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MINIMALLY INVASIVE PROCEDURE FOR TREATING CARIES IN PEDIATRIC DENTAL PATIENTS

Dr. Heena[1], Dr. Manvi Malik[2], Dr. Geetima Khanna[3], Dr. Shubham Srivastava[4], Dr. Abhishek Jain[5*]

[1]MDS (3rd YEAR PG), Department of Pediatric and Preventive Dentistry, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh.
[2]MDS, Professor and Head, Department of Pediatric and Preventive Dentistry, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh.
[3]MDS, Reader, Department of Pediatric and Preventive Dentistry, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh.
[4]MDS, Department of Pediatric and Preventive Dentistry.
[5]MDS, Department of Pediatric and Preventive Dentistry.

***Corresponding Author: Dr. Abhishek Jain**
MDS, Department of Pediatric and Preventive Dentistry.

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ABSTRACT

Minimally invasive dentistry (MID) is a conservative approach focusing on early diagnosis and minimally invasive procedures to prevent the progression of carious lesions. MID has revolutionized pediatric dental care by emphasizing the preservation of healthy tooth structures, reducing treatment-related trauma, and improving patient compliance. This review focuses on advancements in MID techniques, including silver diamine fluoride (SDF), atraumatic restorative treatment (ART), resin infiltration, bioactive materials and laser therapies for caries.

KEYWORDS: Silverdiamineflouride; Resininfilteration; ART; SMART; Laser; Bioactive materials.

INTRODUCTION

Minimally invasive dentistry (MID) has emerged as a game changing approach in modern day pediatric dental care, focusing on conservation of healthy tooth structures while effectively treating dental diseases.[1] It is a drastic shift in ideology to approach and treat caries from the traditional "extension for prevention" approach to minimal instrumentation. This technique emphasizes upon early diagnosis, prevention, and minimally invasive interventions.[2] "Early Childhood Caries (ECC) is defined as the presence of one or more decayed, non cavitated or cavitated lesions, missing or filled due to caries surfaces, in any primary tooth of a child under six years of age.[3]

Conventional restorative technique requires invasive drilling which often causes dental anxiety in pediatric patients. Also, it needs unnecessary removal of healthy tooth structure, and remain inaccessible in resource-limited settings.[4] For pediatric patients, MID holds special implication as it accentuates upon limiting psychological trauma, uplifting treatment outcomes, and minimising dental anxiety.[5]

MID aims to address these challenges by replacing conventional drilling methods with noninvasive approaches, preserving primary dentition until natural exfoliation, and focusing on preventive strategies.[6] As primary teeth play a critical role in speech development, chewing efficiency, and guiding permanent teeth eruption, preserving them is vital for both functional and psychological health.[7]

This review focuses on advancements in MID techniques, including silver diamine fluoride (SDF), resin infiltration, atraumatic restorative treatment (ART), bioactive materials and laser therapies for caries.

Silver Diamine Flouride

SDF, Ag(NH3)2F (also referred to as diamine silver fluoride and silver ammonium fluoride) is a colourless alkaline solution containing silver and fluoride, which forms a complex with ammonia. The ammonia ions combine with silver ions to produce a complex ion called the diamine-silver ion, and this complex is more stable than silver fluoride.[8]

Both fluoride and silver ions contained in SDF appear to have the ability to inhibit the formation of cariogenic biofilms. High-concentration fluorides inhibit biofilm formation by binding to bacterial cellular components and influencing enzymes related to both carbohydrate metabolism and sugar uptake. Silver ions' antibacterial action is threefold: penetrating and destroying bacteria cell wall structures, inhibiting enzymatic activity thus influencing metabolic processes, and inhibiting the replication of bacterial DNA. SDF has been shown to have a remineralisation effect on dentine caries, as the reaction between SDF and hydroxyapatite leads to the formation of nanoscopic metallic silver particles attached to hydroxyapatite crystals, thus inhibiting the development of future caries on the arrested lesion.[9]

SDF is indicated in cases where arresting the caries is prioritised over providing definitive restorative treatment such as in kids below 2 years of age or extremely uncooperative children or in cases of Rampant caries. It can also be used in cases of dentinal hypersensitivity.

