Journal of Dental Specialities 2024;12(2):108–114

Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Dental Specialities

Journal homepage: https://www.jdsits.in/

Review Article

Alternative methods for caries removal: A narrative review

Sanchay Thakur[1]*, **Anshul Arora**[1], **Akriti Dheer**[1]

[1] *Dept. of Conservative Dentistry and Endodontics, ITS Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, India*

ARTICLE INFO

Article history:
Received 23-08-2024
Accepted 07-09-2024
Available online 20-09-2024

Keywords:
Dental caries
Caries removal
Recent advances
MID
minimal invasive dentistry

ABSTRACT

Dental caries, commonly known as tooth decay, remains a significant global oral health concern. Traditional methods of caries removal, such as mechanical drilling, have proven effective but often result in the removal of healthy tooth structure and may cause patient discomfort.

As,, 9a result, alternative methods for caries removal have emerged, aiming to preserve tooth structure, minimize pain, and provide more conservative treatment options. This review article explores various alternative methods for caries removal, including mechanical methods, chemomechanical methods, ultrasonic methods, laser-based techniques, cryotherapy, 'silver diamine fluoride, sealants and ozone based approaches.

The article summarizes the scientific literature surrounding these methods, including their efficacy, advantages, limitations, and potential applications. Additionally, the article discusses the potential challenges and future directions in the field of alternative caries removal methods. By providing a comprehensive overview of these innovative approaches, this review article aims to contribute to the growing body of knowledge on minimally invasive dentistry and enhance the understanding of alternative techniques for caries removal.

1. Introduction

Dental caries, According to world health organization (WHO), it is defined as "Localized post-eruptive pathologic process of external origin involving softening of the hard tissue and proceeding to the formation of a cavity."[1] Sturdevant defined it as "An infectious microbiological disease of the teeth that results in localized dissolution and destruction of calcified tissues". According to Shafers "Dental caries is a microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth, which often leads tocavitations"[2,3]

Dental caries, commonly known as tooth decay, is a prevalent oral health issue affecting individuals of all ages worldwide. The overall prevalence of dental caries in India is reported to be 54.16%, with age-specific rates of 52% among individuals aged 3-18 years and 62% among those above 18 years.[4]

Worldwide, dental caries affects nearly 100% of adults in most countries, and among children, approximately 240 crore (2400 million) permanent teeth and 62.1 crore (621 million) primary teeth are reported to be affected.[5] Traditionally, caries removal has been performed using mechanical methods, such as drilling, to excavate the decayed tooth structure. However, it is effective, but this approach may cause discomfort, anxiety, and fear in some patients, leading to dental phobia and avoidance of necessary treatments.[6]

* *Corresponding author*.
E-mail address: sanchaythakur_mds21_24@its.edu.in (S. Thakur).

https://doi.org/10.18231/j.jds.2024.020

There are two schools of thought - complete caries removal and a newer concept referred to as selective caries removal. Complete caries removal, also known as "traditional" or "conventional" caries removal, involves the complete removal of all infected and affected dentin and enamel during cavity preparation.[7] The goal is to eliminate all decayed tissue and create a clean cavity before placing the dental restoration. It typically uses hand instruments, dental drills, or rotary instruments to remove the decayed material.[8]

Selective caries removal, also known as "minimally invasive" or "conservative" caries removal, takes a more conservative approach to caries management.[7] Instead of removing all decayed tissue, dentists selectively remove only the soft, actively infected dentin, leaving the harder, more mineralized dentin unaffected. The focus is on preserving healthy tooth structure while still removing areas of active caries.[9]

The choice between complete and selective caries removal depends on various factors, such as the extent of decay, the patient's oral health, their risk of developing recurrent caries, and the dentist's clinical judgment.[10]

