

Minimal Intervention Dentistry: Comprehensive Approaches to Modern Caries Management

Monica¹, Teena Gupta², Manjul Mehra³, Sunil Gupta⁴, Rashu Grover⁵

¹Postgraduate student, Department of Pedodontics and Preventive Dentistry, Sri Guru Ram Das Institute of Dental Sciences and Research, Baba Farid University of Health Sciences, Punjab, 143001

²Professor, Department of Pedodontics and Preventive Dentistry, Sri Guru Ram Das Institute of Dental Sciences and Research, Baba Farid University of Health Sciences, Punjab, 143001

³Reader, Department of Pedodontics and Preventive Dentistry, Sri Guru Ram Das Institute of Dental Sciences and Research, Baba Farid University of Health Sciences, Punjab, 143001

⁴Professor & Head of Department, Department of Pedodontics and Preventive Dentistry, Sri Guru Ram Das Institute of Dental Sciences and Research, Baba Farid University of Health Sciences, Punjab, 143001

⁵Reader, Department of Pedodontics and Preventive Dentistry, Sri Guru Ram Das Institute of Dental Sciences and Research, Baba Farid University of Health Sciences, Punjab, 143001

Email Id: monicasgrddental@gmail.com

ABSTRACT

Minimal Intervention Dentistry is a new way of managing caries, which focuses on prevention, early detection and minimally invasive treatment, preserving natural tooth structure. The principles, practices and advancements of MID are reviewed in this paper, including its emphasis on caries risk assessment, use of remineralizing agents, atraumatic restorative treatment (ART) and sealants. Findings include that MID significantly reduces the need for invasive procedures, improves patient comfort, and represents a cost effective solution, especially in underserved populations. Expanding MID's potential further are innovations, including bioactive materials, chemomechanical methods, and lasers. Integrating MID in dental practice and public health policies can enable dentistry to stop doing invasive treatments and to practice sustainable and patient centered care. It reviews the role of MID as an essential component of modern dentistry providing effective, preventive measures to enhance global oral health outcomes with minimal associated physical and psychological burden of conventional interventions.

KEYWORDS: *Minimal Intervention Dentistry, Caries Management, Remineralization Techniques, Atraumatic Restorative Treatment, Preventive Dentistry, Conservative Dental Care*

How to Cite: Monica, Teena Gupta, Manjul Mehra, Sunil Gupta, Rashu Grover., (2025) Minimal Intervention Dentistry: Comprehensive Approaches to Modern Caries Management, *Journal of Carcinogenesis*, Vol.24, No.9s, 540-549.

1. INTRODUCTION

Dental caries has been recognised as one of the most prevalent of all non-communicable diseases worldwide across all age groups and socioeconomic strata. The World Health Organization (WHO) reports that almost 3.5 billion people suffer from oral diseases, and untreated dental caries of permanent teeth are among the most prevalent worldwide. Caries in deciduous teeth is the leading cause of pain and tooth loss in children, which greatly injures their quality of life and may compromise oral nutrition and (thereby) their academic performance. Similar challenges exist for adults where untreated caries is often followed by infections, loss of teeth and complex restorations [1].

Dental caries etiology is multifactorial, comprising an interaction between dietary habits, oral hygiene practices, microbial activity, and host factors, including saliva composition. The disease progresses by way of cycles of demineralization and remineralization that are in turn affected by the consumption of fermentable carbohydrates and

the presence of cariogenic bacteria. Caries, left unchecked, can cause significant structural damage, infections and systemic health complications [2].

Dental caries is a disproportionately high burden in low and middle income countries where access to preventive and restorative dental care is limited. The issue is exacerbated by social determinants, such as poverty, no or very little education, and inadequate healthcare infrastructure. Although caries prevalence is low in high income nations, underserved and marginalized children and adults have considerable prevalence and this is indicative of worldwide oral health inequities [3].

In the past, traditional caries management has often been invasive, resulting in unnecessary loss of tooth structure.

Also, progress in knowledge of caries pathogenesis has enabled the development of preventive and minimally invasive approaches. This is in keeping with the philosophies of MID, which seeks to save natural tooth structure, emphasizes prevention, and addresses disease progression early. Given the global health significance of caries and the need for innovative, patient friendly approaches to the problem, MID represents a potential improvement to oral and systemic health outcomes [4].

