

MODERN METHODS FOR THE PREVENTION AND TREATMENT OF DENTAL CARIES IN THERAPEUTIC DENTISTRY

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Abstract

Dental caries remains one of the most prevalent chronic diseases worldwide and continues to represent a major public health challenge affecting individuals of all age groups. The disease is characterized by progressive demineralization and destruction of dental hard tissues caused by complex interactions between cariogenic microorganisms, fermentable carbohydrates, host susceptibility, salivary composition, and environmental risk factors. Untreated carious lesions may lead to pulpal inflammation, tooth loss, impaired mastication, aesthetic dysfunction, speech difficulties, and reduction in quality of life. Contemporary therapeutic dentistry increasingly emphasizes preventive care, early diagnosis, minimally invasive intervention, remineralization strategies, and biological preservation of natural dental structures. Modern preventive and therapeutic approaches focus not only on restoration of structural defects but also on control of etiological factors responsible for disease initiation and progression. Advances in cariology, adhesive dentistry, digital diagnostics, biomaterials science, nanotechnology, and preventive medicine have significantly improved effectiveness of caries management and long-term oral rehabilitation. Preventive methods including fluoride therapy, pit and fissure sealants, oral hygiene programs, dietary counseling, antimicrobial therapy, salivary stimulation, probiotics, and remineralizing agents have demonstrated substantial effectiveness in reducing incidence and progression of dental caries. Contemporary diagnostic technologies such as laser fluorescence devices, digital radiography, transillumination systems, quantitative light-induced fluorescence, and optical coherence tomography facilitate early identification of demineralization before cavitation develops. Minimally invasive therapeutic techniques including selective caries removal, atraumatic restorative treatment, resin infiltration, adhesive restoration, air abrasion, and bioactive restorative systems significantly improve preservation of healthy dental tissues and reduce postoperative complications. Bioactive restorative materials including glass ionomer cements, resin-modified glass ionomers, giomers, nanocomposites, and calcium-phosphate-based biomaterials demonstrate favorable antibacterial activity, fluoride release, remineralization potential, and improved biological compatibility. The present study evaluates modern preventive and therapeutic methods used in management of dental caries in contemporary therapeutic dentistry and analyzes their clinical effectiveness, biological advantages, and long-term outcomes. Clinical findings confirm that integration of preventive strategies, minimally invasive restorative procedures, advanced biomaterials, and patient-centered oral hygiene programs significantly improves caries control, preservation of natural dentition, and overall oral health status.

Keywords: Dental caries, preventive dentistry, minimally invasive treatment, remineralization, fluoride therapy, adhesive restoration, bioactive materials, therapeutic dentistry, oral health, caries management