In cases where the cavity is shallow and the risk of residual bacteria is low, selective caries removal may be a viable option. However, in deeper or more extensive cavities, complete caries removal may be necessary to ensure a durable restoration and reduce the risk of future complications.[11] Caries-excavating burs such as polymer burs are designed for more conservative and precise caries removal, preserving healthy tooth structure.[12] Instead of drilling, air-abrasion systems use a gentler approach. They direct a stream of air loaded with tiny particles at the damaged tooth area. This high-velocity "sandblasting" effectively removes decayed tissue, creating a clean foundation for further treatment cavity.[13] It uses Aluminum oxide particles (fine for enamel, coarse for dentin). They're blasted at 70-120 m/s by 50-80 psi air pressure, angled 45-60 degrees to remove debris and minimize cavity undercuts. For sensitive patients or cleaning, other options like sodium bicarbonate or glycine powder are used with lower pressure.[14] Sono-abrasion offers a different approach to removing cavities compared to traditional drilling. It utilizes high-frequency sound waves emitted by sonic air-scalers equipped with specially designed abrasive tips. These tips come in various shapes to precisely follow the desired cavity outline while gently removing decayed dentin.[15] Sonic and ultrasonic devices are commonly used in several dental practices, such as periodontology and endodontics. These devices belong to a conservative and alternative group so-called "micro-traumatic" tool to caries removal.[16] Chemomechanical Caries Removal (CMCR): Uses a chemical agent to soften carious tissue, followed by gentle excavation, minimizing the need for drilling.[17] Laser systems for removing cavities use specific wavelengths that effectively target either the minerals or the water content, or both, within the decayed tissue. Unlike ultrashort pulse lasers that employ plasma-mediated ablation, many common systems rely on heating water both at the surface and deeper within the cavity. This rapid heating causes water expansion, leading to the explosive removal of decayed tissue. Popular laser systems for this purpose include the Er:YAG and Er, Cr:YSGG laser.[18] Beyond traditional methods, ozone therapy has emerged as a potential ally in dental care. This approach utilizes a mixture of oxygen and ozone, often alongside standard treatments, especially when conventional methods fall short. Proponents highlight its potential as a gentle and atraumatic treatment option. One suggested application involves using ozone on decaying teeth to halt their progression, offering an alternative to traditional drilling and fillings. Theoretically, reducing bacterial populations in active caries with ozone could offer temporary stabilization of the lesion.[19] In recent years, there has been a growing interest in exploring alternative methods for caries removal that are less invasive, more patient-friendly, and capable of preserving more healthy tooth structure. These alternative techniques aim to revolutionize the way we manage caries and revolutionize the patient experience during dental procedures.[20]

This paper aims to provide a comprehensive overview of the emerging strategies in caries removal, shedding light on their advantages, limitations, and implications for modern dental practice. By accepting these innovative techniques, we can deliver improved oral healthcare experiences, enhance patient satisfaction, and promote better overall oral health outcomes for patients.

2. Types of Caries Removal

2.1. Types of caries removal methods

Different caries removal methods can be broadly categorized based on their primary mechanism of action, encompassing chemical softening, mechanical abrasion, laser ablation, ultrasonic method and the utilization of novel agents like ozone gas each of it offering distinct advantages and limitations for effective enamel and dentin excavation.[21]

2.2. Need for alternative methods for caries removal

The need for alternative methods of caries removal arises due to several factors. Caries, commonly known as tooth decay or cavities, is a prevalent dental problem affecting people of all ages. Traditional methods of caries removal involve the use of rotary instruments (drills) to remove decayed tooth material. While effective, these methods have some drawbacks and limitations. To address these issues, researchers have been exploring alternative methods with potential benefits. Here are some reasons why alternative methods are sought after.[22]

1. Minimally invasive dentistry: Traditional drilling methods often remove more healthy tooth structure than necessary, leading to the loss of tooth substance. Alternative methods aim to preserve as much healthy tooth structure as possible, minimizing damage to the surrounding tissues.
2. Pain and anxiety reduction: Dental drills can cause discomfort and anxiety in patients. Alternative methods that are less invasive and more comfortable can help improve the overall dental experience for patients.
3. Fear and phobia management: Dental phobia is a common problem that prevents many people from seeking regular dental care. Alternative methods that are less intimidating may help overcome this barrier.
4. Preservation of tooth vitality: Some alternative techniques focus on preserving the vitality of the tooth, allowing it to maintain its natural function and responsiveness.
5. Faster treatment: Novel approaches may offer faster and more efficient caries removal, reducing the time spent in the dental chair.
6. Avoidance of heat and vibration: Dental drills generate heat and vibration, which can cause discomfort during the procedure. Alternative methods that do not produce these effects can enhance patient comfort.

