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Review Article

Recent Advances in Caries Prevention: A Comprehensive Review

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ABSTRACT:
Caries, a prevalent global health issue, significantly affects individuals of all ages. Recent advances in caries prevention have underscored the importance of multifaceted approaches that integrate technological innovations, behavioral modifications, and advancements in material science. This review examines the latest evidence pertaining to the efficacy of fluoride varnishes, silver diamine fluoride, and minimally invasive techniques in preventing caries development. We also explore the role of dietary modifications, including reduced sugar intake and the incorporation of xylitol, in enhancing oral health. Furthermore, digital tools such as artificial intelligence in risk assessment and personalized preventive strategies are highlighted. By synthesizing current research findings, this review aims to provide a comprehensive understanding of contemporary strategies in caries prevention and their implications for public health policies.
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INTRODUCTION

Caries, commonly known as dental cavities, is one of the most widespread chronic diseases globally, affecting individuals across all age groups. The World Health Organization underscores its importance as a public health concern, as untreated caries can lead to pain, infections, and significant morbidity. Recent advances in caries prevention have revolutionized the understanding and management of this condition, emphasizing proactive rather than reactive approaches.[1]

Historically, caries prevention focused primarily on mechanical means, such as drilling and filling cavities once they developed. However, emerging research has shifted the paradigm towards prevention and early intervention. This shift is supported by evidence-based approaches that leverage technological innovations, materials science advancements, and behavioral modification strategies. The objective of this comprehensive review is to explore and discuss recent developments in caries prevention methodologies, assessing their effectiveness and practical implications.[2]

One of the most significant advancements in caries prevention is the enhanced use of fluoride treatments. Fluoride, a naturally occurring mineral, has long been recognized for its ability to remineralize enamel and inhibit microbial activity. Recent studies have demonstrated the efficacy of high-concentration fluoride varnishes and gels, which provide prolonged fluoride release and enhanced penetration into the tooth structure. Additionally, the introduction of silver diamine fluoride (SDF) represents a novel approach to caries management. SDF not only arrests caries

progression but also serves as a cost-effective, minimally invasive solution, especially in vulnerable populations.[3,4]

Minimally invasive dentistry emphasizes early intervention and conservative treatment options. Techniques that involve sealing fissures or re-mineralizing early carious lesions have gained traction in recent years. These approaches reduce the need for more invasive procedures, thus preserving tooth structure and improving patient comfort. Moreover, there is a growing body of evidence supporting dietary modifications in caries prevention. Limiting sugar intake, particularly refined sugars, plays a crucial role in reducing caries risk. The introduction of sugar alternatives, such as xylitol, has shown promise in disrupting the oral microbiome and reducing cavity formation.[1,2]

Alongside these treatment advancements, the integration of technology has provided new avenues for caries prevention. Artificial intelligence (AI) and machine learning techniques are being utilized for risk assessment. By analyzing patient data, these technologies can help predict caries susceptibility, enabling personalized preventive strategies tailored to individual needs. The use of mobile applications and digital platforms has also fostered greater patient engagement and education, empowering individuals to take proactive steps in their oral health.

Public health initiatives focusing on community education and awareness are essential for effective caries prevention. Programs promoting regular dental check-ups, proper oral hygiene practices, and healthy dietary habits can significantly lower caries prevalence rates. Collaboration among dental professionals, policymakers, and communities is crucial to ensure that effective preventive measures reach those most at risk.[5]

In conclusion, the landscape of caries prevention is rapidly evolving, driven by scientific innovation and a deeper understanding of preventive strategies. This review aims to synthesize current research findings and practical applications, providing a comprehensive overview of recent advances in caries prevention. By embracing a multifaceted approach, we can enhance the efficacy of recent advancements, reduce the incidence of caries, and ultimately improve the oral health of populations worldwide.

Fluoride V/S Non-Fluoride

Fluoride and non-fluoride methods for caries prevention each offer distinct approaches to maintaining oral health. Fluoride is renowned for its effectiveness in reducing caries incidence by remineralizing enamel, inhibiting demineralization, and disrupting bacterial metabolism. Common forms of fluoride include varnishes, gels, and fluoridated toothpaste, making it widely accessible for both high-risk populations and the general public. However, excessive use in children can lead to dental fluorosis, raising concerns about its application. On the other hand, non-fluoride methods, such as xylitol products, calcium phosphate supplements, and dental sealants, focus on dietary changes and alternatives for remineralization. These approaches can be effective but generally rely more on individual commitment to proper hygiene and dietary choices. While non-fluoride strategies may be recommended for those avoiding fluoride, incorporating a combination of both methods may provide the most comprehensive and personalized prevention against caries, catering to the unique needs and circumstances of individuals.[1,6]

Caries Prevention

Always choose prevention to treatment. Preventing caries requires a plan of action or set of steps to be taken. Various methods of prevention of dental caries has been illustrated below:

Sugar Substitutes

Sugar substitutes can play a significant role in caries prevention by reducing the risk of tooth decay. Xylitol, sorbitol, and erythritol are popular sugar alcohols that not only provide sweetness but also inhibit the growth of cavity-causing bacteria. These substitutes can help maintain oral health by promoting saliva production, which aids in remineralization of enamel. Incorporating sugar substitutes into chewing gums, mints, and other products encourages healthier dietary choices while minimizing sugar intake. As a result, these alternatives contribute to a lower risk of caries, making them effective tools in a comprehensive oral health strategy.

