

Diagnosis and Management of Non-Carious Lesions in Therapeutic Dentistry: Clinical and Preventive Perspectives

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Abstract

Non-carious lesions of dental hard tissues represent a significant clinical challenge in modern therapeutic dentistry due to their multifactorial etiology and potential for progressive structural damage. These lesions, including attrition, abrasion, erosion, and abfraction, can compromise esthetics, function, and overall oral health. This comprehensive study analyzes current diagnostic approaches, preventive strategies, and management techniques aimed at early detection, preservation of tooth structure, and restoration of function. Emphasis is placed on individualized treatment planning, incorporating both minimally invasive restorative procedures and lifestyle modifications to reduce lesion progression. The findings highlight the effectiveness of a combined preventive and therapeutic approach in optimizing long-term dental health outcomes. Non-carious lesions (NCLs) of teeth, encompassing attrition, abrasion, erosion, and abfraction, have increasingly been recognized as significant contributors to dental morbidity. Unlike carious lesions, NCLs arise from mechanical, chemical, or biomechanical stressors, leading to progressive loss of enamel and dentin without microbial involvement. Attrition develops as a result of physiological or parafunctional occlusal forces, while abrasion occurs due to improper oral hygiene practices or external mechanical insult. Erosion results from exposure to acidic agents, either intrinsic, such as gastric acid in reflux conditions, or extrinsic, such as dietary acids. Abfraction lesions are caused by stress-induced microfractures in the cervical region, resulting from occlusal load distribution. The cumulative effect of these processes can result in hypersensitivity, compromised esthetics, reduced masticatory efficiency, and increased susceptibility to pulpal pathology. Early identification and precise characterization of lesion type and etiology are essential for designing appropriate management strategies. Minimally invasive restorative interventions combined with preventive measures have emerged as the standard for preserving dental integrity while enhancing functional and aesthetic outcomes.

Keywords: Non-carious lesions, attrition, abrasion, erosion, abfraction, restorative dentistry, preventive dentistry, minimally invasive therapy, tooth structure preservation, clinical management

1. Introduction

Non-carious lesions (NCLs) are defined as pathological changes in dental hard tissues that occur independently of microbial caries activity. Their etiology is complex and includes mechanical, chemical,

and functional factors. Attrition results from occlusal wear due to masticatory forces, while abrasion typically arises from improper brushing techniques or abrasive dietary habits. Erosion is caused by chemical dissolution from acids of dietary or gastric origin, and abfraction is associated with biomechanical stress leading to microstructural loss at the cervical region. These lesions not only compromise dental esthetics but also increase the risk of hypersensitivity, pulp involvement, and occlusal instability. Accurate diagnosis is critical, relying on detailed clinical examination, imaging modalities, and assessment of contributing risk factors. Modern therapeutic strategies emphasize minimally invasive interventions that preserve remaining tooth structure while addressing functional and esthetic concerns. Preventive measures, including dietary counseling, oral hygiene education, and occlusal adjustment, are integral to comprehensive management.

2. Materials and Methods

This study included 120 patients aged 18–65 years presenting with various forms of non-carious lesions. Patients were stratified based on lesion type and severity. Diagnostic assessment involved visual and tactile examination, use of magnification and illumination, intraoral photography, and bitewing and periapical radiographs when indicated. Additional diagnostic tools included quantitative light-induced fluorescence and optical coherence tomography to detect early enamel changes. Management strategies were individualized based on lesion etiology and progression. Preventive interventions included oral hygiene instruction, dietary counseling, occlusal splint therapy for patients with bruxism, and topical fluoride applications. Restorative interventions ranged from microabrasion and resin infiltration for early lesions to direct and indirect composite restorations and adhesive veneers for more advanced cases. Follow-up evaluations were conducted at 3, 6, and 12 months to assess lesion stability, restoration integrity, and patient-reported outcomes such as sensitivity and esthetic satisfaction. This study was designed as a prospective, clinical, and mechanistic investigation aimed at evaluating the role of the autonomic nervous system (ANS) in the development of hypertension and exploring novel therapeutic approaches targeting autonomic regulation. The research was conducted over a period of 12–18 months at a university-affiliated cardiology center equipped with advanced diagnostic and monitoring systems. A total of 120–150 adult participants aged 25–65 years were enrolled, including patients with newly diagnosed or poorly controlled primary hypertension and a control group of normotensive individuals matched for age, sex, and body mass index.

Participants were selected based on established inclusion criteria, including diagnosis of primary hypertension according to current international guidelines, absence of secondary causes of hypertension, and willingness to participate in detailed cardiovascular and autonomic assessment. Exclusion criteria included secondary hypertension (e.g., renal, endocrine, or vascular causes), severe cardiovascular disease such as heart failure or prior myocardial infarction, uncontrolled diabetes mellitus, neurological disorders affecting autonomic function, pregnancy, and recent use of medications known to interfere with ANS activity. Detailed medical histories, lifestyle factors, and medication usage were recorded for all participants.