We can categories the alternative method for caries removal as follows :

3. Mechanical Methods

Mechanical methods are traditional approaches to caries removal, relying on instruments like burs and excavators to physically remove infected dentin.

While effective, their efficacy can vary depending on several factors:[23]

1. Operators skill and experience: Skilled operators can minimize healthy tissue removal and achieve precise cavity preparation.
2. Caries depth and severity: Deep or extensive caries may require more aggressive removal, increasing the risk of complications.
3. Instrument selection and technique: Appropriate burs and excavators used with proper technique can improve efficacy and reduce invasiveness.[24]

3.1. Advantages

1. Thorough removal: Can effectively remove even hard, deeply infected dentin.
2. Precise control: Allows for precise cavity preparation and margin shaping.
3. Familiar and widely available: Most dentists have extensive experience with mechanical tools.[21]

3.2. Disadvantages

1. Potentially invasive: Can remove healthy tooth structure along with infected dentin.
2. Risk of pulp exposure: Increased risk with deeper caries, potentially requiring root canal treatment.
3. Sensitivity: May cause post-operative sensitivity due to dentin removal near the pulp.[23]

3.3. Polymer burs

Polymer burs commonly consist of Bis-phenol A diglycidyl ether dimethacrylate (Bis-GMA), Triethylene glycol dimethacrylate (TEGDMA), and Urethane dimethacrylates (UDMA). Alternatively, some burs utilize a combination of Bis-GMA, Polymethyl methacrylate (PMMA), and Methyl methacrylates (MMA).

These burs are designed to reduce heat generation during cutting, which helps minimize the risk of damaging the tooth or causing discomfort to the patient. The use of polymer burs also decreases the likelihood of producing microfractures in the tooth structure, promoting better long-term outcomes.[25] Due to their softer nature compared to metal burs, polymer burs are less abrasive and cause less wear on dental restorative materials like composites, reducing the potential for restoration damage over time.[26] Recently, incorporating nanoparticles into these polymer matrices has gained traction as a response to two key demands: enhancing the biocompatibility of the burs and improving their effectiveness in demineralizing tooth surfaces.[27] Furthermore, the use of polymer burs in dental procedures has been found to reduce the noise level, making the patient's experience more comfortable and less stressful during treatment.

Overall, polymer burs have proven to be a valuable addition to modern dental practices, offering enhanced cutting efficiency, reduced heat production, decreased wear on restorative materials, and a more patient-friendly experience.

Their increasing popularity demonstrates the benefits they bring to both dental professionals and patients alike.[12]

3.4. Air abrasion

The procedure is conservative as it allows for the selective removal of decayed or damaged tooth structure, preserving more healthy tooth material compared to traditional drilling methods. The fine abrasive particles interact with the target area, causing minimal discomfort to the patient and often eliminating the need for local anesthesia.[28] The different air abrasive particles are Aluminum Oxide (Al2O3), Baking Soda (Sodium Bicarbonate - NaHCO3), Calcium Phosphate, Silicon Carbide and Glass Powder.[29]

Air abrasion offers several advantages, including reduced noise, less vibration, and a reduced risk of microfractures compared to traditional dental drills. Moreover, it provides

better control, enabling dentists to be more conservative in their approach and maintain more of the natural tooth structure.[13] Its disadvantages are generation of heat during the procedure, potential for aerosol production, and the limited ability to remove certain types of restorative materials. For example might be ineffective for removing older, stubborn amalgam fillings or large composite restorations, where traditional drilling methods are more effective.[30]

3.5. Sono abrasion

Sono-abrasion is a minimally invasive procedure that uses high-frequency sound waves to remove decayed tooth tissue. It is a safe and effective alternative to traditional rotary instruments, which can cause heat, vibration, and noise. Sono-abrasion is also less likely to damage the surrounding healthy tooth structure.[31]

The various tips used for enamel and dentine caries excavation are-

Enamel: Use finer grits (50 μm or less) of aluminum oxide (Al2O3) for initial caries or sensitive patients.

