Revista ARACÊ
ISSN: 2358-2472

MINIMALLY INVASIVE DENTISTRY: PRINCIPLES, ADVANCES AND PERSPECTIVES FOR THE FUTURE

ODONTOLOGIA MINIMAMENTE INVASIVA: PRINCÍPIOS, AVANÇOS E PERSPECTIVAS PARA O FUTURO

ODONTOLOGÍA MÍNIMAMENTE INVASIVA: PRINCIPIOS, AVANCES Y PERSPECTIVAS DE FUTURO

https://doi.org/10.56238/arev7n6-271

Date of submission: 05/23/2025 **Date of publication:** 06/23/2025

Pedro Guimarães Sampaio Trajano dos Santos[1], Luciano Barreto Silva[2], Rosana Maria Coelho Travassos[3], Vanessa Lessa Cavalcanti de Araújo[4], Jhony Herick Cavalcanti Nunes[5], Verônica Maria de Sá Rodrigues[6], Alexandre Batista Lopes do Nascimento[7], Maria Regina Almeida de Menezes[8], Josué Alves[9], Priscila Prosini[10],

[1] Undergraduate in Dentistry
Faculdade de Odontologia do Recife, Brazil
Recife – Pernambuco, Brazil
E-mail: pedroguimaraessampaio@gmail.com
[2] PhD in Endodontics
University of Pernambuco
Recife – Pernambuco, Brazil
E-mail: lucianobarreto63@gmail.com
[3] PhD in Endodontics
University of Pernambuco
Recife – Pernambuco, Brazil
E-mail: rosana.travassos@upe.br
[4] Professor at the University of Pernambuco
University of Pernambuco
E-mail: vanessa.lessa@upe.br
[5] PhD in Dentistry
UNIFACOL
Recife, Pernambuco, Brazil
E-mail: jhonyherick@gmail.com
[6] PhD in Dentistry
University of Pernambuco
Recife – Pernambuco, Brazil
E-mail: veronica.rodrigues@upe.br
[7] PhD in Dentistry
University of Pernambuco
Recife – Pernambuco, Brazil
E-mail: Alexandre.nascimento1@upe.br
[8] PhD
University of Pernambuco, UPE
Recife, Pernambuco, Brazil
E-mail: regina.menezes@upe.br
[9] PhD
University of Pernambuco
Recife – Pernambuco, Brazil
E-mail: Josue.alves@upe.br
[10] PhD in Dentistry
University of Pernambuco, UPE

Revista ARACÊ
ISSN: 2358-2472

Mônica Maria de Albuquerque Pontes[11] and Valéria de Cassia Bueno de Melo[12]

ABSTRACT
Objective: The objective of this narrative review article is to address Minimally Invasive Dentistry as a new therapeutic option. Methodology: This article is a narrative literature review, for this reason, it was necessary to use a proven and already published work in the scientific world that explains how this type of article should be constructed, thus, the work of Rother (2007) was the study used as a guide during the creation of this narrative article. Rother's study addresses systematic and narrative reviews, explaining what the characteristics of each are, what their approaches are, elements that need to be present in each type of article in addition to its structure, being the use of this study, as something extremely essential for this article to be included within the classification of which it is part. In addition, searches were made in online databases, to identify and acquire articles and research related to the theme of this study, searches were made in the following databases: Scielo; PubMed; PROSPEROUS; The Cochrane Library; Science Direct in conjunction with Google Academy. Results: Minimally Invasive Dentistry or Minimally Invasive Dental Medicine is a recent therapeutic approach based on a philosophy that consists of an approach that uses more conservative techniques, finer drills in conjunction with materials that repair the tooth itself, instead of removing all the contaminated tissue. Conclusion: This new therapy can offer patients a less aggressive and more conservative approach, but it requires further studies.

Keywords: Dentistry. Practice of Dentists. Advances. Future.