1.1 Historical shift from invasive techniques to minimally invasive approaches.

In the past, caries management has involved invasive procedures, frequently involving the removal of large pieces of affected and surrounding healthy tooth structure. The late 19th-century concept of "extension for prevention," introduced by G.V. Black, dominated restorative dentistry for decades. The approach which favoured the complete removal of caries affected tissues, resulted in substantial loss of natural tooth structure [5].

Advances in understanding the etiologic of caries, especially its multifactorial nature and dynamic demineralization-remineralization process, by the mid 20th century, led to a paradigm shift. Keyes and Fitzgerald's research stressed preventive measures and conservative treatment. In the 1990s, there was a substantial shift in the emergence of adhesive materials and minimally invasive techniques. Today, MID focuses on preserving healthy tooth structure and treating disease progression biologically and conservatively [6].

1.2 Importance and applicability of MID principles in clinical and public health contexts.

Revolutionizing Dental Care: MID is where prevention, early detection and minimally invasive treatments matter the most. MID provides a clinical focus on the causation of dental caries, rather than the treatment of symptoms, thereby preserving tooth structure and improving patient comfort. Remineralization, pit and fissure sealants and ART are particularly useful in paediatric and anxiety-prone patients, who are more accepting of dental care [7].

MID provides scalable, cost effective solutions for the underserved in public health. Its principles are consistent with preventive strategies, which prevent the burden of untreated caries and costly invasive interventions. With the integration of MID into public health programs, dental care would be available in a quality manner for all, and alternatively, more effective while improving global oral health outcome [8].

2. REVIEW OF LITERATURE

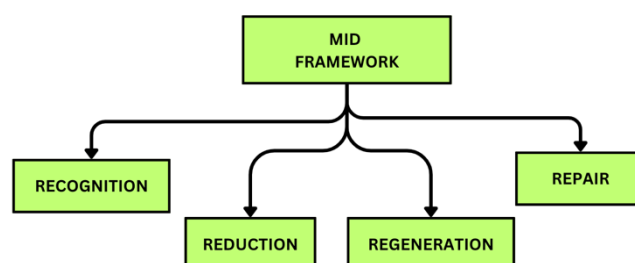
2.1 Historical Development of MID

Dental caries management has seen a dramatic shift from invasive treatment to conservative, biologically oriented care. In the late 19th and early 20th centuries, G.V. Black's "extension for prevention" philosophy dominated, advocating for extensive removal of carious and adjacent healthy tooth structure to prevent disease recurrence. Although effective for the materials available at the time, this invasive approach usually led to unnecessary loss of natural tooth structure and compromised long term tooth viability [9].

Research, as early as the mid 20th century, by Keyes and Fitzgerald found that caries progression is a dynamic process, involving cycles of demineralization and remineralization. Using this understanding, less invasive strategies that focused on controlling caries activity as opposed to removing it, were developed. Adhesive restorative materials and fluoride-based preventive strategies were developed to support this shift [10].

In 2000, Martin et al. first introduced the concept of MID as a philosophy that emphasised prevention, early detection and minimally invasive treatments. MID rests on four core principles: The four R's: Recognition, Reduction, Regeneration, and Repair. Using these principles encourages early identification and mitigation of their impact, on caries risk factors and conservative interventions aimed at preserving as much of the natural tooth structure as possible [11].

Figure: Flowchart of MID Principles



MID has become an important approach to modern dentistry worldwide. There has been official endorsement of tongue visualization's use from organizations, including the World Dental Federation (FDI) in low resource settings where normal dental care is not accessible. The philosophy of MID is consistent with a more comprehensive philosophy of patient centred care, prevention, and sustainable dental practices [12].

2.2 Clinical Evidence Supporting MID

2.2.1 Effectiveness of remineralizing agents in managing initial caries.

The role of remineralizing agents in conservative management of initial carious lesions is in accordance with the MID core principles. Sodium fluoride, as well as other fluorides including silver diamine fluoride (SDF), are well known for their ability to increase enamel resistance by depositing fluorapatite, which is more insoluble in acids. The remineralization is further promoted by casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), which stabilizes calcium and phosphate ions and delivers them to the enamel subsurface lesions.