Calcium Carbonate Carrier – SensiStat

The SensiStat technology is composed of calcium carbonate, a typical abrasive in toothpaste, and arginine bicarbonate, an amino acid combination. The calcium carbonate particles are held to the dentin or enamel surface by the arginine complex, which also enables the calcium carbonate to gradually dissolve and release calcium, making it possible to remineralize the tooth surface.[3]

CPP-ACP

Case in Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP) is a popular agent in caries prevention. It's derived from milk protein and works by stabilizing calcium and phosphate ions, which are essential for remineralizing tooth enamel. When applied to the teeth, CPP-ACP helps to deliver these minerals directly to areas affected by demineralization, promoting enamel repair and improving resistance to acid attacks from bacteria.

Key Benefits

1. Remineralization: CPP-ACP enhances the natural remineralization process, effectively reversing early carious lesions.

2. Acid Resistance: It increases enamel resistance to acids produced by bacteria, reducing the risk of caries.
3. Safe for Use: CPP-ACP is safe and can be used in various formulations, including toothpaste, chewing gum, and topical applications.

Usage
It is particularly beneficial for individuals at high risk of caries, such as those with dry mouth or orthodontic appliances. Incorporating CPP-ACP into daily oral care routines can significantly contribute to better oral health and caries prevention.[8]

Bioactive Glass
Bioactive glass is an innovative material used in caries prevention and management. Composed of silicate-based compounds, it has the unique ability to chemically bond with bone and dental tissues, promoting oral health in several ways.

Key Features
Remineralization
Bioactive glass releases calcium and phosphate ions when in contact with saliva or dental tissues. These ions aid in remineralizing demineralized enamel and dentin, enhancing their strength and decay resistance.

Antimicrobial Properties
The material can inhibit the growth of cariogenic bacteria. Its alkaline nature helps neutralize acids produced by bacteria, reducing the overall acidity in the oral environment and minimizing the risk of caries.

Longevity
Bioactive glass materials can maintain their effectiveness over time, providing a sustained release of beneficial ions that support long-term dental health.

Versatile Applications
It can be incorporated into dental pastes, varnishes, or restorative materials, making it adaptable for various dental treatments and preventive care.
Using bioactive glass in dental products represents a promising approach to caries prevention, promoting enamel health, and ensuring a protective effect against tooth decay through its unique calcium and phosphate release properties.[9]

Probiotics
Probiotics, beneficial bacteria that promote gut and oral health, are emerging as a novel approach in caries prevention. Certain strains, like Lactobacillus and Streptococcus, can inhibit the growth of cariogenic pathogens, such as Streptococcus mutans, by competing for nutrients and space. They also produce substances that lower acidity and strengthen enamel. Incorporating probiotics into oral care products, such as toothpaste or lozenges, can help maintain a balanced oral microbiome. By fostering a healthy environment in the mouth, probiotics may reduce the risk of dental caries, complementing traditional preventive measures like brushing and flossing.[10]

Silver Diamine Fluoride (SDF)
SDF has emerged as a groundbreaking solution in caries prevention, particularly for patients unable to undergo traditional restorative treatments. SDF works by arresting carious lesions and preventing further decay through its antimicrobial properties, which inhibit the growth of cariogenic bacteria. Its application is quick, painless, and does not require local anesthesia, making it ideal for children and elderly patients. Additionally, SDF promotes remineralization of affected enamel, enhancing its strength. The treatment leaves a temporary dark stain on the cavity but is effective in preserving tooth structure and improving overall oral health.[11]

Pit and Fissure Sealants
Pit-and-fissure sealants reduce the risk of carious lesions by efficiently penetrating and sealing anatomical grooves or fissures on molar occlusal surfaces that trap food debris and increase the presence of bacterial biofilm with a dental material. Sealants have been used in clinical practice for many decades, so sealants have undergone many changes in their structure and usage in recent years for better and easier application. Traditional pit and fissure sealants need a clean, dry etched enamel surface, and the clinician will wait for teeth to fully erupt for proper isolation as moisture contamination is a contraindication.Advanced moisture-tolerant resin-based sealant technology has been developed that performs well with and benefits from the persistent moisture in the mouth, allowing sealants to be placed on slightly moist teeth even during the early eruption.[12]