Dentine and deeper lesions: Use coarser grits (60-125 μm) of Al2O3 for efficient removal.[32]

The procedure is performed using a handpiece that is fitted with a diamond-coated tip. The tip is vibrated at a high frequency, which creates sonic energy that is transferred to the tooth surface. This energy causes the decayed tissue to break down and be removed.[4]

Sono-abrasion is a relatively quick and painless procedure. It can be used to prepare cavities for fillings and crowns.[33]

3.6. Limitations of sono-abrasion

1. Limited Effectiveness on Hard Materials: Sono-abrasion is generally less effective at removing very hard materials such as old amalgam restorations. For instance, if a patient has a heavily calcified lesion or a very old filling, sono-abrasion might not be sufficient, and traditional methods may be necessary.
2. Generation of Heat: Similar to air abrasion, sono-abrasion can generate heat during the procedure. This can potentially cause discomfort or damage to the tooth if not managed properly. Effective cooling and water irrigation are required to mitigate this issue.
3. Potential for Sensitivity: The vibrations from the ultrasonic device can sometimes cause tooth sensitivity, particularly if the enamel or dentin is already compromised. This can be uncomfortable for some patients, especially those with sensitive teeth.
4. Aerosol Production: Sono-abrasion can create aerosols, which poses a risk for the spread of infectious agents. Proper suction and infection control measures are necessary to minimize this risk.
5. Preparation Time and Precision: The process may take longer compared to traditional methods, especially for larger or more complex carious lesions. Additionally, while sono-abrasion provides good control, it may not always be as precise as hand instruments or rotary tools in certain situation.[14]

3.7. Chemomechanical Methods

Chemomechanical methods of caries removal are minimally invasive techniques used to selectively remove decayed tooth structure.

This method involves the application of a chemical agent that softens and loosens the carious dentin, followed by gentle mechanical excavation to remove the softened material.[17]

The most common chemomechanical method is known as Carisolv.

Carisolv takes a different approach to tackling tooth decay it's a chemomechanical agent. Think of it as a two-part solution that gets mixed just before use.

Part one contains a trio of amino acids (leucine, lysine, and glutamic acid) along with sodium hydroxide and sodium chloride, all dissolved in purified water.

Part two is simpler, consisting only of a diluted sodium hypochlorite solution (0.5%).When combined, these solutions work together. The amino acids are thought to help the sodium hydroxide target and break down decayed dentin more precisely. Meanwhile, the sodium hypochlorite acts as a disinfectant, taking care of any bacteria.[34]

Essentially, Carisolv offers an alternative to the traditional drill by using chemicals to weaken and disinfect decayed tooth tissue, potentially making the process gentler and more targeted.[35]

It consists of a gel-like solution containing enzymes that target and break down the infected dentin while leaving the healthy dentin intact. After applying the Carisolv gel, the softened carious dentin is carefully removed using hand instruments, such as curettes or spoon excavators.[36]

Efficacy of chemomechanical caries removal in reducing cariogenic microbiota found chemomechanical methods were comparable to traditional methods in removing bacteria from dentin caries lesions.[37]

The study showed Carie-Care™ was effective and comfortable for removing caries in primary teeth compared to ttraditional methods.[38]

Limitations of existing chemomechanical agents, including their slowness and limited effectiveness for deep caries.[39]

The key advantages of chemomechanical caries removal are its conservative nature, as it preserves more of the healthy tooth structure, and its minimal discomfort for the patient, often eliminating the need for local anesthesia. Additionally, the risk of damaging the pulp or creating microfractures in the remaining tooth structure is reduced.[40]

However, it's essential to note that chemomechanical methods are most suitable for shallow to moderate caries lesions and may not be as effective for extensive or deep decay. In such cases, traditional drilling techniques or alternative approaches may be necessary.[41]

Overall, chemomechanical methods offer a viable and patient-friendly option for caries removal in specific cases, aligning with the principles of minimally invasive dentistry and improved patient experience.[42]

3.8. Ultrasonic Method

Ultrasonic methods of caries removal involve the use of ultrasonic instruments to selectively remove decayed tooth structure. These instruments utilize high-frequency vibrations to break down and remove the infected dentin while preserving the healthy dentin.

