries. This change in sound could assist the user in determining when caries removal is complete.[15]

Chemo-mechanical Excavation

As the name suggests, Chemomechanical Caries Removal involves the application of a chemical solution to the carious dentine followed by gentle removal with hand instruments. It has seen to be very efficient in its caries removal effectiveness while maintaining its minimal invasive potential. It is based on biological principles which involves removal of only the infected dentine while retaining the affected dentin.

Sodium hypochlorite based agents

These agents contain sodium hypochlorite derivatives which chlorinate and disrupt the hydrogen bonds of partially degraded, collagen in carious dentine which are then removed using hand instruments[26]. In the early 1970's, 5% NaOCl solution was used, but was rendered unstable[27] and non-specific[28].

GK-101/N-monochloroglycine

Goldman and Kronman (1976) incorporated sodium hypochlorite into Sorensen's buffer (containing glycine, sodium chloride and sodium hydroxide) to reduce the corrosiveness.[29] GK-101 acts by disrupting the organic structure of dentine by converting hydroxyproline (which stabilizes collagen) to pyrrole-2-carboxyglycine (which is friable and can easily be removed). However, this solution was not very effective in caries removal.[30]

Caridex/GK-101E/N monochloroaminobutyrate

Schutzbank found that the GK101 system was more effective if glycine was replaced by amino butyric acid[31], The NMAB system was patented in the US.

It received FDA approval for use in the USA and was marketed as Caridex (1984).

Solution I contained sodium hypochlorite and Solution II contained glycine, aminobutyric acid, sodium chloride and sodium hydroxide. The action of Caridex on denatured collagen fibrils was similar to that of GK-, which involved chlorination of the partially degraded collagen in the carious lesion and the conversion of hydroxylproline to pyrrole-2-carboxylic acid[32]. Yip et al suggested a modification using Urea which increased the caries removal potential[33]. Limitations of Caridex were that large volumes of solution were needed (200–500 ml), a delivery system was required and the procedure was very slow[26],[27].

Carisolv

MediTeam in Sweden developed Carisolv (1998) which was in the form of a pink gel that can be applied to the carious lesion with specially designed hand instruments[33]. Syring I contains the sodium hypochlorite solution and the syring II is pink viscous gel which contains three amino acids: lysine, leucine and glutamic acid, together with carboxymethylcellulose to make it viscous and erythrocin dye to make it readily visible in use. Because it is a gel, the volume required is less than 1ml, it is much easier to apply, and there is better contact with the carious lesion[34].

The New Carisolv system was introduced by Rubicon Life Science and (2013) 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 method of excavation is not a complete non-rotary as the system includes the tissue preserving burs comprise of the ceramic bur Cera Bur K1SM and the round polymer bur Poly Bur P1. By means of a unique patented technology, the burs offer a considerably more minimally invasive treatment than traditional techniques. The Cera Bur helps the dentist to distinguish between healthy and carious tissue in a tactile manner, which is reinforced when used with Carisolv Gel. The disposable Poly Bur 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[35].

Enzymatic based agents

Papacarie and Carie-care have been reported to be effective in removal of caries by the action of the natural extract of pepsin enzyme from the Carica papaya tree [36,37]. An experimental product called Biosolv (SFC-V and SFC-VIII) is being developed using pepsin enzyme in a buffered solution[38].

a. Papacarie gel: Bussadori et al (2003) introduced Papacarie[39] which consists of papain enzyme (extracted from the latex of leaves and fruits of the green adult Carica papaya tree[36], chloramine, toluidine blue, salts, preservatives, a thickener, stabilizers and deionized water[39]. The papain enzyme is a proteolytic enzyme that causes degradation of proteoglycans in the dentinal matrix[39]. It also has bactericidal and anti-inflammatory actions [40]. The chloramine enhances the removal of denatured tissues [41].

b. **Carie-care** It is a more recent solution developed by Uni-Biotech Pharmaceuticals Private Limited, Chennai, India in collaboration with Vittal Mallya Scientific Research Foundation (2010). Even this is a gel-based formulation containing papain enzyme along with the benefits of Clove oil. Papain breaks peptide bonds and involves deprotonation of Cys-25 by His-159. Clove oil is a natural analgesic and anaesthetic[37].

c. 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[38]. 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[41]. Meanwhile, this softened mass can

then be easily removed by the specially designed plastics instruments (Star V1.3) without affecting sound tissue [38].