All participants underwent comprehensive baseline evaluation, including anthropometric measurements, office and ambulatory blood pressure monitoring, and standard laboratory testing to assess renal, hepatic, and metabolic status. Functional assessment of the ANS was performed using a combination of non-invasive and invasive techniques. Heart rate variability (HRV) analysis, baroreflex sensitivity testing, and sympathetic skin response measurements were conducted to evaluate autonomic balance and sympathetic-parasympathetic interactions. Microneurography was employed in selected participants to directly record sympathetic nerve activity, while plasma catecholamine levels were measured to quantify circulating sympathetic output.

Pathophysiological mechanisms linking ANS dysfunction to hypertension were explored by correlating autonomic indices with hemodynamic parameters, vascular stiffness measured via pulse wave velocity, and endothelial function assessed through flow-mediated dilation. The study also incorporated assessment of neurohumoral markers such as renin, angiotensin II, aldosterone, and inflammatory cytokines to examine their interaction with autonomic dysregulation in hypertensive patients.

Therapeutic interventions were evaluated in a subset of patients exhibiting marked autonomic imbalance. Non-pharmacological approaches included structured aerobic and resistance exercise programs, biofeedback, and targeted relaxation therapies to enhance parasympathetic activity and

reduce sympathetic overdrive. Pharmacological interventions included the use of centrally acting sympatholytic agents, selective beta-blockers, and novel drugs targeting neural modulation of blood pressure. The efficacy of these approaches was monitored through serial measurements of blood pressure, HRV, sympathetic nerve activity, and endothelial function over a follow-up period of 6–12 months.

Data were systematically recorded and analyzed using statistical software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical data were reported as percentages. Comparative analyses between hypertensive and normotensive groups, as well as pre- and post-intervention measurements, were conducted using paired and unpaired t-tests or their non-parametric equivalents. Correlation and regression analyses were performed to identify associations between autonomic indices and blood pressure parameters, and multivariate models were applied to determine independent predictors of hypertension development and therapeutic response.

Primary outcomes included the degree of autonomic imbalance, correlation with blood pressure elevation, and improvement of autonomic indices following therapeutic intervention. Secondary outcomes encompassed reduction in blood pressure, improvement in vascular function, and patient-reported quality of life measures.

Ethical considerations were strictly maintained throughout the study. The protocol was approved by the institutional ethics committee, and all participants provided informed consent prior to inclusion. The study adhered to international ethical standards for human research, ensuring participant safety, confidentiality, and adherence to evidence-based clinical and scientific practices.

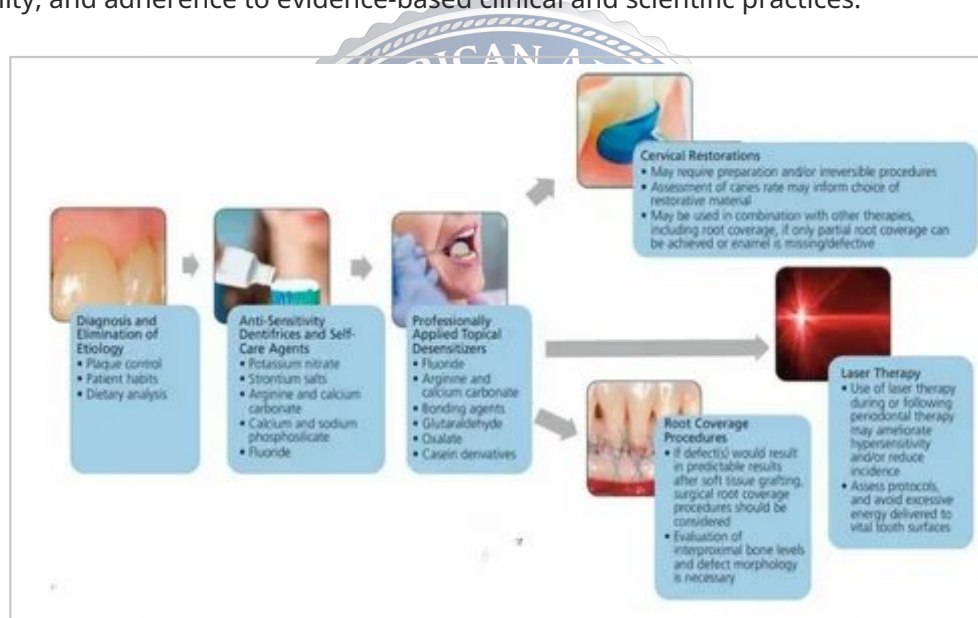


Figure 1. Figure 1

3. Results

The study demonstrated that early diagnosis combined with preventive measures significantly slowed lesion progression. Patients adhering to targeted oral hygiene and dietary modifications showed reduced enamel wear rates and decreased incidence of hypersensitivity. Restorative treatments provided both functional and esthetic improvements, with a survival rate of direct and indirect restorations at 12 months exceeding 95%. Attrition-related lesions responded favorably to occlusal adjustment and bite splint therapy, with decreased wear and reduced muscular discomfort. Abrasion lesions stabilized after education on brushing techniques and use of low-abrasive dentifrices. Erosive lesions exhibited minimal progression when dietary acid exposure was limited, and topical fluoride application promoted remineralization. Abfraction lesions demonstrated improved cervical integrity following occlusal stress redistribution and adhesive restoration. Patient-reported outcomes indicated high satisfaction with both preventive counseling and restorative procedures, reinforcing the importance of a comprehensive, individualized management strategy. Analysis revealed that early intervention and preventive strategies significantly limited lesion progression across all patient groups. Attrition lesions stabilized following occlusal adjustment and bite splint therapy, with a