Ultrasonics are generally used in two types of frequencies-

1. Lower frequencies (25,000-30,000 Hz) tend to be more effective for removing softer caries and debris, while minimizing heat generation and damage to healthy dentin.
2. Higher frequencies (35,000-45,000 Hz) provide greater cutting efficiency for harder dentin but raise the risk of heat generation and potential damage to healthy tissue.[43]

The ultrasonic device consists of a handpiece with a small, vibrating tip that can be directed precisely to the carious area. When activated, the tip vibrates at ultrasonic frequencies, causing cavitation and microstreaming effects. These actions help to dislodge and remove the decayed dentin from the tooth.[44]

The benefits of ultrasonic caries removal include its minimally invasive nature, which allows for the preservation of more healthy tooth structure. It also reduces the risk of damaging the pulp and decreases patient discomfort during the procedure, often eliminating the need for local anesthesia.

Additionally, ultrasonic methods can be more effective in removing caries from difficult-to-reach areas, such as narrow pits and fissures. The fine and controlled vibrations of the ultrasonic tip allow for precise and targeted caries removal.[45]

3.9. Ozone Method

The ozone method of caries removal is a dental approach that utilizes ozone gas to treat decayed tooth tissue. Ozone, a molecule composed of three oxygen atoms, is applied to the affected area using a specialized device.[46]

Upon contact, ozone's oxidative properties break down bacterial cells and organic matter in the decayed tooth structure, aiding in disinfection and tissue removal. This technique aims to minimize damage to healthy tooth structure and has potential antimicrobial benefits.[47]

3.10. Laser Method

The laser method of caries removal involves using a focused laser beam to selectively target and remove decayed tooth tissue. This precise technique can help minimize damage to healthy tooth structure. The laser's energy is absorbed by the decayed area, causing it to vaporize or be expelled. This method offers potential advantages, such as reduced discomfort and the possibility of preserving more of the natural tooth. However, its effectiveness depends on factors like the type of laser used and the extent of decay.[48]

Types of lasers :-can be used for caries removal, each with its own advantages and disadvantages:

Erbium:YAG (Er:YAG) lasers: These are the most common type for caries removal, effectively ablating infected dentin with minimal tooth structure loss. They offer excellent precision and control, especially in hard-to-reach areas.

1. Diode lasers: Less powerful than Er:YAG lasers, they're primarily used for removing soft decay and preparing tooth surfaces for bonding. They offer gentle heat generation and are often preferred for sensitive patients.
2. Carbon dioxide (CO2) lasers: These high-power lasers are mainly used for soft tissue procedures but can be utilized for deep caries removal in specific cases. Their use requires caution due to potentially higher heat generation and tissue damage.

3.11. Efficacy of lasers

Studies have shown lasers to be effective in removing caries, particularly compared to traditional rotary instruments. They offer several advantages:

1. Reduced invasiveness: Lasers preserve more healthy tooth structure, minimizing the risk of pulp exposure and future sensitivity.
2. Precise control: Laser beams can be precisely targeted, minimizing damage to surrounding tissues.
3. Better visibility: Laser ablation often creates clean margins, improving visibility for restoration placement.
4. Painless and comfortable: Many patients experience less discomfort with laser procedures compared to drills.

However, lasers also have limitations:

1. Slower removal: Laser ablation can be slower than rotary instruments, particularly for deep caries.
2. Costly equipment: Laser therapy is currently more expensive than traditional methods.

3. Not suitable for all cases: Deep caries close to the pulp might not be ideal for laser treatment due to heat generation concerns.

Overall, lasers represent a promising approach for caries removal, offering benefits such as precision, minimal invasiveness, and patient comfort. However, their wider adoption depends on cost-effectiveness, improved technology, and further research on their long-term outcomes.

4. Conclusion

Dental caries, or tooth decay, is a common oral health problem caused by bacterial activity that demineralizes tooth enamel. While traditional caries removal involves mechanical drilling, several alternative methods have emerged, aiming to provide more conservative and efficient approaches.

4.1. These alternative methods include

Air abrasion: Uses high-pressure streams of abrasive particles to gently remove decayed material, preserving more healthy tooth structure.