Ozone technology (O3)

Ozone (O3) is an energized form of oxygen. Ozone therapy has been extensively used in the medical professions since more than a century. It is no longer a discussion point reserved for the environmentalists only. Currently, a new treatment modality based on ozone is being introduced as an alternative to local anesthesia, drilling and filling for the management of dental caries. Ozone is one of the nature's most powerful oxidant, which accounts for its ability to kill bacteria, spores, and viruses. Ozone therapy is based on the premise that the primary carious lesions when exposed to ozone become sterile and re-mineralize after some time. Thus, it presents a radically different approach to the traditional "ampulation" approach to remove the acidophilic microorganisms in dental caries.[42]

Conclusion

It is apparent that it is time for a change in operative dentistry. It is not possible to really imitate natural tooth structure on a long term basis, so it is best that it be retained as far as possible. The surgical approach for the restoration of diseased tooth structure leads to loss of both esthetics and strength. The non-rotary methods eliminate the noise of motor driven instruments, reduce pain perception, which in turn reduce the anxiety .These methods can be considered as viable alternatives to conventional rotary caries removal methods with no harm expected either on the healthy dentine or the pulp tissues due to their Conservative and Pain-free approach.

References

1. Murdoch-Kinch CA, McLean ME. Minimally invasive dentistry.*J Am Dent Assoc* 2003;134:87-95.
2. Black GV. Cavity preparation. In: Black GV (ed). A work on operative dentistry. Chicago: *Medico-Dental Publishing Company*, 1908:105-116.
3. Horiguchi S, Yamada T, Inokoshi S, Tagami J. Selective cariesremoval with air abrasion. *Oper Dent* 1998;23:236-43.
4. Black RE. Technique for non-mechanical preparation of cavities and prophylaxis.*J Am Dent Assoc* 1945;32:955-965.
5. Reyto R. Lasers and air abrasion. New modalities for tooth preparation. *Dent Clin North Am 2001*;45(1):189-206.
6. White JM, Stephan EW, Rationale and treatment approach in minimally invasive dentistry. J Am Dent Assoc. 2000;131:13s-19s.
7. Motisuki C, Lima LM, Bronzi ES, Spolidorio DMP, Santos-Pinto L. The effectiveness of alumina powder on carious dentin removal. *Oper Dent 2006*;31:371-376.
8. Banerjee A, Kidd EA, Watson TF. In vitro evaluation of five alternative methods of carious dentine excavation. *Caries Res* 2000;34:144-150.
9. Banerjee A, Watson TF. An in vitro investigation of the effect and retention of bioactive glass air-abrasive on sound and carious dentine. *J Dent* 2008;36:214-218.
10. Rainey JT. Air abrasion: an emerging standard of care in conservativeoperative dentistry. *Dent Clin North Am* 2002;46(2):185-209.
11. Nielson AG, Richards JR, Wolcott RB. Ultrasonic dental cutting instrument: I. *J Am Dent Assoc* 1955; 50(4): 392-9.
12. Nielson AG. Ultrasonic dental cutting instrument: *J Am Dent Assoc* 1955; 50(4): 399-408.
13. Peters MC, Mclean ME. Contemporary technique and materials;an overview. *J Adhes Dent* 2001;3:17-31.
14. Yazici AR, Ozgunaltay G, Dayangac B. A scanning electron microscopic study of different caries removal techniques on human dentin. *Oper Dent2002*;27:360-366.

