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Concepts on Chemo-Mechanical Caries Removal Method

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Abstract

Minimal invasive dentistry embraces beliefs that assimilate remineralisation, and inhibition as well as minimal intervention for restorations. By using the least intrusive surgical approach, minimally invasive dentistry affects the treatment objective where a minimal number of healthy tissues are removed. Various methods are now accessible for the excavation of caries. The crudest way to deal with the management of cavities can be done by using hand equipment or instruments, which was an excruciating as well as insufficient strategy for caries removal. Accordingly, the "mission" for more current materials and procedures in the field of caries management led to the utilization of minimally invasive methodologies. Among all the minimally invasive dentistry procedures, the chemo mechanical caries removal method can remove carious tooth material efficiently by hand instruments and a solution. The concept of caries removal by chemo mechanical method reveals the initial diagnosis of carious lesions and helps in minimal destruction of tooth structure during caries removal. This review paper highlights the caries removal methods by the chemo mechanical concept and discusses the various chemo mechanical caries removal agents as well as their properties.

Keywords: Advantages, Caridex, Carisolv, Chemo Mechanical Caries Removal (CMCR), Dental Caries, Disadvantages, Mechanism of Action, Minimal Invasive Dentistry, Papacarie.

Introduction

"Caries" is a derivative word from Latin signifying "rot," and in Greek means (ker), it signifies "death." As per WHO, caries is characterized as a pathological process of external localized post-eruptive origin which involves softening of hard tooth tissue that proceeds towards the formation of a cavity"(1). Various methods are now accessible for the excavation of caries. This was followed with the conventional technique for caries expulsion that used low-speed rotary instruments to ultrahigh-speed instruments. Nonetheless, this method is constantly connected with numerous weaknesses, for example, (a) conventional drilling is disagreeable by many patients, (b) the incessant necessity of local anesthesia, (c) Malicious thermal effects will be enhanced by drilling methods, (d) can likewise be the effect of pressure consequences on the pulp, (e) utilization of drilling may bring about inordinate elimination of sound tooth structure (2). Studies (3, 4) done on dental apprehension have revealed that dental drilling is the most exceptionally traumatic element in delivering discomfort or pain while treating numerous patients, particularly youngsters. All such difficulties in the field of caries management led to the utilization of minimally invasive procedures. Minimal invasive dentistry embraces beliefs that assimilate remineralization, and inhibition as well as minimal intervention for the restorations. MID comprises several technical methods: a) Air abrasion (4) b) ART (5) c) Sono abrasion (6) d) Laser (7) e) CMCR (8). This review paper highlights the caries removal methods by the chemomechanical concept and discusses the various chemochemical caries removal agents as well as their properties.

Concept of Chemochemical Caries Removal Method

Concept of Chemochemical Caries Removal Method (CMCR) method is a type of non-invasive procedure that removes infected dentine through a chemical solution or agent. Rather than drilling, the CMCR method utilizes a chemical solution helped by a traumatic mechanical way to eliminate delicate carious structure (9). This process of caries excavation relies upon dissolution by mechanical force or hand instruments without causing any trauma while removing soft carious structures. The chemo-chemical concept of the

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caries removal method reveals the initial diagnosis of carious lesions and helps in minimal destruction of tooth structure during caries removal. The primary target is to conserve the natural tooth structure (10).

Advantages of Chemo Mechanical Method

The chemomechanical caries removal method is more comfortable and will cause fewer traumas for patients. Especially in children as well as medically compromised patients, the CMCR method causes less anxiety as well as fear and leads to less discomfort to patients during treatment. This method will help in preservation of tooth structure as it removes only the infected layer of dentin as well as there will be no pulpal sensitivity or irritation. It is very advantageous in patients having tuberculosis-like infectious diseases as this method will help in preventing droplet infection.

Indications for Chemomechanical Caries Removal Method

The eligible indicative criteria for this method includes the following: - a) Where protection of tooth structure is significant b) Root/cervical caries removal c) Coronal caries with cavitation d) Removal of caries at crown edges and bridge abutments e) Local anesthesia is contraindicated f) Needle phobia in dentally anxious patients g) Primary carious lesions in deciduous teeth h) In patients with exceptional necessities.

Principal of Chemomechanical Caries Removal Method

The principal behind the CMCR method is the solution that is used to modify the tissue of cavitated tooth chemically to soften it further, thus enabling its stress-free excavation. By using a hand instrument, the tempered dentine that is softened now is then mechanically removed. The process of excavating caries by using this chemomechanical caries removal method preserves a healthy dental structure that only removes infected tissues and helps in avoiding pulp irritation as well as patient discomfort. Usually, GIC as a restorative material tends to bond to the dentine surface (11) very well and is preferred with such kind of caries removal technique (CMCR).

Advancement of Chemomechanical Caries Removal Agents

Early years of the 1970s were having researchers who had started using various chemomechanical caries removal agents like EDTA (12), collagenase (13, 14) and sodium dodecyl sulphate (13). During these years, several chemomechanical caries removal agents were developed and are commercially available. Because of the overview of new agents, CMCR agents are categorized into either NaOCl or enzyme-based agents as shown in Figure 1. The different types of CMCR agents as listed in Table 1 (5, 7, 11, 15–19).