Two novel materials, bioactive glass and tri-calcium phosphate (TCP), offer a controlled ion release for sustained enamel repair. These agents have been shown in clinical studies to arrest caries progression as well as to improve enamel aesthetics and the strength of the surface. The non-invasive nature of remineralizing therapies makes them ideal for paediatric and anxiety prone patients, all in line with MID's ultimate goal of preserving natural tooth structure while controlling disease progression biologically [13].

2.2.2 Success of pit and fissure sealants in preventing occlusal caries.

Occlusal caries can be prevented effectively in children and high risk population by pit and fissure sealants. Sealants are physical barriers that seal in food particles and bacteria from entering the deep grooves and pits that can be found on molar and premolar surfaces where caries is most likely to occur. Applying sealant correctly and keeping it in place, studies indicate, can reduce caries incidence by 60–80%.

The durability and retention of sealants has also been enhanced by advances in the sealant materials, including resin based and glass ionomer sealants. Fluoride releasing sealants also serve to help remineralize the surrounding enamel. Application of sealants depends on an exacting process, including isolation and surface preparation. The cost-effectiveness and their ability to prevent invasive restorative procedures fit perfectly with the MID principles of prevention and preservation of natural tooth structure. To maintain their long term efficacy they require regular follow up and reapplication [14].

2.2.3 Outcomes of ART and chemomechanical methods for minimally invasive treatments.

MID is dependent upon ART and CMCR, two techniques which provide effective, patient centered methods of managing caries. The use of hand instruments and high viscosity GIC removes decayed tissue and restores cavities conserving as much healthy tooth structure as possible. It is especially successful in resource limited settings, both

reducing patient anxiety and eliminating the need for drills or anesthesia.

At CMCR we use the chemical agents of Carisolv to selectively dissolve the infected dentin while leaving sound tissue, limiting patient discomfort. Similarly, both methods are based on MID principles of prioritization of preservation and prevention. High patient acceptance, reduced procedural pain, and equivalent efficacy to traditional restorative techniques are reported in studies. ART and CMCR together offer conservative alternatives that are less invasive and more cost effective, and more appropriate for underserved populations, showing the transformative potential of MID for the modern dentistry [15].

2.2.4 Role of lasers in enhancing precision and patient comfort in MID.

Laser are a major improvement in MID, providing precise, minimally invasive alternatives to conventional dental procedures. Lasers like Er:Both YAG and Er,Cr:YSGG effectively remove carious tissue without damaging healthy structures, which decreases dependence on mechanical drills. They are able to sterilize treatment area, which limits secondary infections and makes treatment overall outcomes better [16].

Laser therapy is especially useful for pediatric and anxious patients, as the treatment is virtually vibration free and often eliminates the need for anesthesia. In many applications, they are very effective for pit and fissure preparation, root canal sterilization, and soft tissue procedures. These benefits are consistent with MID's concern for conservative and patient friendly care, which makes lasers a revolutionary tool in modern dentistry. Laser technology is a perfect example of the MID principles: precision and improved patient comfort, combining to support minimally invasive approaches that focus on preservation, prevention, and the positive patient experience [17].

1. CORE COMPONENTS OF MID

3.1 Diagnostic Advances

Early detection of caries and caries associated risk factors was also possible because of the advances in diagnostic capabilities facilitated the implementation of MID. Advanced tools such as laser fluorescence devices (e.g. DIAGNOdent) and digital imaging technologies have supplemented traditional methods such as visual-tactile examination and radiographs in the detection of early carious lesions with precision [18].

Demineralization and enamel changes are assessed at a microscopic level by quantitative light induced fluorescence (QLF) and optical coherence tomography (OCT). Diagnostics of salivary samples (pH testing and microbial analysis) help in identifying caries risk factors (low buffering capacity and high bacterial counts) [19].

These technologies follow the principles of MID by detecting lesions at an early, reversible stage, and permit non-invasive interventions such as remineralization. These advances in diagnostics move the focus from symptom management to prevention, which is in keeping with MID's commitment to preserving natural tooth structures and encouraging long term oral health.