Contraindications for use of SDF include: Silver allergy; Significant desquamative gingivitis or mucositis; Pregnancy; Breastfeeding; Restorations in the aesthetic zone; signs or symptoms of periapical pathology.[10]

Common unwanted effect with SDF is black discoloration of the effected area. To overcome this problem a new product with the name RivaStar had been introduced which provides all the effects of SDF without discoloration.[11]

SMART Restoration

A modification of SDF, Silver Modified Atraumatic Restorative Technique combines use of SDF on a carious lesion and using ART (no instrumentation technique) to restore the decayed portion of tooth using GIC.[12]

Atraumatic Restorative Technique

Atraumatic Restorative Treatment (ART) is a minimally invasive dental approach that removes decayed tooth tissue using only hand instruments. The cavity is then restored using an adhesive, fluoride-releasing material like Glass Ionomer Cement (GIC), which chemically bonds to the tooth to protect against further decay. It was developed in 1980s in Tanzania to provide dental treatment to kids in remote areas and is still very useful in modern pediatric dental care.[13]

Resin Infiltration

Subsurface enamel demineralization beneath an intact surface layer or white spots lesions can and should be treated with non-invasive procedures to impede the development of a cavitated lesion. Resin infiltration is a minimally invasive technique for the management of smooth surface and proximal non-cavitated caries lesions. Infiltrative resin improves enamel roughness, microhardness, shear bond strength, and penetration depth. The infiltration of resins creates a diffusion barrier inside the enamel lesion body, retarding enamel dissolution, and the retention loss is unlikely to occur. Clinical evidence points to the partial or total ability of infiltrative resins to mask enamel whitish discoloration.[14]

The penetration of resin infiltration into the intercrystalline spaces of enamel is driven by capillary forces which are determined by its penetration coefficient (PC). According to the "Washburn equation," the infiltrant must have a low-viscosity and a low-contact angle in order to completely penetrate porous enamel.[15]

Different types of acids have been used for etching dental enamel such as phosphoric acid (H_3PO_4), HCL, polyacrylic acid and maleic acid. It has been reported that HCL 15% gel erodes surface layers more effectively than 37% H_3PO_4 and etching with HCL 15% gel for 120 s is recommended prior to placement of resin infiltration on natural enamel lesions.[16]

Bioactive Material

In recent years, many bioactive materials with mineralising and/or antibacterial properties for caries treatment have emerged with the development of nanotechnology. Common bioactive materials for caries management include fluoride-based materials, calcium- and phosphate-based materials, graphene-based materials, metal and metal-oxide nanomaterials and peptide-based materials.[17]

Fluoride-based materials

Silver diamine fluoride, Sodium fluoride, Sodium monofluorophosphate, Acidulated fluorophosphate, Stannous fluoride, Amine fluoride.

Calcium- and phosphate-based materials

Casein phosphopeptide-amorphous calcium phosphate, Casein phosphopeptide-amorphous calcium, fluoride phosphate, Functionalised tricalcium phosphate, Nano-hydroxyapatite, Calcium sodium phosphosilicate.

Casein phosphopeptide-amorphous calcium phosphate

CPP-ACP comprises nanoclusters of casein phosphopeptide bound to amorphous calcium phosphate. CPP stabilises calcium and phosphate ions by forming CPPACP complexes. CPP-ACP promotes the remineralisation of subsurface lesions by supplying a high concentration of calcium and phosphate ions. CPP-

ACP products include chewing gums, mouthwashes and dental creams. These products exhibit anticaries properties without unpalatability or allergenicity.[18]

Casein phosphopeptides-amorphous calcium phosphate (CPP-ACP) is a bioactive agent with a base of milk products, which has been formulated from two parts: casein phosphopeptides (CPP) and amorphous calcium phosphate (ACP). CPP was produced from milk protein casein and has a remarkable ability to stabilize calcium phosphate in solution and to substantially increase the level of calcium phosphate in dental plaque. CPP-ACP buffers the free calcium and phosphate ion activities, thereby helping to maintain a state of supersaturation with respect to tooth enamel, reducing demineralisation and promoting remineralisation. The free calcium and phosphate ions move out of the CPP, enter the enamel rods and reform onto apatite crystals. Laboratory, animal and human studies have shown that CPP-ACP inhibits cariogenic activity. CPP-ACP is useful in the treatment of white spot lesions, hypomineralised enamel, mild fluorosis, tooth sensitivity and erosion, and prevents plaque accumulation around brackets and other orthodontic appliances. CPP-ACP also facilitates a normal post-eruptive maturation process and is ideal for protecting primary teeth at a time when oral care is difficult. CPP-ACP has commercial potential as an additive to foods, soft drinks and chewing gum, as well as additive to toothpastes and mouthwashes to control dental caries.[19]

