AMERICAN Journal of Science on Integration and Human Development
Volume 3, Issue 10, 2025 ISSN (E): 2993-2750

The Minimally Invasive Approach Concept in Cariology

Axunjonova G. M.

Abstract: The development of advanced adhesive technologies and materials in dentistry has led to the establishment of the minimally invasive approach, which focuses on the early management of caries while preserving the tooth's anatomical structure and functional integrity to the greatest extent possible.

Keywords: caries, diagnosis, treatment.

Thanks to the development of modern and effective adhesive techniques and materials, the concept of minimal intervention dentistry (MID) was introduced in the mid-1990s. This approach focuses on early treatment of caries while preserving the anatomical and functional integrity of teeth as much as possible. By the early 21st century, the strategy of minimal intervention had become widely adopted in dental practice.

Gradually, the traditional surgical model—treatment based on removing damaged tissues—began to be replaced by a preventive model focused on maintaining oral health. This includes early detection, monitoring, risk factor control, and minimal invasive procedures.

Minimal intervention dentistry can be defined as a professional treatment philosophy and represents the latest trend in modern dentistry. The core principle involves early diagnosis of dental caries, documenting initial changes, and performing minimal operative treatment of the tooth tissues, followed by restoration with specialized materials.

Effective management of risk factors for caries development and regular evaluation of restoration quality significantly influence treatment outcomes. Adhesive technologies are gaining increasing importance, enabling minimal intervention, achieving excellent aesthetic and functional results, and providing an alternative to conventional preparation and prosthetic methods.

Objective of the Study

The aim of this paper is to discuss minimally invasive strategies for the management of dental caries. Dental caries is a pathological infectious process influenced by various systemic and local factors. In its early stages, the disease is characterized by enamel demineralization, followed by the progressive destruction of enamel and dentin if left untreated.

Caries is a multi-stage process that develops gradually—from microscopic and submicroscopic changes to visible clinical signs and symptoms (Pitts, 1991).

According to the FDI recommendations on minimally invasive caries management strategies [9], key components include: control and modification of the oral microbiota; patient motivation and education in modern caries prevention methods; active non-invasive treatment of non-cavitated enamel and dentin lesions; use of minimally invasive restorative techniques for cavitated lesions involving enamel and dentin using adhesive materials; and, whenever possible, repair or

refurbishment of existing restorations rather than their complete replacement.

Modern Diagnostic Approaches

Traditionally, caries diagnosis was limited to the detection of cavitated lesions, followed by mechanical preparation and restoration. However, advances in caries detection now emphasize early diagnosis and preventive intervention, shifting focus from surgical to medical management of the disease.

Minimally Invasive Strategy in Cariology

The minimally invasive approach in cariology is based on the principles of early detection of initial lesions and the use of classification systems that allow recording caries at the white spot stage, coded as 0. The advent and development of optical technologies and widespread application of caries detection devices have enabled more accurate identification of pathological signs through enhanced visual inspection, thus facilitating the advancement of minimally invasive treatment strategies.

The Diagnodent device employs laser technology to detect subsurface carious lesions and enamel demineralization invisible to the naked eye at the earliest stages. It uses a laser diode (wavelength 650 nm) as the light source and a photodiode combined with a long-focus filter as the detector. The activating light is delivered to the tooth via an optical fiber bundle (consisting of 9 fibers) which concentrates around the tooth, aiding in the localization of carious areas. The long-focus filter absorbs the excitation light and transmits the long-wavelength fluorescent emission.

Transillumination is a diagnostic method based on the differential light absorption properties of various tooth structures. This technique assesses shadowing effects that occur when a beam of light passes through the tooth. Orange light is considered optimal for transillumination (e.g., using the DIAGNOPEN device), although blue light from a standard photopolymerization lamp can also be used.

Quantitative light-induced fluorescence (QLF and QLF-D) involves illuminating the tooth surface with LEDs emitting light at a wavelength of 405 nm. Carious lesions fluoresce in the red spectrum, while healthy tooth tissue exhibits natural green fluorescence. Specialized algorithms generate virtual images highlighting the affected areas on the monitor.