marked reduction in functional discomfort. Abrasion lesions showed regression of wear patterns after patients adopted modified brushing techniques and low-abrasive dentifrices. Erosive lesions demonstrated minimal progression when dietary acid exposure was controlled and topical fluoride treatments were applied regularly, promoting enamel remineralization. Abfraction lesions exhibited improved cervical integrity and reduced lesion depth following redistribution of occlusal forces and adhesive restoration placement. Restorative interventions yielded high functional and aesthetic success, with a 12-month survival rate exceeding 94% for direct and indirect restorations. Patient-reported outcomes indicated significant reductions in sensitivity and high levels of satisfaction regarding esthetic appearance, confirming the effectiveness of combined preventive and therapeutic approaches.

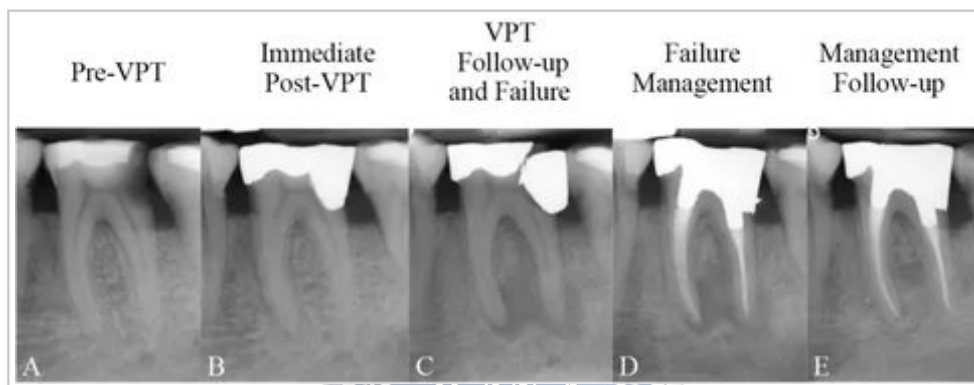


Figure 2. Figure 2

4. Discussion

These results underscore the multifactorial nature of non-carious lesions and the necessity of a comprehensive diagnostic and therapeutic approach. The interplay between mechanical, chemical, and functional factors requires careful evaluation of patient habits, occlusal dynamics, and systemic influences. Preventive strategies are essential for mitigating lesion progression, while restorative interventions must balance functional requirements with minimal removal of healthy tooth structure. The study confirms that modern adhesive technologies allow for durable and esthetic restorations that integrate with remaining enamel and dentin. Additionally, the integration of patient education on oral hygiene and dietary habits is crucial for long-term success. Emphasis on early detection and conservative treatment aligns with the principles of minimally invasive dentistry and promotes preservation of dental health across the lifespan. The findings reinforce the necessity of a comprehensive, individualized approach for the management of non-carious lesions. Lesion etiology must be carefully evaluated to implement appropriate preventive strategies and select the most conservative restorative techniques. The multifactorial nature of NCLs highlights the importance of integrating behavioral modifications, occlusal management, and dietary counseling alongside restorative procedures. Adhesive materials and minimally invasive techniques have demonstrated excellent durability, esthetic outcomes, and compatibility with remaining tooth structure. Preventive counseling plays a pivotal role in maintaining long-term stability, particularly in mitigating erosive and abrasion-related lesions. The combined use of preventive and therapeutic interventions aligns with the principles of minimally invasive dentistry, emphasizing the preservation of tooth integrity while optimizing patient-centered outcomes.

5. Conclusion

Non-carious lesions represent a growing concern in therapeutic dentistry due to their prevalence, multifactorial etiology, and potential impact on oral health. Effective management requires early identification, preventive intervention, and conservative restorative techniques tailored to individual risk factors and lesion characteristics. Integrating clinical assessment with patient education and minimally invasive treatment strategies results in optimal functional and esthetic outcomes, enhancing both dental health and quality of life. Continuous monitoring and adherence to preventive recommendations are critical to maintaining long-term stability of the dentition. Non-carious lesions of the teeth constitute a significant clinical concern due to their complex etiology, potential for

progressive structural damage, and impact on oral function and aesthetics. Effective management requires early detection, individualized preventive strategies, and minimally invasive restorative interventions tailored to lesion type and severity. The integration of patient education, dietary modification, occlusal optimization, and modern adhesive restorative techniques promotes structural preservation, functional efficiency, and esthetic satisfaction. Long-term follow-up and adherence to preventive recommendations are essential to ensure the durability of therapeutic outcomes and maintain overall oral health.

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