Ozone Therapy
Ozone, an allotropic form of oxygen, plays a vital role in maintaining ecological balance on Earth by shielding living organisms from harmful ultraviolet rays. This gas is characterized by its distinct smell. Currently, extensive research has focused on several properties of ozone, including its bactericidal, virucidal, and fungicidal actions; stimulation of metabolism; anti-hypoxic effects; optimization of pro- and antioxidant systems; detoxification properties; anti-inflammatory effects; dose-dependent influence on proteolytic systems; pain relief capabilities; and immunomodulatory characteristics.
In their study, Mohammadi et al. identified three key ways to apply ozone to oral tissues: ozonated water, ozonated olive oil, and ozone gas. These methods can be used individually or in combination to address various dental issues. Research has highlighted the significant application of ozone across different fields

of dentistry, including maxillofacial surgery, endodontics, and pediatric therapy.[13]

Dähnhardt et al. conducted an eight-month study showing that ozone treatment significantly reduced fear levels in children with dental phobia while effectively addressing dentin caries.This noninvasive method minimized discomfort without compromising the quality of fillings over six months. Further research by Baysan and Lynch and Johansson et al. demonstrated ozone's antimicrobial effects, leading to a significant reduction of Streptococcus mutans and Streptococcus sobrinus in carious cavities after just 10-20 seconds of exposure, with no effect on Lacticaseibacillus casei.[14]

FUTURE PROSPECTIVE AND CONCLUSION

The future of dental caries prevention is marked by significant advancements focused on early detection and innovative treatments. Technologies like artificial intelligence are enhancing diagnostic accuracy, allowing for personalized care plans that address individual needs. Biomaterials such as bioactive glass and resin-based composites are promoting remineralization and providing more durable restorations. Additionally, ozone therapy offers a noninvasive approach to treating caries, particularly beneficial for children and those with dental anxiety. The exploration of fluoride alternatives is gaining momentum, focusing on natural compounds that deliver effective protection without associated risks. Community-based initiatives that emphasize education on oral hygiene and regular dental visits are crucial for reducing caries prevalence. In conclusion, these recent advances signal a transformative shift toward more effective, patient-centered care in dental practices, fostering healthier smiles and improved oral health outcomes across all demographics.

REFERENCES

1. Meyer F, Schulze Zur Wiesche E, Amaechi BT, Limeback H, Enax J. Caries Etiology and Preventive Measures. Eur J Dent. 2024 Jul;18(3):766-776.
2. Pitts NB, Zero DT, Marsh PD, Ekstrand K, Weintraub JA, Ramos-Gomez F, Tagami J, Twetman S, Tsakos G, Ismail A. Dental caries. Nat Rev Dis Primers. 2017 May 25;3:17030.
3. Warreth A. Dental Caries and Its Management. Int J Dent. 2023 Jan 3;2023:9365845.
4. Giacaman RA, Fernández CE, Muñoz-Sandoval C, León S, García-Manríquez N, Echeverría C, Valdés S, Castro RJ, Gambetta-Tessini K. Understanding dental caries as a non-communicable and behavioral disease: Management implications. Front Oral Health. 2022 Aug 24;3:764479.
5. Anil S, Porwal P, Porwal A. Transforming Dental Caries Diagnosis Through Artificial Intelligence-Based Techniques. Cureus. 2023 Jul 11;15(7):e41694.
6. Goswami M, Saha S, Chaitra TR. Latest developments in non-fluoridated remineralizing technologies. *J Indian Soc Pedod Prev Dent*. 2012;30(1):2-6.
7. Luo BW, Liang NL, Townsend JA, Lo ECM, Chu CH, Duangthip D. Sugar substitutes on caries prevention in permanent teeth among children and adolescents: a systematic review and meta-analysis. J Dent. 2024 Jul;146:105069.
8. Reema SD, Lahiri PK, Roy SS. Review of casein phosphopeptides-amorphous calcium phosphate. Chin J Dent Res. 2014;17(1):7-14.
9. Dai LL, Mei ML, Chu CH, Lo ECM. Mechanisms of Bioactive Glass on Caries Management: A Review. Materials (Basel). 2019 Dec 12;12(24):4183.
10. Cagetti MG, Mastroberardino S, Milia E, Cocco F, Lingström P, Campus G. The use of probiotic strains in caries prevention: a systematic review. Nutrients. 2013 Jul 5;5(7):2530-50.
11. Surendranath P, Krishnappa S, Srinath S. Silver Diamine Fluoride in Preventing Caries: A Review of Current Trends. Int J Clin Pediatr Dent. 2022;15(Suppl 2):S247-S251.
12. Priscilla S, Gs P, Mohandoss S, Kavitha M. Moisture Tolerant Pit and Fissure Sealant: A Literature Review. Int J Clin Pediatr Dent. 2022 Mar-Apr;15(2):233-239.
13. Mohammadi Z, Shalavi S, Soltani MK, Asgary S: A review of the properties and applications of ozone in endodontics: an update. Iran Endod J. 2013, 8:40-3.
14. Dähnhardt JE, Jaeggi T, Lussi A: Treating open carious lesions in anxious children with ozone. A prospective controlled clinical study. Am J Dent. 2006, 19:267-70.