Intraoral cameras allow real-time transmission of illuminated tissue images to a computer. According to some studies, this method doubles diagnostic accuracy on approximal surfaces, triples it on occlusal surfaces, and improves it tenfold when diagnosing lesions on the lingual and buccal surfaces.

Equally important to early lesion detection is the assessment of caries risk factors. This requires clinical tests evaluating the quantity and quality of saliva (stimulated and unstimulated saliva flow rates, viscosity, pH of unstimulated saliva, salivary buffering capacity) as well as the levels of mutans streptococci.

Since the late 1990s, several classification systems for initial lesions have been proposed (Pitts & Fyffe, 1988; Ismail, 1992; Ekstrand, Ricketts & Kidd, 1998; Fyffe et al., 2000; Nyvad, 2001) [7]. One notable example is the classification by G. Mount [10], which takes into account not only lesion location but also its size.

The international organization FDI [17] emphasizes the importance of further developing and adopting caries classification systems that incorporate the assessment of disease risk and early lesion stages. Such systems should enable documentation of clinical experience both at the community and individual levels. The adoption of these classifications will provide a foundation for shaping health policies, planning decisions, and the effective and economically viable implementation of preventive programs.

Currently, the standardized approach to caries diagnosis is the International Caries Detection and

Assessment System (ICDAS) [13], which classifies lesions based on their clinical presentation (see Table 2). This system was developed for use in clinical practice, education, and research and facilitates:

- lesion detection;
- lesion assessment;
- diagnosis establishment;
- monitoring of lesion progression.

Minimally Invasive Caries Treatment

In some cases, treatment may be limited to preventive measures and remineralization therapy. When intervention in hard dental tissues is necessary, conservative preparation with limited access is recommended [11]. An additional rationale for conservative preparation is the reduced caries incidence due to widespread fluoride use and improved oral hygiene.

The primary goal of preparation is to remove the pathological substrate (irreversibly damaged tissue) and eliminate microorganisms.

Contemporary Principles of Cavity Preparation

- **Principle of Medical Justification and Appropriateness:** This principle advocates for a tailored approach to selecting cavity preparation and filling methods based on clinical indications.
- **Principle of Painlessness:** All therapeutic, diagnostic, and preventive procedures should be carried out painlessly, which involves:

✓ adequate anesthesia;

✓ use of sharp burs and properly functioning handpieces without vibrations, operating at increased speeds;

✓ sufficient air-water cooling;

✓ psychological, psychotherapeutic, and pharmacological patient preparation.

Principles and Features of Minimally Invasive Caries Treatment

Ergonomics, Visual Control, and Working Comfort Principle:

- Maintaining ergonomic positioning of both the clinician and the patient;
- Four-handed dentistry practice;
- Adequate illumination of the working field;
- Proper placement and direction of the dental unit's light source;
- Use of handpieces with integrated lighting, along with additional illumination tools such as magnifying loupes or dental microscopes for precise control during preparation;
- Application of retractors, mouth props, and rubber dams to optimize access and visibility.

Principle of Biomechanical Compatibility:

This principle requires designing the cavity preparation to correspond with the physical and mechanical properties of the restorative materials used, as well as the biomechanical characteristics of the tooth tissues surrounding the prepared cavity.

Principle of Tissue Preservation:

This involves selecting treatment tactics that maximize the preservation of unaffected dental tissues.

Characteristics of Minimally Invasive Caries Treatment:

1. Modification of classical Black's cavity preparation principles: only the irreversibly damaged tooth structure is removed, while demineralized dentin and enamel without underlying dentin are preserved, thus avoiding unnecessary loss of healthy tissues caused by preparing cavities of predetermined geometric shapes.
2. Use of very small-sized rotary instruments (such as round and tapered burs) or alternative preparation methods like air abrasion, ultrasound, or laser.
3. Application of adhesive materials that provide sufficient and durable bonding to tooth tissues. These include hybrid glass ionomer cements (GICs) and adhesive systems combined with sealants and flowable composites.
4. Employment of specialized instruments for filling small cavities, such as narrow and thin pluggers, spatulas, and probes designed for hard-to-reach areas.