3.2 Remineralizing Agents

3.2.1 Mechanisms of Action and Examples

Non-invasive caries management requires remineralizing agents that replenish lost minerals in enamel, halt caries progression and increase tooth resistance. Fluoride is still a key agent that produces fluorapatite and thus makes enamel more resistant to acid attack. Calcium and phosphate ions are delivered to enamel subsurface lesions and stabilized and delivered to enamel subsurface lesions promoting repair by casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). Bioactive glass releases ions of calcium, phosphate and silicate that promote enamel and dentin remineralization and neutralize acidic conditions [20].

These agents effectively arrest early carious lesions, improve enamel hardness, and improve the aesthetics, making them important tools for maintaining natural tooth structure and arresting disease progression [21].

3.2.2 Innovations and Challenges in Application

Remineralizing agents such as SDF and TCP are innovations with the ability to repair enamel as well as have antimicrobial properties. Nano-hydroxyapatite (n-HAp) mimicking natural tooth minerals has exhibited a great potential for enamel integrity restoration. Firstly these advancements offer an efficient non-invasive system for caries management [22].

Although such agents are effective, patient adherence to frequent topical applications remains a challenge, as does the limited ability of these agents to penetrate deeper carious lesions. But, acceptance of SDF is limited by aesthetic concerns, especially from the dark staining caused by SDF. To overcome these barriers requires developing advanced delivery system and combination therapies. Further research is needed to advance the efficacy, ease of access and patient acceptance of these agents so they can become part of clinical practice, and subsequently be more widely adopted in prevention and treatment of caries [23].

3.3 Pit and Fissure Sealants

3.3.1 Advances in materials, application techniques, and clinical outcomes.

Occlusal caries on vulnerable tooth surfaces can be prevented by use of pit and fissure sealants. Traditional resin based materials have graduated to GIC and fluoride releasing sealants. In addition to the physical barrier, fluoride releasing sealants promote remineralization of adjacent enamel. Moisture tolerant and hydrophilic sealants provide improved retention in difficult oral environments and coloured and fluorescent sealants are useful in application and monitoring at the follow up time [25].

Application techniques for enamel preparation, including air abrasion and laser etching, are improved to increase their utility in improving sealant adhesion. These advances, according to clinical studies, have high retention rates and are associated with highly significant reductions in caries incidence, indicating their long term effectiveness in preventive dentistry [26].

3.3.2 Use in paediatric dentistry for preventive care.

In paediatric dentistry, sealants are of particular benefit in reducing the high risk of caries on newly erupted molars. They are ideal for children because they are non-invasive and can preclude the need for future restorative treatment. Substantial reductions in caries prevalence have been demonstrated in high risk populations through regular application in school based dental programs. Sealants provide a painless, effective means of caries prevention and are therefore an example of MID, which supports long term oral health and reduces the burden of dental diseases in children. [27]

3.4 Atraumatic Restorative Dentistry

3.4.1 Clinical protocols, benefits in underserved populations.

Unlike those of most developed countries, dental caries management in the US context continues to pose a significant challenge to many. The protocol involves removing decayed tooth tissue with hand instruments, and restoring cavities with high viscosity GIC. ART also involves sealing pits and fissures adjacent to teeth, to prevent future caries. That's its simplicity, affordability, and not requiring electricity or anesthesia which make it suitable for low resource settings, community outreach programs [28].

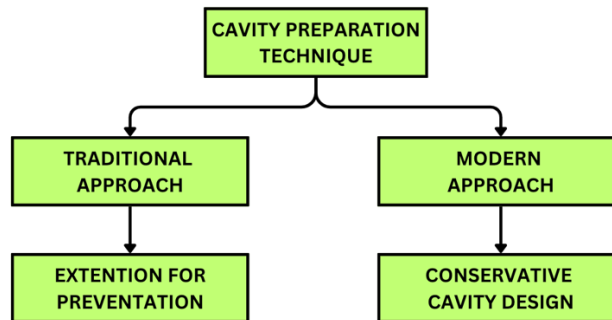
With no need of drilling or injection of an anesthetic, ART decreases patient anxiety, especially in children. Numerous clinical studies demonstrate its ability to conserve tooth structure, to create durable restorations, and to deliver fluoride for long term caries protection.