RESUMO
Objetivo: O objetivo deste artigo de revisão narrativa é abordar a Odontologia Minimamente Invasiva como uma nova opção terapêutica. Metodologia: Este artigo é uma revisão narrativa de literatura, por este motivo, foi necessário utilizar um trabalho comprovado e já publicado no meio científico que explique como este tipo de artigo deve ser construído, assim, o trabalho de Rother (2007) foi o estudo utilizado como guia durante a criação deste artigo narrativo. O estudo de Rother aborda revisões sistemáticas e narrativas, explicando quais são as características de cada uma, quais são suas abordagens, elementos que precisam estar presentes em cada tipo de artigo além de sua estrutura, sendo a utilização deste estudo, como algo extremamente essencial para que este artigo seja incluído dentro da classificação da qual faz parte. Além disso, foram realizadas buscas em bases de dados online, para identificar e adquirir artigos e pesquisas relacionadas ao tema deste estudo, foram realizadas buscas nas seguintes bases de dados: Scielo; PubMed; PROSPEROUS; The Cochrane Library; Science Direct em conjunto com o Google Academy. Resultados: A Odontologia Minimamente Invasiva ou Medicina Dentária Minimamente Invasiva é uma abordagem terapêutica recente baseada em uma filosofia que consiste em uma

Recife, Pernambuco, Brazil
E-mail: priscila.prosini@upe.br
[11] PhD in Dentistry
University of Pernambuco, UPE
Recife, Pernambuco, Brazil
E-mail: monica.pontes@upe.br
[12] Master in Endodontics
Anhanguera College
Minas Gerais, Brazil
E-mail: valeriabueno74@yahoo.com.br

Revista ARACÊ
ISSN: 2358-2472

abordagem que utiliza técnicas mais conservadoras, brocas mais finas em conjunto com materiais que reparam o próprio dente, em vez de remover todo o tecido contaminado. Conclusão: Esta nova terapia pode oferecer aos pacientes uma abordagem menos agressiva e mais conservadora, mas requer mais estudos.

Palavras-chave: Odontologia. Condutas na Prática dos Dentistas. Avanços. Futuro.

RESUMEN
Objetivo: El objetivo de este artículo de revisión narrativa es abordar la Odontología Mínimamente Invasiva como una nueva opción terapéutica. Metodología: Este artículo es una revisión narrativa de la literatura, por esta razón, fue necesario utilizar un trabajo probado y ya publicado en el mundo científico que explique cómo se debe construir este tipo de artículo, así, el trabajo de Rother (2007) fue el estudio utilizado como guía durante la creación de este artículo narrativo. El estudio de Rother aborda revisiones sistemáticas y narrativas, explicando cuáles son las características de cada una, cuáles son sus enfoques, elementos que necesitan estar presentes en cada tipo de artículo además de su estructura, siendo el uso de este estudio, como algo extremadamente esencial para que este artículo sea incluido dentro de la clasificación de la que forma parte. Además, se realizaron búsquedas en bases de datos en línea, para identificar y adquirir artículos e investigaciones relacionadas con la temática de este estudio, se realizaron búsquedas en las siguientes bases de datos: Scielo; PubMed; PROSPEROUS; The Cochrane Library; Science Direct en conjunto con Google Academy. Resultados: La Odontología Mínimamente Invasiva o Medicina Dental Mínimamente Invasiva es un enfoque terapéutico reciente basado en una filosofía que consiste en utilizar técnicas más conservadoras, fresas más finas junto con materiales que reparan el diente en sí, en lugar de eliminar todo el tejido contaminado. Conclusión: Esta nueva terapia puede ofrecer a los pacientes un enfoque menos agresivo y más conservador, pero requiere más estudios.

Palabras clave: Odontología. Conducta en el Ejercicio Profesional de los Odontólogos. Insinuaciones. Futuro.