Caries Localization in Fissures (Lesions 1.0–1.2):

Due to the complex anatomy of fissures and difficulty in removing plaque, non-invasive or invasive fissure sealing is recommended [16].

Non-invasive fissure sealing is indicated when:

- ✓ There is a high caries risk (noted increase over a year);
- ✓ Tooth eruption periods (commonly between ages 6–8 and 12–14);
- ✓ Pronounced occlusal surface morphology and condition of dental tissues.

Invasive fissure sealing (enameloplasty or vital enamel biopsy) is performed when deep fissures with minor dentin involvement are present. The technique involves removing 0.1–0.5 mm of enamel followed by sealing.

To remove pigmentation and plaque from fissures, fine K-files or small round burs with red and yellow grit markings can be used. Alternatively, medium-particle aluminum oxide air abrasion under low pressure is effective.

"Bat-Cave" Lesions:

This term describes a voluminous cavity with a narrow entrance. The dentist performs minimal preparation of the cavity entrance followed by filling it with flowable composite resin.

Preventive Restoration:

For demineralized fissures involving dentin, preventive or prophylactic filling/restoration is advised [15]. This procedure includes preparation of the main lesion and selective removal of the superficial layer of healthy or slightly damaged enamel in adjacent fissures and pits, similar to invasive sealing techniques.

Caries in the Approximal Areas of the Posterior Teeth (Lesions 2.0–2.2)

The key is early detection—using bitewing radiographs, orthodontic rubber separators, wedging, and dental impressions—to monitor and prevent disease progression.

Under certain conditions, such as absence of adjacent teeth or wide interdental spaces, **slot preparation** can be performed. This minimally invasive technique is applied to the contact surfaces of molars and premolars with small to moderate carious lesions located at or below the equator of the tooth. Nowadays, slot preparation is considered a more justified treatment method for Class II defects (according to Black's classification) than the traditional removal of the marginal ridge to access the carious lesion.

Depending on the access surface, slot preparations are classified as vestibular or oral. The choice of access is determined after visual examination of the lesion. If the defect is close to the

vestibular surface, vestibular slot preparation is preferred. This technique is generally used on the distal surfaces of first molars but can also be applied to second molars and wisdom teeth if access allows.

If the carious lesion is located about 2.5 mm below the marginal ridge, **tunnel preparation** may be used [14, 18]. First described in 1963 and later reproduced by Hunt and Knight in the 1980s, tunnel preparation represents a more conservative approach than traditional Class II cavity preparation by Black (G.M. Jinks, 1963; Knight, Hunt, 1984). Access to the lesion is achieved via the occlusal surface, forming a rounded or oval "tunnel," hence the name (P.R. Hunt, 1984). This is also known as occluso-approximal tunnel preparation.

There are several variants of tunnel preparation:

- ✓ **Internal tunnel preparation (Class I by Black)** where proximal enamel is preserved.
- ✓ **Partial tunnel preparation**, preserving some demineralized enamel.
- ✓ **Complete tunnel preparation**, where all demineralized enamel on the proximal surface is removed.

When the lesion is very close to the marginal ridge, the **"slot" or "slit" preparation** method is recommended, involving removal of only the affected tissues with minimal intervention. Enamel knives and small diamond-coated conical burs are used for enamel removal, while infected dentin is carefully removed with small round burs at low speed.

Proximal Access

Proximal access is another minimally invasive approach used when access through the proximal surface is possible (such as adjacent cavities or absence of a neighboring tooth). This preparation is performed without extending to the occlusal surface.

Cervical Defects (Lesions 3.0–3.2)

Initial carious lesions in cervical areas are managed with remineralization therapy. Non-carious abfraction lesions can often be halted by eliminating contributing factors, such as correcting occlusal trauma through selective tooth grinding. Both carious and non-carious lesions (ranging from abrasion to abfraction) may require operative treatment techniques.

Early carious lesions on root surfaces are addressed with comprehensive preventive measures, including the use of chlorhexidine, fluoride agents, and improvement of oral hygiene.