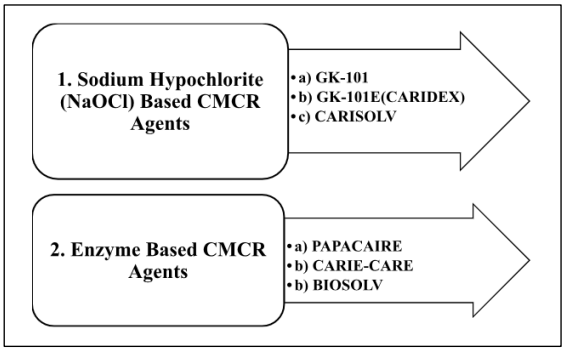

Figure 1: Classification of Chemomechanical Caries Removal Agents

Table 1: Summary of the Chemo-Mechanical Caries Removal Agents

CMCR Agent	Year of Introduction	Chemical Composition	Instrumentation	Mean Excavation Time
GK-101	Introduced by Goldman & Kronman in the year 1976.	Solution A: 0.05% N-monochloroglycine.	Need special delivery equipment	Average of 8.5 min

			Solution B: 4 – 6 % NaOCl.		
Sodium Hypochlorite (NaOCl) Based CMCR Agents	GK-101E (CARIDEX)	GK-101E got FDA approval in 1984 & was marketed as 'caridex' (USA, NJ, National Patent Dental Products, Inc., New Brunswick)	Solution A: N-monochloro-DL-2 amino butyrate (NAMB) Solution B: 4 – 6 % NaOCl.	Need special delivery equipment	When compared to GK-101 time duration, there was not much significant improvement except for the lag period of 30-90 seconds.
	CARISOLV	1998, revised at 2004 by Fure and Lingstrom, ¨ 24. 2013 the New Carisolv System © was introduced. Medi Team Dentalutvecklin g AB, now Rubicon Life Science AB, G€oteborg, Sweden.	1. Original gel (before 2004): Syringe A: carboxymethylce llulose-based gels, colouring agent, and amino acids (glutamic, leucine and lysine) in one Syringe B: 0.25% NaOCl in the other. 2. Modified gel (after 2004) Multimix syringe comes into market 3. New Carisolv SystemTM (2013) Incorporation of minimally invasive burs. Special Carisolv caries detector dye to the modified Carisolv gel to shorten the caries excavation time. Commercially Carisolv gel is marketed in two different packages:- € Carisolv gel – Multimix € Carisolv gel – Single mix Carisolv gel is available in 2 syringes. From each syringe equal parts mixed	Non-cutting tip hand instruments: Ceraand Polymer Burs (Komet, UK)	Original carisolv gel showed prolonged time duration of 10.4+6.1 min & 12.2+4.1min respectively. However, new carisolv gel exhibited shorter time duration in deep carious lesion 9.0+7.0 min10 in converse of its action in moderate sized lesions. Overall mean excavation time is 5.5 min.

			to form the active gel substance. a) Syringe I: 0.5% NaOCl b) Syringe II: Amino acids-Lysine, Leucine and glutamic acid, Carboxymethyl cellulose, Erythrocin, and NaOH		
Enzyme Based CMCR Agents	PAPACAIRE	2003 (Brazil, Formula & Acao)	Chloramine, Papain enzyme, chloramine, toluidine blue, salts,preservatives, athickener, stabilizers, and deionized water	Recommended for utilizing the back of blunt spoon excavator	For primary teeth -4.2 min & for permanent ones -4.17 min.
	CARIE-CARE	By Unitech Pharmaceuticals Vittal Mallya Scientific Research Foundation, 2010	Papain-derived gel; its modified version		
	BIOSOLV (SFC-V & SFC-VIII, 3M-ESPE AG, Seefeld, Germany)	Introduced by Clementino Luedemann et al., is still under the wraps because of its confusing and contradictory limited data.	It consists of pepsin enzyme dissolved in phosphoric acid along with sodium phosphate buffer.	Demands special instrument star V1.3 for its application (specially designed plastic instruments (Star V1.3)	

Table 2: Mechanism of Action / Biological Response of Chemomechanical Caries Removal Agents on Carious Tooth

CMCR Agent		Biological Response to Carious Tooth
Sodium Hypochlorite (NaOCl) Based CMCR Agents	GK-101	Conversion of hydroxyproline (which stabilizes collagen) to pyrrole-2- carboxyglycine (friable and easy to remove) is initiated by disrupting the organic structure of dentine.
	GK-101E (CARIDEX)	The chlorination mode of action as like GK-101 along with the dissolution of the denatured collagen fibrils causes the oxidation of glycine residues.
	CARISOLV	Same as caridex but here collagen fibrils get disrupted which helps in becoming more friable and thus easily removable. The mechanism of action of carisolv gel is based on the proteolytic action of sodium hypochlorite which helps in dissolving infected dentin. It is because of the breakdown of the degraded collagen by chlorine. The amino acids intensify the effect on the denatured collagen.
	PAPACARIE	Caries affected tooth tissues lost the antiprotease a-1-antitrypsin. while the action of papacarie causes the degradation of

Enzyme-Based CMCR Agents		proteoglycans of the dentinal matrix. The chloramine enhances the removal of denatured tissues.
	BIOSOLV	It is believed that this solution consists of pepsin enzyme in a phosphoric acid buffer that dissolves the inorganic components of caries-infected dentine and thus the denatured collagen fibrils get disrupted.