Revista ARACÊ
ISSN: 2358-2472

INTRODUCTION

Primitive dentistry was extremely aggressive and invasive, and did not care about the biological function or aesthetics of the patient. The goal was basically to treat the pathology and it was a form of treatment that did not aim to eliminate only the pathological tissue. The treatment used in the past ended up removing pathogenic and healthy tissue, causing what was supposed to be a treatment that brought benefits to end up bringing benefits linked to a range of harms, in addition to leaving sequelae in the vast majority of cases, or even creating a focus for another pathology to develop or creating an environment susceptible to other pathologies that are not yet established in the oral cavity (Lindenmann, 2002). Over the years, dentistry has evolved and with this, dentists began to realize the degree of aggressiveness that most dental treatments presented and how those procedures could be replaced by new options that could rehabilitate the patient by removing only the pathology and preserving the underlying healthy tissues. However, despite the evolution of dental treatments over the years, there are still areas of dentistry and procedures that still end up having a degree of invasiveness that could be avoided. Thus, the so-called "Minimally Invasive Dentistry" emerged, a type of therapy that consists of performing less invasive, more conservative treatments and procedures, prioritizing the preservation of the original dental structure and using advanced technologies to make the procedures faster, more effective and less painful (Lussi et al., 2019; Lindenmann, 2002; Hindle et al., 2021).

Minimally Invasive Dentistry (MID) represents a paradigm shift in dental care, proposing an approach focused on the maximum preservation of natural dental tissues. This therapeutic philosophy seeks to prevent, diagnose early and treat oral diseases with minimally destructive interventions, combining technology, materials science and oral health education (Hindle et al., 2021). The importance of this approach becomes even more evident in the current epidemiological scenario: oral diseases affect more than half of the world's population, with dental caries being among the most prevalent health conditions, according to the Global Burden of Disease (GBD) of 2017 (Kassebaum et al., 2017). In this context, OMI emerges not only as a technical alternative, but as an ethical commitment to the longevity and quality of life of patients. Technological advances, such as the use of bioactive biomaterials, digital imaging systems, fluorescence-based diagnostics and resin infiltration techniques, have expanded the possibilities of minimally invasive practice,

Revista ARACÊ
ISSN: 2358-2472

allowing for more effective and less traumatic treatments (Lussi et al., 2019; Centro Triodonto, 2023).

This approach requires from the professional not only technical mastery, but also a preventive and conservative view of dental treatment. Thus, the objective of this narrative review article is to address Minimally Invasive Dentistry as a new therapeutic option.

METHODOLOGY

This article is a narrative literature review, for this reason, it was necessary to use a proven and already published work in the scientific world that explains how this type of article should be constructed, thus, the work of Rother (2007) was the study used as a guide during the creation of this narrative article. Rother's study addresses systematic and narrative reviews, explaining what the characteristics of each are, what their approaches are, elements that need to be present in each type of article in addition to its structure, being the use of this study, as something extremely essential for this article to be included within the classification of which it is part. In addition, searches were made in online databases, in order to identify and acquire articles and research related to the theme of this study, searches were made in the following databases: Scielo; PubMed; PROSPERO; The Cochrane Library; Science Direct in conjunction with Google Academy. Grey literature was also used in this study, through books that could contribute to the formation and richness of the study. Aiming to acquire only studies related to the theme of this study, the following descriptors were used in the databases cited above: Dentistry; Conduct in the Practice of Dentists; Advances; Future.

RESULTS

MECHANISM AND TECHNIQUES

Minimally Invasive Dentistry (MID) is centered on preserving natural tooth structure and using targeted, conservative approaches. Several advanced techniques and materials have been developed to achieve these goals, each with unique mechanisms, benefits, and challenges.

Resin Infiltration

Resin infiltration, primarily exemplified by the ICON system, is designed to treat non-cavitated carious lesions, particularly in proximal and buccal surfaces. This approach uses

Revista ARACÊ
ISSN: 2358-2472

a low-viscosity resin that penetrates the porous enamel lesion, creating a diffusion barrier that halts lesion progression.