LASERS

The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. In modern dental practise, laser technology quickly is becoming as useful as the high speed hand piece, and dental procedures can be accomplished with less invasive methods, a more relaxed appointment and less postoperative discomfort. Many different lasers are used in pediatric dentistry. Diagnodent are used for diagnosing dental caries. Argon lasers are available for curing composite restorations and soft tissue surgical procedures. CO2 lasers are used for surgical treatment of large soft tissue lesions where coagulation, vaporization and precision in tissue cutting is required. The pulsed Nd:YAG are good for treatments involving pigmented soft tissue and are absorbed by haemoglobin in blood and are therefore effective haemostatic devices.[20]

With the development and introduction of the erbium family of lasers, the pediatric dentist has safe and efficient laser to treat hard and soft tissue of the oral cavity. The erbium laser has shallow depth of tissue penetration, high affinity for water, lack of thermal damage and minimal reflective property make it ideal laser for pediatric dentistry.[21] Applications of laser in minimal invasive caries control and treatment.

1. Removal of amalgam and other direct restorations: Lasers can be used to remove defective amalgam, composite and glass ionomer restorations.
2. Caries removal and tooth preparation: Typical average settings for the erbium family of lasers are total power of 6 watts for removal, 4 watts for dentin preparation, and 2 watts for caries removal, all with water spray. The parameters should be adjusted on each device using the manufacturer ‘s guidelines.
3. Fissure Sealant Therapy: The use of laser gives the dentist the ability to clean and sterilize enamel fissures. Studies have shown that enamel surface prepared with Erbium laser has properties similar to enamel etched with acid. The important point is to not move the Erbium laser in a way to produce more etch in a zone compared to other regions.
4. Etching: There were some important differences between the results of various studies in evaluation of the bond strength of restorative material bonded to teeth surfaces etched with Erbium laser family and with acid etch technique. These differences could be the results of laser parameters (Output energy and frequency) and the type of restorative material used. The obtained SEM images showed an increase in retention of restorative material for the surfaces irradiated by laser and a decrease in bacteria in the pits and fissures, the sterilization property of laser on irradiated surfaces is seen. In general, the best results have been obtained in simultaneous use of laser and acid.
5. Carious Lesions Prevention: The main objective of preventive treatments in modern dentistry is caries prevention. Fluoride therapy either in a systemic way or local application can prevent the beginning and the progress of caries. Laser via changes in the enamel crystal structure efficiently improves the resistance to acids and prevents the spread and progress of lesions. The use of fluoride before and after laser irradiation increases the fluoride uptake and decreases the amount of solubility in acidic solutions. Laser irradiation provokes more adhesion of fluoride to lower layers of enamel and dentin which is possible by penetration of fluoride in micro spaces in enamel and dentin.
6. Pulp Therapy in Deciduous Teeth: Today substances like formocresol are used in deciduous teeth pulp therapies, which smell disturbs children, but also its contact with mucosal surfaces can cause necrosis and ulcers that are very unpleasant and painful for children. Studies have shown that laser have good effects in pulp therapy, which results are similar or even better than formocresol.

Taking into account the many advantages of laser compared to conventional methods, like hemostasis, preservation of living tissues near the tooth apex, absence of vibrations and smells, satisfaction of children and parents are more guarantied. Concerning the use of laser in pulp therapy, one of its main advantage and perhaps actually more important is its safety compared to other conventional methods and their possible side effects, especially concerning formocresol which is strongly criticized in the literature. Nd:YAG laser with output power of 2W and frequency of 20Hz and Erbium

laser with power of 0.5W and frequency of 20Hz can be used for this purpose.[22]

CONCLUSION

It is apparent that it is time for a change in operative dentistry. It is not possible to really imitate natural tooth structure on a long term basis, so it is best that it be retained as far as possible.

The MID treatment philosophy is not just a technique, but it should be considered as a conjunction of clinical preventive strategies and restorative therapies aiming to facilitate caries management in young children, with little discomfort and to increase the useful survival lifespan of primary teeth. This philosophy impacts the child's behaviour management on the dental chair positively because many treatments can be carried out without local anaesthesia, rubber-dam isolation or high-speed rotatory instruments, which reduce fear and anxiety in the patients. MID represents an attractive, cost effective alternative for improving dental care coverage and enhancing the quality of life of pediatric patients, both at the individual and the community level, particularly in vulnerable or underserved populations. Because of its several advantages, in comparison with traditional caries management, MID should be encouraged and implemented among the pediatric dentists.