Table 3: Advantages and Disadvantages of various CMCR Methods

CMCR Agent		Advantages	Disadvantages
Sodium Hypochlorite (NaOCl) Based CMCR Agents	GK-101	• No potential harm to pulp & other oral tissues	• Inefficient in removal of entire carious lesion & for achieving the adequate finishing of excavated sites, use of burs become mandatory. • Time consuming procedure and require a great quantity of solution to achieve caries-free surface.
	GK-101E (CARIDEX)	• Increased specificity of solution towards infected dentin than affected dentin; Combination of urea and caridex improved its efficacy while removing caries in deciduous teeth.	• Slow and costly method where large volumes of solution are required (200 to 500 ml). • Efficacy and speed of caries removal needed improvement. • During application large reservoir with a pump is required and also the hand instruments are not optimal. • The shelf-life of an opened container was short.
	CARISOLV	• No requisite of prior heating because of its gel form. • Improved handling properties due to the high viscosity of carboxymethylcellulose. • It exhibits both bactericidal and haemostatic impact on exposed pulp tissue promoting its regeneration. Apart from its role as CMCR, it can be utilised in other halves of dentistry as plaque removal, irrigating solution, and treatment of oral ulcers. e. Root caries can be effectively removed by this gel.	• Proven to be less effective than the rotary technique due to its gradual process, customised instrument & and large usage of solution (which leaves the dentin surface irregular) thus, making it cost-effective. • Patient often complains of bad taste/odour like that of chlorine. • Application is time-consuming and costly. • Unpleasant smell and taste • It has limited shelf life and there are chances of wastage of material while re-application.

Enzyme-Based CMCR Agents	PAPACARIE	• Papacarie gel is easily available on a commercial basis at a low cost. • Highly effective with shorter excavation period • Papain, being the main constituent has got the bactericidal & anti-inflammatory properties, thus being the most biocompatible. • There is no requisite of either special instruments or extensive training thereby, making it user friendly	• Papacarie somewhat affects the mechanical properties of mineralised dentin.

Mode of Action

The various chemomechanical caries removal solutions or agents act differently on carious teeth and are explained in Table 2 (13, 19–28). The pros and cons of various chemomechanical caries removal agents are mentioned in Table 3 (9, 12, 29-32).

Importance of Chemomechanical Caries Removal Methods in the Pediatric Population

The chemomechanical caries removal technique was developed especially to overcome these difficulties and to preserve the healthy dentine tissue. The known barriers such as anxiety and fear towards dental treatment can opt for this CMCR method (7). The conventional drilling techniques are accompanied by discomfort, specifically among children as well as the low and high-speed rotary instruments (2, 15). The local anesthetic injection is the most anxiety-provoking procedure for children (16) so in that case this CMCR method will be very helpful. By adopting the chemomechanical caries removal method, the anxiety-provoking factors can be easily managed at any dental setup, especially in the case of children.

Discussion

The concept of chemomechanical caries removal method has been there in dentistry since an early period. The method of chemomechanical caries removal concept is always an effective cost efficacy method. By using various chemomechanical caries removal agents, the approach made is even more effective. The various agents discussed here in this study have their own pros and cons but no doubt the agents have always made the chemomechanical concept of caries removal more easy and approachable. The time required for caries removal with respect to various caries removal agents may vary but they all have the efficacy of removing caries properly.

Conclusion

CMCR was acquainted with dentistry as an elective technique for caries excavation and is primarily shown to come out from the burden of utilizing burs as well as local anaesthesia, making less restlessness patients as well as protecting healthy tooth anatomy, thereby agreeing to the idea of minimal invasive dentistry (MID). Given existing indications, it tends to be inferred that the presently accessible chemomechanical caries removal techniques should be reflected as a practical option in contrast to customary rotary caries removal methods. The concept of caries removal by using the CMCR technique with its various chemical gels or solutions is now trending successfully because of its beneficial properties like great efficiency, easy application, not at all destructive in nature, and very comfortable to the dentinal tissue. There is immense scope of

research that can be taken up on the effect of chemomechanical caries removal in the future.

Abbreviations

WHO: World Health Organization, CMCR: Chemo Mechanical Caries Removal, ART: Atraumatic Restorative Technique, GIC: Glass Ionomer Cement, EDTA: Ethylene Diamine Tetra-acetic Acid, NaOCl: Sodium Hypochlorite, MID: Minimal Invasive Dentistry.

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Author Contributions

Debasruti Naik: conceived the idea, analysed the material and prepared the original draft. Dharmashree S, Nikita Sahu, Utkalika Das have structured and edited the manuscript.

Conflict of Interest

There is no conflict of interest among the listed authors.

Ethics Approval

Not Applicable.

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