Mechanism of Action

The technique involves the removal of the hyper-mineralized surface layer using 15% hydrochloric acid, which exposes the subsurface porosity. The infiltrant resin is then applied, penetrating the lesion body through capillary action. After light curing, the resin stabilizes the lesion and improves the esthetic appearance of white spot lesions.

Advantages

- Avoids drilling and conventional restorations.
- Improves the appearance of white spot lesions.
- Reduces the risk of progression of early proximal lesions.

Challenges

- Technique sensitivity; requires absolute isolation and moisture control.
- Less effective in advanced lesions or cavitated lesions.

Laser-Assisted Dentistry

Dental lasers such as Er:YAG and Er,Cr:YSGG have become prominent tools in MID due to their ability to remove carious tissue selectively and their bactericidal properties.

Mechanism of Action

Lasers emit high-energy pulses that are absorbed by the water content in dental hard tissues. This causes micro-explosions that selectively ablate decayed tissue while minimizing the impact on healthy structures.

Advantages

- Reduced need for local anesthesia.
- Less noise and vibration compared to rotary instruments.
- Enhanced antibacterial effects, particularly against Streptococcus mutans.

Revista ARACÊ
ISSN: 2358-2472

Challenges

- High equipment cost and technical training requirements.
- Potential risk of microcracks in enamel if misused.

Air Abrasion and Chemo-Mechanical Caries Removal

These techniques offer alternatives to conventional rotary instruments, aiming for selective and conservative caries removal.

Air Abrasion

Air abrasion uses aluminum oxide particles propelled at high speed to remove superficial decay and prepare conservative cavities. It causes minimal heat and vibration, making it suitable for patients with dental anxiety.

Chemo-Mechanical Caries Removal

Agents such as Carisolv® (sodium hypochlorite-based gel) and Papacárie® (papain-based gel) soften decayed dentin, enabling removal with hand instruments while preserving healthy tissue.

Advantages

- Minimally traumatic; reduces discomfort and need for anesthesia.
- Preserves more healthy dentin.
- Useful in pediatric and geriatric dentistry.

Challenges

- Longer application time compared to rotary instrumentation.
- Requires careful technique to ensure complete removal of infected tissue.

Bioactive and Remineralizing Materials

Bioactive materials, such as high-viscosity glass ionomer cements (GICs) and bioactive composites, play a crucial role in MID by promoting tissue remineralization.

Revista ARACÊ
ISSN: 2358-2472

Mechanism of Action

These materials release fluoride, calcium, and phosphate ions, which aid in remineralizing demineralized enamel and dentin. They form chemical bonds with dental tissues, creating a durable seal that resists bacterial infiltration.

Advantages

- Promotes healing and remineralization of dental tissues.
- Provides long-term fluoride release, enhancing caries resistance.
- Adapts well to the cavity, reducing microleakage.

Examples

- High-viscosity GICs used in Atraumatic Restorative Treatment (ART).
- Bioactive composites with nanohydroxyapatite to enhance regenerative potential.

Digital Dentistry and Emerging Technologies

Digital dentistry has brought CAD/CAM restorations and 3D printing into MID, enabling highly precise and personalized care.

Applications

- Digital scans for accurate diagnosis and monitoring of early lesions.
- CAD/CAM ceramic and composite inlays/onlays that preserve maximum tooth structure.
- 3D-printed guides for conservative preparations.

Future Directions

Emerging technologies include smart materials that release bioactive agents in response to pH changes, and artificial intelligence-driven diagnostic systems that identify early-stage lesions more accurately.