Chemomechanical removal: Applies a chemical agent to soften carious tissue before mechanical removal with hand instruments.

Ultrasonic method: Employs high-frequency vibrations and water irrigation to eliminate decayed tissue with minimal damage to healthy structure.

Ozone method: Utilizes ozone gas to treat carious lesions, leveraging its oxidative properties to break down decayed tissue and disinfect the area.

Laser technology: Allows for precise tissue interaction, vaporizing decayed material while minimizing damage to healthy tooth structure.

These alternative approaches offer potential benefits such as increased preservation of healthy tooth structure, reduced patient discomfort, and less need for anesthesia. However, their effectiveness varies depending on factors like the extent of decay, dentist expertise, and individual patient needs.

While these methods show promise for less invasive and more patient-friendly treatments, each has its own limitations. The choice of method should be based on careful consideration of the specific case and consultation with a qualified dentist. Ongoing research and clinical studies are crucial to further establish the effectiveness and long-term outcomes of these alternative caries removal methods in various clinical scenarios.

5. Source of Funding

None.

6. Conflict of Interest

None.

References

1. World Health Organization. Oral health surveys: Basic methods (5th ed.). Geneva; 2013.
2. Sivapathasundharam B. Shafer's Textbook of Oral Pathology. 8th ed. Elsevier; 2016.
3. Pandey P, Nandkeoliar T, Tikku AP, Singh D, Singh MK. Prevalence of Dental Caries in the Indian Population: A Systematic Review and Meta-analysis. *J Int Soc Prev Comm Dent*. 2021;11(3):256–65.
4. Kittur M, Ghivari S, Pujar M. Comparative evaluation of efficacy of two minimally invasive caries removal techniques on fracture resistance of the teeth restored with composite: An SEM study. *J Conserv Dent*. 2021;24(2):204–8.
5. Kim C, Chen B, Mohandas S, Rehman J, Sherif ZA, Coombs K, et al. The importance of patient-partnered research in addressing long COVID: Takeaways for biomedical research study design from the RECOVER Initiative's Mechanistic Pathways taskforce. *Elife*. 2023;12:e86043. doi:10.7554/eLife.86043.
6. Philip N, Suneja B. The revolutionary evolution in carious lesion management. *J Conserv Dent*. 2023;26(3):249–57.
7. Clarkson JE, Ramsay CR, Ricketts D, Banerjee A, Deery C, Lamont T, et al. Selective Caries Removal in Permanent Teeth (SCRiPT) for the treatment of deep carious lesions: a randomised controlled clinical trial in primary care. *BMC Oral Health*. 2021;21:336. doi:10.1186/s12903-021-01637-6.
8. Lim ZE, Duncan HF, Moorthy A, Mcreynolds D. Minimally invasive selective caries removal: a clinical guide. *Br Dent J*. 2023;234(4):233–40.
9. Widbiller M, Weiler R, Knüttel H, Galler KM, Buchalla W, Scholz KJ, et al. Biology of selective caries removal: a systematic scoping review protocol. *BMJ Open*. 2022;12(2):61119. doi:10.1136/bmjopen-2022-061119.
10. Elgezawi M, Haridy R, Abdalla MA, Heck K, Draenert M, Current KD, et al. Current Strategies to Control Recurrent and Residual Caries with Resin Composite Restorations: Operator- and Material-Related Factors. *J Clin Med*. 2022;11(21):6591. doi:10.3390/jcm11216591.
11. Schwendicke F, Paris S, Tu YK. Effects of using different criteria for caries removal: A systematic review and network meta-analysis. *J Dent*. 2015;43(1):1–15.
12. Asal MA, Abdellatif AM, Hammouda HE. Clinical and Microbiological Assessment of Carisolv and Polymer Bur for Selective Caries Removal in Primary Molars. *Int J Clin Pediatr Dent*. 2021;14(3):357–63.
13. Hegde V, Khatavkar R. A new dimension to conservative dentistry: Air abrasion. *J Conserv Dent*. 2010;13(1):4–8.
14. Banerjee A, Watson TF. Air abrasion: its uses and abuses. *Dent Update*. 2002;29(7):340–6.
15. Jingarwar M, Bajwa NK, Pathak A. Minimal Intervention Dentistry - A New Frontier in Clinical Dentistry. *J Clin Diagn Res*. 2014;8(7):4–8.
16. Cianetti S, Abraha I, Pagano S, Lupatelli E, Lombardo G. Sonic and ultrasonic oscillating devices for the management of pain and dental fear in children or adolescents that require caries removal: a systematic review. *BMJ Open*. 2018;8(4):e020840. doi:10.1136/bmjopen-2017-020840.
17. Abdelaziz E, Badran A, Allam G. Chemomechanical Caries Removal Agents and Their Applications in Pediatric Dentistry. *Adv Dent J*. 2022;4(1):11–8.
18. Cardoso M, Coelho A, Lima R, Amaro I, Paula A, Marto CM, et al. Efficacy and Patient's Acceptance of Alternative Methods for Caries Removal-A Systematic Review. *J Clin Med*. 2020;9(11):3407. doi:10.3390/jcm9113407.
19. Almaz ME, Sönmez IS. Ozone therapy in the management and prevention of caries. *J Formos Med Assoc*. 2015;114(1):3–11.