3.4.2 Comparison with traditional treatments.

Unlike many traditional restorative techniques, which often necessitate extensive removal of healthy tooth structure and mechanical retention, ART preserves healthy tooth structure and seeks to prevent disease. But, traditional methods may require costly pieces of equipment and specialised training, thereby limiting their use in low resource setting. Clinical success rates with ART are equivalent and are associated with less pain and higher patient acceptance. When ART is integrated into public health initiatives, communities can receive cost effective, patient friendly dental care, which resonates with the MID principles [29].

3.5 Cavity Preparation Techniques

Figure. Illustrative Diagram of Cavity Preparation Techniques



Techniques of cavity preparation have changed dramatically, from mechanical to conservative designs that are congruent with the principles of MID. Traditional methods, such as G.V. Black's "extension for prevention," focused on removing both infected and healthy tooth structure to prevent disease recurrence. The invasive techniques usually compromise long term tooth viability [30].

Current practice emphasizes the retention of remineralizable infected dentin and selective removal of demineralized and infected dentin. Preventive resin restorations (PRR) are techniques that use minimal preparation, seal off unaffected pits and fissures, and generally do not require extensive restorations. Adhesive materials have advanced, and minimally invasive tools, such as smart burs and lasers, increase precision and do not require mechanical retention [31].

Conservative designs enhance the longevity of restorations, lessen patient discomfort and reflect MID's philosophy of biologically driven, tissue preserving dental care. The shift is a critical step toward sustainable and patient centred treatment strategies.

3.6 Chemomechanical Caries Removal (CMCR)

A minimally invasive technique, selectively dissolving infected dentin while preserving healthy tissue, is called CMCR. Carisolv and Papacarie are materials that contain amino acids or papain enzymes which degrade demineralized collagen in carious dentin. Hand instruments are used to remove the softened dentin [32].

CMCR is better than traditional rotary methods because it causes less patient discomfort, eliminates or reduces the need for anesthesia, and decreases the chance of pulp damage. It is especially useful for pediatric and anxious patients. Clinical studies demonstrate that CMCR is as efficacious as current methods in caries removal and in line with MID's aim to provide conservative, patient friendly care.

3.7 Lasers in MID

MID is a transformative technology where lasers are precise and minimally invasive applications. In caries removal, lasers such as Er:Decayed tissue is ablated using YAG and Er, Cr:YSGG, while preserving healthy structures. They also sterilize the cavity, lowering microbial load. Laser etches enamel and dentin for hard tissue modification and improve adhesive bond strength.

Lasers have atraumatic solutions for gingivectomy, frenectomy, and tissue contouring in soft tissue procedures that result in minimal bleeding and faster healing. This quiet, vibration free operation enhances patient comfort in pediatric and anxious patients, which is why lasers are an integral part of MID's conservative and patient friendly approach to treatment [33].

2. ADVANTAGES OF MID

4.1 Preservation of natural tooth structure.

A goal of MID is to preserve as much natural tooth structure as possible and minimize the amount of needed tissue removal. The techniques used are remineralization and selective caries removal, and these are compared on affected regions with no intervention on sound teeth. This method enhances the long term survival of teeth, decreases the likelihood of structural weakening, and decreases the necessity of subsequent restorations.

Tissue preservation is supported by conservative cavity designs and advanced materials including adhesive restoratives and bioactive agents. Although MID maintains the tooth's integrity, it is in line with the sustainable, patient centered care principles of modern dentistry [34].

4.2 Enhanced patient comfort, especially in pediatric care.

Because MID makes it less invasive for dental procedures, MID significantly improves patient comfort. Techniques like CMCR and ART dispense with the need for anesthetic, drills, and thus pain and anxiety. In pediatric care in particular, this is very valuable because fear of dental procedures is so common.

Lasers and fluoride based preventive measures further enhance the experience, providing treatments that are quieter, faster and more acceptable to young patients. MID creates a stress free environment that fosters better cooperation, builds trust and promotes long term adherence to dental care in children [35].

4.3 Cost-efficiency and adaptability in low-resource settings.

MID's cost effective solutions provide quality dental care at low cost in low resource settings. ART and CMCR techniques do not require expensive equipment, electricity, or anesthesia. High viscosity GIC is an affordable material offering durable restorations, and fluoride release for caries prevention [36].