1. Introduction

Dental caries is considered one of the most widespread non-communicable diseases globally and remains a major concern in modern therapeutic dentistry despite significant advances in preventive and restorative technologies. The disease affects both primary and permanent dentition and can develop throughout life under the influence of microbial, dietary, behavioral, genetic, and environmental factors. Carious lesions result from prolonged acid-mediated demineralization of enamel and dentin caused primarily by metabolic activity of cariogenic bacteria including *Streptococcus mutans*, *Lactobacillus* species, and other acidogenic microorganisms within dental biofilms. Frequent consumption of fermentable carbohydrates, inadequate oral hygiene, reduced salivary flow, systemic diseases, and poor preventive care substantially increase susceptibility to dental caries and accelerate disease progression. Untreated lesions may lead to pulpitis, periapical infection, abscess formation, tooth loss, periodontal complications, and significant impairment of oral function and aesthetics. Traditional restorative approaches focused mainly on mechanical removal of decayed tissues and replacement of structural defects using restorative materials. However, modern therapeutic dentistry increasingly recognizes that dental caries is a dynamic and preventable biological process requiring comprehensive management of etiological and risk factors rather than solely mechanical restoration of cavities. Contemporary concepts in cariology emphasize prevention, early diagnosis, remineralization, minimally invasive intervention, and long-term preservation of healthy dental tissues. Advances in preventive dentistry have significantly improved effectiveness of caries control programs through use of fluoride therapy, dietary modification, oral hygiene education, antimicrobial strategies, fissure sealants, salivary diagnostics, and remineralizing agents. Fluoride remains one of the most effective preventive agents because it enhances enamel resistance to acid dissolution, promotes remineralization, inhibits bacterial metabolism, and reduces progression of early demineralization. Topical fluoride varnishes, gels, mouth rinses, fluoridated toothpaste, and community water fluoridation have demonstrated substantial reductions in caries prevalence across different populations. Pit and fissure sealants provide mechanical protection of occlusal surfaces and significantly reduce development of occlusal caries in children and adolescents. Salivary diagnostics and caries risk assessment systems facilitate individualized preventive planning and identification of high-risk patients requiring intensive monitoring and therapeutic intervention. Technological advances in diagnostic imaging including digital radiography, laser fluorescence systems, transillumination techniques, quantitative fluorescence methods, and optical coherence tomography enable early detection of enamel demineralization before cavitation occurs. Early diagnosis significantly improves opportunities for non-invasive management through remineralization and preventive care. Minimally invasive restorative dentistry has become increasingly important because it preserves healthy dental tissues while effectively controlling disease progression. Selective caries removal, atraumatic restorative treatment, resin infiltration, air abrasion, laser-assisted preparation, and adhesive restorative procedures reduce unnecessary structural destruction and improve patient comfort. Development of modern adhesive and bioactive restorative materials has additionally transformed contemporary therapeutic dentistry. Glass ionomer cements, resin-modified glass ionomers, giomers, nanocomposites, calcium-silicate biomaterials, and bioactive restorative systems provide chemical adhesion, fluoride release, antibacterial activity, remineralization potential, and improved biological compatibility. Biomimetic restorative concepts aim to reproduce natural structural and functional properties of enamel and dentin while maintaining pulpal vitality and biomechanical integrity of teeth. Contemporary therapeutic dentistry therefore integrates preventive medicine, adhesive technologies, minimally invasive operative techniques, digital diagnostics, and patient education to achieve long-term control of dental caries and preservation of oral health.

2. Materials and Methods

The study was conducted through clinical evaluation and analysis of preventive and therapeutic

methods used in management of dental caries in patients treated between 2021 and 2025. Comprehensive dental examination included assessment of oral hygiene status, caries activity, salivary flow, dietary habits, periodontal condition, and individual risk factors associated with demineralization and bacterial colonization. Diagnostic procedures involved visual-tactile examination, digital radiography, laser fluorescence assessment, transillumination imaging, and caries risk evaluation. Preventive interventions included topical fluoride therapy, fissure sealant application, professional oral hygiene procedures, dietary counseling, salivary stimulation, antimicrobial mouth rinses, and remineralization therapy using calcium-phosphate agents. Therapeutic procedures involved selective caries removal, atraumatic restorative treatment, resin infiltration, adhesive restorations, bioactive restorative systems, and minimally invasive cavity preparation techniques. Various restorative materials including nanocomposites, glass ionomer cements, resin-modified glass ionomers, giomers, and calcium-silicate biomaterials were used according to clinical indications and lesion characteristics. Clinical evaluation focused on restoration integrity, caries recurrence, postoperative sensitivity, patient comfort, remineralization effectiveness, and long-term oral health outcomes during follow-up observation.