20. Banerjee A, Kidd EA, Watson TF. In vitro evaluation of five alternative methods of carious dentine excavation. *Caries Res*. 2000;34(2):144–50.
21. Shindova M. Alternative methods for caries removal. *Sci Youth*. 2021;7:307–11.
22. Senthilkumar V, Ramesh S. Systematic review on alternative methods for caries removal in permanent teeth. *J Conserv Dent*. 2020;23(1):2–9.
23. Peters MC, Flamenbaum MH, Eboda NN, Feigal RJ, Inglehart MR. Chemomechanical caries removal in children: efficacy and efficiency. *J Am Dent Assoc*. 2006;137(12):1658–66.
24. Duruk G, Kizilci E, Malkoç MA. Effectiveness of Different Methods in Removing Dentin Caries of Primary Teeth: Micro-CT and SEM Evaluation. *J Clin Pediatr Dent*. 2022;46(3):211–8.
25. Prabhakar A, Kiran NK. Clinical evaluation of polyamide polymer burs for selective carious dentin removal. *J Contemp Dent Pract*. 2009;10(4):26–34.
26. Inamdar M, Chole D, Bakle S, Gandhi N, Hatte N, Rao M, et al. Comparative evaluation of BRIX3000, CARIE CARE, and SMART BURS in caries excavation: An in vivo study. *J Conserv Dent*. 2020;23(2):163–8.
27. Chisnoiu RM, Muntean A, Păstrav O, Chisnoiu AM, Cuc S, Dumitrescu LS, et al. Polymer Mixtures for Experimental Self-Limited Dental Burs Development-A Preliminary Approach (Part 1). *J Funct Biomater*. 2023;14(9):447. doi:10.3390/jfb14090447.
28. Banerjee A, Thompson ID, Watson TF. Minimally invasive caries removal using bio-active glass air-abrasion. *J Dent*. 2011;39(1):2–7.
29. Neuhaus KW, Ciucchi P, Donnet M, Lussi A. Removal of enamel caries with an air abrasion powder. *Oper Dent*. 2010;35(5):538–46.
30. Farooq I, Imran Z, Farooq U. Air Abrasion: Truly Minimally Invasive Technique. *Int J Prosthodont Restor Dent*. 2011;1(2):105–7.
31. Oliveira MT, Freitas PM, Eduardo CP, Ambrosano G, Giannini M. Influence of Diamond Sono-Abrasion, Air-Abrasion and Er:YAG Laser Irradiation on Bonding of Different Adhesive Systems to Dentin. *Eur J Dent*. 2007;1(3):158–66.
32. Mandinić Z, Vulićević ZR, Beloica M, Radović I, Mandić J, Carević M, et al. The application of air abrasion in dentistry. *Srp Arh Celok Lek*. 2014;142(1-2):99–105.
33. Hassan U, Farooq I, Moheet IA, Alshwaimi E. Cutting efficiency of different dental materials utilized in an air abrasion system. *Int J Health Sci (Qassim)*. 2017;11(4):23.
34. Carraro RLC, Fontanella V, Carvalho JC, Alves LS, Maltz M. Loss of dental tissue after restoration or sealing of occlusal carious lesions: 3-4-year results of randomized clinical trials. *J Conserv Dent*. 2022;25(5):521–5.
35. Pai VS, Nadig RR, Jagadeesh T, Usha G, Karthik J, Sridhara K, et al. Chemical analysis of dentin surfaces after Carisolv treatment. *J Conserv Dent*. 2009;12(3):118–22.