Lastly, the easy adaptability of MID for use in community health programs facilitates use of the system in populations with limited access to health care services. MID, which emphasizes prevention and minimal intervention, lowers the mean cost of care, lessens the need for sophisticated treatments, and is concordant with the principles of sustainable healthcare practice in environments which are resource constrained.

4.4 Role in public health and preventive dentistry.

Prevention of caries in the public is an important role of MID. The early detection, remineralization and minimally invasive treatment focus make it suitable for implementation in large scale in community dental programs. For high risk populations, especially children, cost effective techniques include pit and fissure sealants and fluoride applications.

A preventive approach of MID minimizes invasiveness and the requirement for invasive procedures and thus eases off healthcare systems. When MID is carried to public health strategies, oral health disparities can be resolved and long-term outcomes can be improved for the least served among populations globally [37].

3. CHALLENGES AND LIMITATIONS

5.1 Barriers to widespread clinical adoption.

Although MID has proved its benefits, it is not widely adopted. As such, many practitioners are used to traditional invasive techniques and the transition to MID involves a new clinical mindset. Dental professionals and patients are in limited awareness and understanding of MID principles making the acceptance of mid rather difficult. Finally, the upfront cost of advanced diagnostic tools and materials, including lasers and remineralizing agents, can be expensive, and particularly out of reach for smaller practices.

5.2 Challenges in training and material access.

MID techniques are not easy to implement and need specialized training in modern diagnostic tools, conservative cavity preparation and use of materials such as bioactive agents. These methods are poorly covered in many dental curricula

and in continuing education programs in many regions. In addition, low resource settings are limited in availability to essential materials, such as high quality GIC, CPP ACP and fluoride releasing sealants. The scarcity of MID impedes its consistent application, especially in underserved areas where its benefits are most needed.

5.3 Patient compliance and technical limitations.

Another challenge is patient compliance – preventive and minimally invasive treatments involving sustained efforts and follow up. But educating patients on the importance of early intervention and long term maintenance is time intensive. Acceptance is limited by technical limitations, including the inability of remineralizing agents to fully penetrate deep lesions and the aesthetics of agents, such as silver diamine fluoride (SDF). Research, education and public health policies are needed to address these challenges, and MID's broader implementation.

4. FUTURE DIRECTIONS AND INNOVATIONS

6.1 Advancements in remineralizing agents and bioactive materials.

Future improvements in remineralizing agents and bioactive materials center on increasing effectiveness, delivery, and patient acceptance. n HAp is an enhanced enamel repair material, which reproduces natural tooth minerals, and provides aesthetic benefits. New formulations of silver based agents (SDF) are reformulated to minimize staining and retain antimicrobial and remineralizing properties. Bioactive glass and TCP are still being used, because they release ions over a prolonged period of time to promote enamel and dentin repair. Delivery systems innovations, including slow release varnishes and microencapsulation, hold the promise of extended effectiveness and reduced application frequency. These advances seek to overcome current constraints and increase access and efficacy of minimally invasive treatments in a wide range of clinical and public health settings.

6.2 Enhanced diagnostic technologies for early detection.

Early caries detection is a cornerstone of MID and revolutionizing early caries detection are emerging diagnostic technologies. Non-invasive and highly accurate, early stage caries can be detected using fluorescence based devices, including DIAGNOdent. With OCT and near infrared imaging clinicians are able to view demineralization in real time without radiation exposure. Artificial intelligence (AI) diagnostic tools powered by AI use big data to improve precision and to provide personalized risk assessment and treatment planning. Non-invasive early detection is a growing frontier of salivary diagnostics, an area that assesses biomarkers for caries risk. These advances prevent the need for invasive therapy, are in line with MID's focus on prevention management and preservation of natural tooth structure, and allow earlier intervention.

6.3 Integration of MID principles into global dental education and policies.

MID is an important addition to dental education and global health policy, and will not gain widespread acceptance without its integration. Preventive care, conservative techniques and advanced diagnostics should be a pertinent feature of dental curricula to prepare future practitioners for MID focused care [38]. The knowledge gaps among existing professionals can be bridged using continuing education programs. MID must be included as one of public health initiatives in improving the accessibility in underserved area including school based sealant programs and fluoride varnish applications [39]. People can integrate MID into insurance coverage and health care designs. Through preventive efforts and cultivation of a preventive viewpoint, the world is being transformed to providing patient centered appropriate sustainable and equitable oral healthcare practices [40].