REFERENCES

1. Alqahtani AM, Alshihri YD, Alhumaid AE, Al Nafaie MM, Alnaim AA, AlQahtani AM, Alhumaid A. Advancements in minimally invasive techniques in pediatric dentistry: a review. Cureus, 2025; 17(1).
2. Al-Kaff AA, Alshehri AZ, Alasmari RA, Najd A, Albandari A, Ameera A, Alshehri RS, Alawaji YM. Minimally invasive techniques for managing dental caries in children: efficacy, applications, and future directions. Cureus, 2025; 17(7).
3. Murdoch-Kinch CA, McLEAN ME. Minimally invasive dentistry. J Am Dent Assoc, 2003; 134(1): 87-95.
4. Ericson D, Kidd E, McComb D, Mjör I, Noack MJ. Minimally invasive dentistry—concepts and techniques in cariology. Oral Health Prev Dent, 2003; 1(1): 59-72.
5. 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.
6. Banerjee A, Frencken JE, Schwendicke F, Innes NP. Contemporary operative caries management: consensus recommendations on minimally invasive caries removal. Br Dent J, 2017; 223(3): 215-22.
7. Tassery H, Levallois B, Terrer E, Manton DJ, Otsuki M, Koubi S, Gugnani N, Panayotov I, Jacquot B, Cuisinier F, Rechmann P. Use of new minimum intervention dentistry technologies in caries management. Aus Dent J, 2013; 58: 40-59.
8. Rosenblatt AT, Stamford TC, Niederman R. Silver diamine fluoride: a caries "silver-fluoride bullet". J Dent Res, 2009; 88(2): 116-25.
9. Greenwall-Cohen J, Greenwall L, Barry S. Silver diamine fluoride-an overview of the literature and current clinical techniques. Br Dent J, 2020; 228(11): 831-8.
10. Zhao IS, Gao SS, Hiraishi N, Burrow MF, Duangthip D, Mei ML, Lo EC, Chu CH. Mechanisms of silver diamine fluoride on arresting caries: a literature review. Int Dent J, 2018; 68(2): 67-76.
11. Jamal D, AlMushayt A, Abujamel T, Bamashmous S, Bamashmous N, Alamoudi N. Silver diamine fluoride: the science behind the action–a narrative review. BMC Oral Health, 2025; 25(1): 1195.
12. Hegde D, Suprabha BS, Rao A. Silver modified atraumatic restorative treatment: a paradigm shift in dental caries management. Primary Dent J, 2024; 13(2): 29-35.
13. Frencken JE. Atraumatic restorative treatment and minimal intervention dentistry. Br Dent J, 2017; 223(3): 183-9.
14. Kielbassa AM, Mueller J, Gernhardt CR. Closing the gap between oral hygiene and minimally invasive dentistry: a review on the resin infiltration technique of incipient (proximal) enamel lesions. Quintessence Int, 2009; 1: 40(8).
15. Dziaruddin N, Zakaria AS. Resin infiltration of non-cavitated enamel lesions in paediatric dentistry: a narrative review. Children, 2022; 9(12): 1893.
16. Zakizade M, Davoudi A, Akhavan A, Shirban F. Effect of resin infiltration technique on improving surface hardness of enamel lesions: A systematic review and meta-analysis. J Evi Based Dent Prac, 2020; 20(2): 101405.
17. Ladino LG, Bernal A, Calderón D, Cortés D. Bioactive materials in restorative dentistry: a literature review. SVOA Dent, 2021; 2(2): 74-81.
18. Baccolini V, da Silva LP, Teixeira L, de Sousa RT, Manarte-Monteiro P. The role of Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP) in white spot lesion remineralization—a systematic review. J Func Biomaterials, 2025; 16(8): 272.
19. Farooq I, Moheet IA, Imran Z, Farooq U. A review of novel dental caries preventive material: Casein phosphopeptide–amorphous calcium phosphate (CPP–ACP) complex. King Saud Univ J Dent Sci, 2013; 4(2): 47-51.
20. Sachelarie L, Cristea R, Burlui E, Hurjui LL. Laser technology in dentistry: from clinical applications to future innovations. Dent J, 2024; 12(12): 420.
21. Kotlow LA. Lasers in pediatric dentistry. Dent Clin, 2004; 48(4): 889-922.
22. Ghaderi F, Ardakani MS, Afshari M. Evaluating pain relief of dental procedures with low-level laser therapy in children: a systematic review. Lasers Dent Sci, 2025; 9(1): 6-17.