36. Asal MA, Abdellatif AM, Hammouda HE. Clinical and Microbiological Assessment of Carisolv and Polymer Bur for Selective Caries Removal in Primary Molars. *Int J Clin Pediatr Dent*. 2021;14(3):357–63.
37. Ammari MM, Moliterno LFM, Júnior RH, Séllos MC, Soviero VM, Filho WPC, et al. Efficacy of chemomechanical caries removal in reducing cariogenic microbiota: a randomized clinical trial. *Braz Oral Res*. 2014;28. doi:S1806-83242014000010024.
38. Ghanem AY, Talaat DM, Essawy MM, Bakry N. The effectiveness of Carie-CareTM, chemomechanical caries removal technique in primary teeth: randomized controlled clinical trial. *BMC Oral Health*. 2023;23(1):882. doi:10.1186/s12903-023-03594-8.
39. Maashi MS, Elkhodary HM, Alamoudi NM, Bamashmous NO. Chemomechanical caries removal methods: A literature review. *Saudi Dent J*. 2023;35(3):233–43.
40. Bratu DC, Nikolajevic-Stoican N, Popa G, Pop SI, Dragoș B, Luca MM, et al. A Bibliometric Analysis (2010-2020) of the Dental Scientific Literature on Chemo-Mechanical Methods of Caries Removal Using Carisolv and BRIX3000. *Medicina (Kaunas)*. 2022;58(6):788. doi:10.3390/medicina58060788.
41. Shashirekha G, Jena A, Mohanty N, Kamilla SK. Novel bioactive caries-detecting dye solution: Cytotoxicity, antimicrobial activity, scanning electron microscope, and stereomicroscopic analysis in diagnosis of dental caries. *J Conserv Dent*. 2020;23(1):79–85.
42. Beeley JA, Yip HK, Stevenson AG. Chemochemical caries removal: a review of the techniques and latest developments. *Br Dent J*. 2000;188(8):427–30.
43. Chery J, Freitas V, Saman DM, Gupta A. Comparison of Cavity Preparation Times Using Conventional High-Speed Handpiece Versus Er, Cr:YSGG Laser: A Pilot Study with Pediatric Dental Residents. *Pediatr Dent*. 2022;44(2):90–4.
44. Postle HH, Postle HH. Ultrasonic cavity preparation. *J Prosthet Dent*. 1958;8(1):153–60.
45. Lima LM, Motisuki C, Corat EJ, Santos-Pinto L. Comparative cutting effectiveness of an ultrasonic diamond tip and a high-speed diamond bur. *Minerva Stomatol*. 2009;58(3):93–8.
46. Almaz ME, Sönmez IS. Ozone therapy in the management and prevention of caries. *J Formos Med Assoc*. 2015;114(1):3–11.
47. Kalaskar A, Balasubramanian S, Kamki H, Kalaskar R, Badhe H. Antimicrobial Effect of Ozone Therapy in Deep Dentinal Carious Lesion: A Systematic Review. *Int J Clin Pediatr Dent*. 2022;15(S2):252–60.
48. Jacobsen T, Norlund A, Englund GS, Tranæus S. Application of laser technology for removal of caries: A systematic review of controlled clinical trials. *Acta Odontol Scand*. 2011;69(2):65–74.

Author biography

Sanchay Thakur, Post Graduate https://orcid.org/0009-0006-7719-6728

Anshul Arora, Professor https://orcid.org/0000-0002-2261-9264

Akriti Dheer, Senior Lecturer

Cite this article: Thakur S, Arora A, Dheer A. Alternative methods for caries removal: A narrative review. *J Dent Spec* 2024;12(2):108-114.