15. Walsh LJ. The current status of laser applications in dentistry. *Austr DentJ* 2003;48:146-155
16. Turkun M, Turkun LS, Celik EU, Ates M. Bactericidal effect of Er,Cr:YSGG laser on streptococcus mutans. *Dent Mater J 2006;25:81-86.*
17. Cecchini RC, Zezell DM, de Oliveira E, de Freitas PM, de Paula CE. Effect of Er:YAG laser on enamel acid resistance: Morphological and atomicspectrometry analysis. *Lasers Surg Med* 2005;37:366-372.
18. Keller U, Hibst R. Effects of Er:YAG laser in caries treatment: A clinical pilot study. *Laser Surg Med* 1997;20:32-38.
19. Keller U, Hibst R, Geurtsen W, Schilke R, Heidemann D, Klaiber B, Raab WHM. Erbium: YAG laser application in caries therapy. Evaluation of patient perception and acceptance. *J Dent* 1998;26:649-656.
20. Jepsen S, Acil Y, Peschel T, Kargas K, Eberhard J. Biochemical and morphological analysis of dentin following selective caries removal with a fluorescence- controlled Er:YAG laser. *Laser Surg Med* 2008;40:350-357.
21. Kinoshita J, Kimura Y, Matsumoto K. Comparative study of carious dentin removal by Er, Cr:YSGG laser and Carisolv. *J Clin Laser Med Surg*2003;21:307-315.
22. Sattabanasuk V, Burrow MF, Shimada Y, Tagami J. Resin adhesion to caries-affected dentine after different removal methods. *Austr Dent J2006*;51:162-169.
23. Cardoso MV, Coutinho E, Ermis RB, Poitevin A, Van Landuyt K, De Munck J, Carvalho RC, Lambrechts P, Van Meerbeek B. Influence of Er,Cr:YSGG laser treatment on the microtensile bond strength of adhesives to dentin.*J Adhes Dent* 2008;10:25-33.
24. Tachibana A, Marques MM, Soler JM, Matos AB. Erbium, chromium: Yttrium, scandium, gallium garnet laser for caries removal: Influence on bonding of a self-etching adhesive system. Lasers *Med Sci* 2008;23:435-441.
25. Van Meerbeek B, De Munck J, Mattar D, Van Landuyt K, Lambrechts P. Microtensile bond strengths of an etch&rinse and self-etch adhesive to enamel and dentin as a function of surface treatment. *Oper Dent* 2003;28:647-660.
26. Maragakis GM, Hahn P, Hellwig E (2001) Chemomechanical caries removal: a comprehensive review of the literature. *Int Dent J* 51(4): 291-299.
27. Burke FM, Lynch E (1995) Chemomechanical caries removal. *J IrDent Assoc* 41: 10-14.
28. Hand RE, Smith ML, Harrison JW (1978) Analysis of the effect of dilution on the necrotic tissue dissolution property of sodium hypochlorite. *J Endod* 4(2): 60-64.
29. Goldman M, Kronman JH (1976) A preliminary report on a chemomechanical means of removing caries. *J Am Dent Assoc* 93(6): 1149-1153.
30. Kurosaki N, Sato Y, Iwaku M, Fusayama T (1977) Effect of acarious dentin softener on the dentin and pulp. *J Prosthet Dent* 38(2): 169-173.
31. SG Schutzbank, J Galaini, JH Kronman, M Goldman, RE Clark (1978) A comparative invitro study of GK-101 & GK-101E in caries removal. JDR 57(9-10): 861-864. Beeley JA, Yip HK, Stevenson AG (2000) Chemochemical caries removal: a review of the techniques and latest developments. *Br Dent J* 188(8): 427-430.
32. HK Yip, AG Stevenson, JA Beeley (1995) An improved reagent for chemomechanical removal of dental caries in permanent & deciduous teeth: an invitro study. *J Dent* 23(4): 197-204.
33. Ericson D, Zimmerman M, Raber H, Gotrick B, Bornstein R, et al. (1999) Clinical evaluation of efficacy and safety of a new method for chemomechanical removal of

caries. A multi-centre study. *Caries Res* 33(3): 171-177.

34. Albrektsson T (2001) Tissue preservation in caries treatment. London:Quintessence : 159.
35. Bussadori SK, Castro LC, Galvao AC (2005) Papain gel: a new chemomechanical caries removal agent. *J Clin Pediatr Dent* 30(2): 115- 119.
36. Looze Y, Boussard P, Huet J, Vandenbusche G, Azarkan M, et al. (2009) Purification and characterization of a wound-inducible thaumatin-like protein from the latex of Carica papaya. *Phyto chemistry* 70(8): 970-978.
37. Fusayama T (1979) Two layers of carious dentin: diagnosis and treatment. *Oper Dent* 4(2): 63-70.
38. Botelho Amaral FL, Martao Florio F, Bovi Ambrosano GM, Basting RT (2011) Morphology and micro tensile bond strength of adhesive systems to in situ-formed caries-affected dentin after the use of a papain-based chemomechanical gel method. *Am J Dent* 24(1): 13-19.
39. Suzan Sahana, Aron Arun Kumar Vasa, Divya Geddam, Vamsi Krishna Reddy, Sowjanya Nalluri, et al. (2016) Effectiveness of Chemomechanical Caries Removal Agents Papacarie® and Carie- Care TM in Primary Molars: An invitro Study. *Journal of International Society of Preventive & Community Dentistry* 6(4): 391.
40. Clementino-Luedemann TN, Dabanoglu A, Ilie N, Hickel R,Kunzelmann KH (2006) Micro-computed tomographic evaluation of a new enzyme solution for caries removal in deciduous teeth. *Dent Mater J* 25(4): 675-683.
41. Neves Ade A, Coutinho E, De Munck J, Van Meerbeek B (2011) Caries removal effectiveness and minimal-invasiveness potential of caries-excavation techniques: a micro-CT investigation. *J Dent* 39(2): 154-162
42. Bogna P, Nikhil V, Singh V, Sharma S, Arora V. Ozone therapy for dental caries – A revolutionary treatment for the future.*J Indian Dent Assoc* 2003;74:41.