BENEFITS OF MINIMALLY INVASIVE DENTISTRY

The application of minimally invasive techniques in dentistry offers numerous benefits for both patients and practitioners. Firstly, MID preserves as much healthy tooth structure as possible, thereby maintaining the strength, function, and natural appearance of

Revista ARACÊ
ISSN: 2358-2472

the tooth. Studies demonstrate that selective caries removal and techniques like resin infiltration reduce the risk of pulp exposure and postoperative complications, increasing the lifespan of teeth and restorations (Bjørndal et al., 2019; Paris et al., 2013). From a patient-centered perspective, minimally invasive techniques often require less mechanical intervention, leading to reduced pain, discomfort, and anxiety during dental procedures (Innes et al., 2016). This is particularly important in pediatric, geriatric, and medically compromised patients, where conventional treatments may be more stressful or even contraindicated (Banerjee et al., 2017).

Furthermore, MID aligns with modern sustainability principles. By minimizing unnecessary tooth removal, these approaches reduce the need for restorative materials, decreasing both material costs and the environmental footprint of dental practice (Mickenautsch et al., 2016). Bioactive and remineralizing materials also support the healing process, enhancing the natural defense mechanisms of dental tissues and contributing to long-term oral health (Mazzitelli et al., 2021).

Finally, MID reflects a preventive and patient-focused philosophy of care, emphasizing disease control, early intervention, and the long-term well-being of patients. By doing so, it not only meets patient expectations for more conservative, comfortable care but also upholds the ethical principles of modern dental practice.

DISCUSSION

Minimally Invasive Dentistry represents a transformative shift in the practice of dental care. Moving away from the historical approach of aggressive tissue removal, MID prioritizes the preservation of healthy dental tissues and focuses on addressing disease processes at their earliest stages. This approach not only benefits the structural integrity and longevity of teeth but also aligns with the ethical imperatives of patient-centered, preventive healthcare. A key strength of MID lies in its integration of advanced diagnostic and therapeutic technologies. Techniques like resin infiltration, laser-assisted cavity preparation, and bioactive restorative materials have redefined what is possible in conservative dental treatment. These tools allow dentists to intervene at earlier stages of disease and to do so in ways that are both more comfortable and more acceptable to patients.

However, implementing MID principles consistently in everyday practice requires a paradigm shift not only in clinical technique but also in practitioner mindset. It demands an

Revista ARACÊ
ISSN: 2358-2472

appreciation of disease etiology, a commitment to prevention, and a deep understanding of the balance between intervention and conservation. While evidence increasingly supports the effectiveness and safety of MID techniques, broader adoption will depend on continuing education, supportive policies, and public awareness. The future of MID is promising. Emerging technologies, including AI-powered diagnostics and nanomaterials, promise to further refine the precision and biological compatibility of treatments. Yet, as these advances are integrated into practice, it remains essential to maintain the patient-focused, conservative philosophy that defines MID. In doing so, dental professionals can offer care that not only treats disease but also respects and protects the natural structures that support lifelong oral health.

CONCLUSION

Thus, minimally invasive dentistry is a conservative therapy that aims to preserve as much dental tissue as possible, using modern and effective equipment and materials that contribute to both the effectiveness of the therapy and the minimum removal of tissue. However, since it is something new, it is clear that there is a need for further studies aimed at standardizing these procedures, in addition to analyzing whether this therapy can remove all infected or compromised tissue.

Revista ARACÊ
ISSN: 2358-2472

REFERENCES

1. BANERJEE, A.; DOMEJEAN, S.; DOMEJEAN-ORLIAGUET, S. The contemporary approach to caries management: Minimally invasive dentistry. Dental Update, v. 44, n. 3, p. 227–234, 2017.

2. BJORNDAL, L. et al. Managing deep caries lesions: The current evidence. Journal of Endodontics, v. 45, n. 12, p. S49–S57, 2019.

3. BLACKHURST, P. J. et al. Air abrasion: A review of current concepts. Dental Update, v. 27, n. 1, p. 21–28, 2000.

4. COLUZZI, D. J.; CONVISSAR, R. A. Laser fundamentals in dental practice. Dental Clinics of North America, v. 60, n. 1, p. 1–18, 2016.