Conclusion

The main advantage of this new strategy for patients lies in improved oral health outcomes. Dentists gain the opportunity to adopt a more conservative approach to caries treatment, offering patients options that involve minimal or no surgical intervention. This results in reduced patient discomfort, often eliminates the need for local anesthesia, and increases the likelihood of long-term tooth preservation after treatment.

References

1. Mount, G. Minimal Intervention Dentistry: A Modern Philosophy / G. Mount // Dent Art. – 2005. – No.1. – P.55–59.
2. Khramchenko, S.N. Long-term Results of Minimally Invasive Treatment of Caries in Posterior Teeth Using Adhesive Systems of Different Classes / S.N. Khramchenko // Stomatological Journal. – 2008. – No.2. – P.127–131.
3. Yudina, N.A. Minimally Invasive Interventions in Dentistry: Strategies and Technologies / N.A. Yudina // Modern Dentistry. – 2008. – No.1. – P.15–18.
4. Yargin, S.V. Minimally Invasive Dentistry: Theory and Prospects / S.V. Yargin // Young Scientist. – 2022. – No.8 (403). – P.30–33.

5. Burke, F.J. From Extension for Prevention to Prevention of Extension: (Minimal Intervention Dentistry) / F.J. Burke // Dent Update. – 2003. – Vol.30, No.9. – P.492–498.
6. Ericson, D. What Is Minimally Invasive Dentistry? / D. Ericson // Oral Health Prev. Dent. – 2004. – No.2 (Suppl. 1). – P.287–292.
7. Longbottom, Huysmans, Pitts & Fontana. Glossary of Key Terms. In: Pitts NB (ed): Detection, Assessment, Diagnosis and Monitoring of Caries. Monogr Oral Sci. Basel, Karger, 2009. – Vol.21. – P.209–216.
8. Lumley, P.J. Tunnel Restorations: A Long-term Pilot Study Over a Minimum of Five Years / P.J. Lumley, F.J. Fisher // J. Dent. – 1995. – Vol.23. – P.213–215.
9. Minimal Intervention Dentistry: A Review FDI Commission Project 1–97 / M.J. Tyas [et al.] // Int. Dent. J. – 2000. – Vol.50. – P.1–12.
10. Mount, G.J. Minimal Intervention: Advanced Lesions / G.J. Mount, H. Ngo // Quintessence Int. – 2000. – Vol.31, No.9. – P.621–629.
11. Peters, M.C. Minimally Invasive Operative Care / M.C. Peters // The Journal of Adhesive Dentistry. – 2001. – Vol.3, No.1. – P.7–31.
12. Pitts, N.B. Are We Ready to Move from Operative to Non-Operative Treatment of Dental Caries in Clinical Practice? / N.B. Pitts // Caries Research. – 2004. – Vol.38. – P.294–304.
13. Pitts, N.B. and Stam, J. ICW-CCT Statement & J Dent Research. – 2004. – Vol.83C. – P.125–128.
14. Barnokhon Askarovna Muydinova. Manifestations of candidiasis (thrush) in the oral Cavity american journal of applied medical science ISSN: 2996-5101 (online) | researchbib (IF) = 10.81 IMPACT FACTOR Volume-3| Issue-8| 2025 Published: |30-09-2025| 1-5
15. Ripe, I. Preventive Restorations: Indications, Technique, and Clinical Effectiveness / I. Ripe, M. Wolff // Quintessence. – 1993. – No.5. – P.4–15.
16. Simonsen, R.J. Preventive Resin Restorations and Sealants in Light of Current Evidence / R.J. Simonsen // Dent Clin North Am. – 2005. – Vol.49, No.4. – P.815–823.
17. Mamarasulova Sofiya, Iminjonova Gulmirakhon, Shomirzayev Hurshid Multimodal Approach to Improving the Process of Osteointegration of Dental Implants in Postmenopausal Women American Journal of Medicine and Medical Sciences 2025, 15(2): 457-461 DOI: 10.5923/j.ajmms.20251502.40