5. CONCLUSION

MID is a milestone change in caries management, aiming prevention, early detection and minimally invasive treatment in order to preserve the natural tooth structure. MID is based on principles of recognition, reduction, regeneration and repair, and uses new diagnostics, remineralizing agents, sealants and new techniques such as lasers and ART. They increase patient comfort, decrease procedural anxiety, and increase long term oral health. MID's adaptability and low cost make it especially relevant in low resource settings and for public health initiatives, because of the possibility of creating scalable solutions for underserved populations. MID targets the early stage of disease progression and thereby alleviates the need for expensive restorative treatments and fits into sustainable healthcare practices.

To transform the 'traditional' model of dentistry the integration of MID in mainstream clinical practice is essential. The

onset of dental technology therefore requires dental professionals to shift from an invasive to a preventive mind set and optimize care with a conservative approach, favoring patient centered care and least intervention. Adoption of MID as part of dental education, public health policies and insurance frameworks is further facilitated by its incorporation into them. MID is an opportunity for clinicians to advance individual patient outcomes, and to help to narrow global oral health disparities. MID is the foundation of a modern, preventative approach to dentistry and as research and innovation refine its tools and techniques, MID will remain so.

REFERENCES

- [1] Torres PJ, Phan HT, Bojorquez AK, Garcia-Godoy F, Pinzon LM. Minimally invasive techniques used for caries management in dentistry: A review. *J Clin Pediatr Dent.* 2021;45(4):224-32.
- [2] Walsh LJ, Brostek AM. Minimum intervention dentistry principles and objectives. *Aust Dent J.* 2013;58:3-16.
- [3] Joshi GM, Patel AR, Jajoo SS, Belsare S. Golden triangle of minimal intervention dentistry in pediatric dentistry. *Int J Health Sci.* 2021;5(S1):552-6.
- [4] Hamama HH, Yiu CK, Burrow MF. Current update of chemomechanical caries removal methods. *Aust Dent J.* 2014;59(4):446-56.
- [5] Oliveira PR, Fonseca AB, Silva ED, Coutinho TC, Tostes MA. Remineralizing potential of CPP-ACP creams with and without fluoride in artificial enamel lesions. *Aust Dent J.* 2016;61(1):45-52.
- [6] Arifa MK, Ephraim R, Rajamani T. Recent advances in dental hard tissue remineralization: A review of literature. *Int J Clin Pediatr Dent.* 2019;12(2):139-44.
- [7] Desai H, Stewart CA, Finer Y. Minimally invasive therapies for the management of dental caries—A literature review. *Dent J.* 2021;9(12):147.
- [8] Holmgren CJ, Roux D, Doméjean S. Minimal intervention dentistry: Part 5. Atraumatic restorative treatment (ART)—A minimum intervention and minimally invasive approach for the management of dental caries. *Br Dent J.* 2013;214(1):11-8.
- [9] Banerjee A. Minimal intervention dentistry: Part 7. Minimally invasive operative caries management: Rationale and techniques. *Br Dent J.* 2013;214(3):107-11.
- [10] Priscilla S, Prathima GS, Mohandoss S, Kavitha M. Moisture-tolerant pit and fissure sealant: A literature review. *Int J Clin Pediatr Dent.* 2022;15(2):233.
- [11] Naaman R, El-Housseiny AA, Alamoudi N. The use of pit and fissure sealants: A literature review. *Dent J.* 2017;5(4):34.
- [12] Anil A, Ibraheem WI, Meshni AA, Preethanath R, Anil S. Demineralization and remineralization dynamics and dental caries. *Dent Caries Selection Restor Methods Mater.* 2022;10:56-65.
- [13] Nuvvula S, Mallineni SK. Silver diamine fluoride in pediatric dentistry. *J South Asian Assoc Pediatr Dent.* 2019;2(2):74.
- [14] Munteanu A, Holban AM, Păuna MR, Imre M, Farcașiu AT, Farcașiu C. Review of professionally applied fluorides for preventing dental caries in children and adolescents. *Appl Sci.* 2022;12(3):1054.
- [15] Saridena US, Sanka GS, Alla RK, Mc SS, Mantena SR. An overview of advances in glass-ionomer cements. *Int J Dent Mater.* 2022;4(4):89-94.
- [16] Young DA, Nový BB, Zeller GG, et al. The American Dental Association caries classification system for clinical practice. *J Am Dent Assoc.* 2015;146(2):79-86.
- [17] Mohanraj M, Prabhu VR, Senthil R. Diagnostic methods for early detection of dental caries—A review. *Int J Pedod Rehabil.* 2016;1(1):29-36.
- [18] Gunda S, Varma N. Minimal intervention in pediatric dentistry. *J Orofac Res.* 2013;3(1):28-33.
- [19] Maashi MS, Elkhodary HM, Alamoudi NM, Bamashmous NO. Chemomechanical caries removal methods: A literature review. *Saudi Dent J.* 2023;35(3):233-43.
- [20] Abdulsamee N, Elkhadem A, Nagi P. Laser: From fundamental principles to applied pediatric dentistry. *Adv Dent J.* 2023;4(1):11-8.
- [21] Freitas MF, Santos JM, Fuks A, Bezerra AC, Azevedo TD. Minimal intervention dentistry procedures: A ten-year retrospective study. *J Clin Pediatr Dent.* 2014;39(1):64-7.
- [22] Gujjar KR, Sumra N. Minimally invasive dentistry: A review. *Int J Clin Prev Dent.* 2013;9(2):109-20.