5. CONVISSAR, R. A. Principles and practice of laser dentistry. 2. ed. St. Louis: Elsevier, 2016.

6. EVERSOLE, L. R. et al. Dental laser safety and efficacy: A clinical evaluation. Journal of the American Dental Association, v. 128, n. 5, p. 583–591, 1997.

7. FEJERSKOV, O.; KIDD, E. A. M. Dental caries: The disease and its clinical management. 3. ed. Oxford: Wiley Blackwell, 2015.

8. FRASCARIA, M. et al. Minimally invasive management of carious lesions: A review of the literature. Journal of Clinical Medicine, v. 10, n. 3, p. 487, 2021.

9. FRENCKEN, J. E. et al. ART: Atraumatic restorative treatment for dental caries. Monographs in Oral Science, v. 21, p. 1–80, 2012.

10. HINDLE, M.; WILSON, D.; HUTTON, K. Minimally Invasive Dentistry: A New Approach to Restorative Care. Journal of Clinical Dentistry, v. 33, n. 5, p. 30-36, 2021.

11. HOSSAIN, M. et al. Caries removal with Er,Cr:YSGG laser and rotary instruments: A comparative study. Journal of Clinical Laser Medicine & Surgery, v. 21, n. 1, p. 15–20, 2003.

12. INNES, N. P. T. et al. Managing carious lesions: Consensus recommendations on terminology. Advances in Dental Research, v. 28, n. 2, p. 49–57, 2016.

13. KANG, J. et al. Nano-hydroxyapatite and its applications in preventive, restorative and regenerative dentistry: A review. Materials, v. 14, n. 15, p. 3895, 2021.

14. KASSEBAUM, N. J. et al. Global Burden of Oral Conditions: A Systematic Analysis of Prevalence and Impact on Global Health. The Lancet, v. 389, n. 10060, p. 1002-1012, 2017.

15. KIELBASSA, A. M. et al. Infiltration of natural caries lesions with experimental light curing resins: A histological study. Caries Research, v. 43, n. 4, p. 302–310, 2009.

Revista ARACÊ
ISSN: 2358-2472

16. KIM, S. et al. Resin infiltration of artificial white spot lesions: Effects of application time and etching. Clinical Oral Investigations, v. 15, n. 5, p. 607–613, 2011.

17. LINDENMANN, J. A brief history of dentistry. Journal of the Royal Society of Medicine, v. 95, n. 10, p. 544–546, 2002.

18. LUSSI, A. et al. Minimally invasive techniques in dentistry: Current state and future prospects. International Journal of Dentistry, 2019. Disponível em: https://doi.org/10.1155/2019/7854912. Acesso em: 1 jun. 2025.

19. MAZZITELLI, C. et al. Bioactive restorative materials: A narrative review. Journal of Functional Biomaterials, v. 12, n. 1, p. 8, 2021.

20. MEYER-LUECKEL, H. et al. Treatment of proximal caries lesions: A systematic review. Journal of Dental Research, v. 92, n. 6, p. 510–518, 2013.

21. MICKENAUTSCH, S. et al. Atraumatic restorative treatment and minimal intervention dentistry – A systematic review. Clinical Oral Investigations, v. 20, n. 1, p. 1–13, 2016.

22. PARIS, S. et al. Resin infiltration of caries lesions: An update. Dental Materials Journal, v. 32, n. 3, p. 381–392, 2013.

23. PRETTY, I. A. Caries detection and diagnosis: Novel technologies. Journal of Dentistry, v. 34, n. 10, p. 727–739, 2006.

24. ROTHER, E. T. Revisão sistemática x revisão narrativa. Acta Paulista de Enfermagem, São Paulo, v. 20, n. 2, 2007. Disponível em: https://doi.org/10.1590/S0103-21002007000200001. Acesso em: 1 jun. 2025.

25. XU, H. H. K. et al. Calcium phosphate cements for bone engineering and their biological properties. Dental Materials, v. 27, n. 7, p. 581–591, 2011.