- [23] Somaraj V, Ravishankar P, Ramya S, et al. Minimal invasive dentistry: Dawn of a new era in tooth preservation. *Int J Res Stud Med Health Sci.* 2018;3(6):10-3.
- [24] Jingarwar MM, Bajwa NK, Pathak A. Minimal intervention dentistry: A new frontier in clinical dentistry. *J Clin Diagn Res.* 2014;8(7):ZE04.
- [25] Kamath P, Nayak R, Kamath SU, Pai D. A comparative evaluation of the remineralization potential of three commercially available remineralizing agents on white spot lesions in primary teeth. *J Indian Soc Pedod Prev Dent.* 2017;35(3):229-37.
- [26] Prakash DK, Vinay C, Uloopi KS, et al. Evaluation of caries-arresting potential of silver diamine fluoride and sodium fluoride varnish in primary molars: A randomized controlled trial. *J Indian Soc Pedod Prev Dent.* 2022;40(4):377-82.
- [27] Singh S, Pandey RK. An evaluation of nanocomposites as pit and fissure sealants in child patients. *J Indian Soc Pedod Prev Dent.* 2011;29(4):294-9.
- [28] Ebrahimi M, Shirazi AS, Afshari E. Success and behavior during atraumatic restorative treatment, the Hall technique, and the stainless steel crown technique for primary molar teeth. *Pediatr Dent.* 2020;42(3):187-92.
- [29] Murdoch-Kinch CA, McLean ME. Minimally invasive dentistry. *J Am Dent Assoc.* 2003;134(1):87-95.
- [30] Perrone BR, Bottesini VC, Duarte DA. Minimal intervention dentistry: What is its clinical application and effectiveness in different continents? *J Conserv Dent Endod.* 2024;27(2):134-9.
- [31] Lewis C, Bassi L. Minimal intervention dentistry for the child patient: The current landscape. *Dent Health.* 2022;61:30-6.
- [32] Mittal R, Relhan N, Tangri T. Remineralizing agents: A comprehensive review. *Int J Clin Prev Dent.* 2017;13(1):1-4.
- [33] Araujo MP, Innes NP, Bonifácio CC, et al. Atraumatic restorative treatment compared to the Hall Technique for occluso-proximal carious lesions in primary molars: 36-month follow-up of a randomized control trial in a school setting. *BMC Oral Health.* 2020;20:1-8.
- [34] Chaudhari HG, Patil RU, Jathar PN, Jain CA. A systematic review of randomized controlled trials on survival rate of atraumatic restorative treatment compared with conventional treatment on primary dentition. *J Indian Soc Pedod Prev Dent.* 2022;40(2):112-7.
- [35] Ablal MA. Atraumatic restorative treatment: More than a minimally invasive approach? *Dent Caries Restor Methods Mater.* 2022;10:112-20.