3. Results

Clinical evaluation demonstrated that modern preventive programs significantly reduced incidence and progression of dental caries among patients receiving regular preventive care and oral hygiene education. Topical fluoride therapy effectively enhanced enamel resistance to acid dissolution and promoted remineralization of early enamel lesions. Fluoride varnishes and fluoridated toothpaste demonstrated substantial reduction in development of new carious lesions and improved stabilization of initial demineralization. Pit and fissure sealants provided effective protection of occlusal surfaces and significantly reduced occurrence of fissure caries in high-risk patients. Remineralization therapies containing calcium-phosphate compounds improved enamel mineral density and reduced sensitivity associated with early demineralization. Salivary stimulation and antimicrobial mouth rinses contributed to suppression of cariogenic bacterial activity and improvement of oral microbial balance. Early diagnostic technologies including laser fluorescence and transillumination systems facilitated identification of non-cavitated lesions and enabled implementation of non-invasive therapeutic strategies before extensive structural destruction occurred. Minimally invasive restorative procedures preserved healthy enamel and dentin while effectively eliminating infected tissues and maintaining pulpal vitality. Selective caries removal techniques significantly reduced risk of pulpal exposure and postoperative complications. Resin infiltration effectively stabilized early enamel lesions and improved aesthetic appearance of white spot defects without conventional cavity preparation. Adhesive restorative systems demonstrated excellent marginal adaptation, reduced microleakage, and favorable retention within conservatively prepared cavities. Bioactive restorative materials showed significant fluoride release, antibacterial activity, remineralization potential, and improved periodontal compatibility. Patients treated with minimally invasive and preventive therapeutic protocols demonstrated lower postoperative sensitivity, improved oral hygiene compliance, and greater satisfaction with functional and aesthetic outcomes. Long-term follow-up confirmed reduced incidence of recurrent caries, enhanced restoration durability, and improved preservation of natural dental tissues. Clinical evaluation demonstrated that comprehensive preventive programs significantly reduced incidence, severity, and progression of dental caries among patients receiving regular preventive care and individualized oral hygiene instruction. Topical fluoride applications effectively enhanced enamel remineralization and increased resistance of dental tissues to acid-mediated demineralization. Fluoride varnishes, gels, and fluoridated toothpaste substantially decreased occurrence of new carious lesions and improved stabilization of initial enamel demineralization. Pit and fissure sealants provided reliable protection of occlusal surfaces and significantly reduced development of fissure caries in pediatric and adolescent populations with elevated caries risk. Remineralizing systems containing calcium-phosphate compounds improved mineral density of enamel lesions and reduced hypersensitivity associated with demineralized dental tissues. Antimicrobial mouth rinses and salivary stimulation therapies contributed to suppression of cariogenic bacterial activity and improvement of oral microbial balance. Early diagnostic technologies including laser fluorescence and optical transillumination enabled accurate identification of non-cavitated lesions and facilitated implementation of non-invasive therapeutic procedures before structural destruction progressed into dentin. Minimally invasive restorative approaches preserved substantial

amounts of healthy enamel and dentin compared with conventional aggressive cavity preparation methods. Selective caries removal significantly reduced frequency of pulpal exposure and postoperative complications while maintaining structural integrity of teeth. Resin infiltration techniques effectively arrested progression of early enamel lesions and improved aesthetic appearance of white spot defects without invasive drilling procedures. Adhesive restorative systems demonstrated favorable marginal adaptation, reduced microleakage, and excellent retention within conservatively prepared cavities. Bioactive restorative materials exhibited significant fluoride release, antibacterial activity, chemical bonding capability, and remineralization potential contributing to prevention of recurrent demineralization. Patients treated using minimally invasive and prevention-oriented therapeutic protocols reported reduced postoperative sensitivity, improved functional comfort, enhanced aesthetic satisfaction, and greater acceptance of dental treatment procedures. Long-term clinical observation confirmed improved durability of restorations, preservation of pulpal vitality, reduction of secondary caries, and enhanced maintenance of oral health in patients receiving comprehensive preventive and minimally invasive therapeutic care.

4. Discussion

The findings confirm that modern prevention-oriented therapeutic dentistry significantly improves management of dental caries and contributes to preservation of natural dentition and long-term oral health. Contemporary understanding of dental caries as a dynamic biofilm-mediated disease supports the importance of comprehensive preventive care and individualized risk assessment rather than solely operative intervention. Fluoride therapy remains one of the most effective preventive strategies because of its ability to enhance enamel remineralization, inhibit bacterial metabolism, and increase resistance of dental tissues to acid attack. Pit and fissure sealants provide substantial protection against occlusal caries and remain highly effective in pediatric and adolescent populations. Advances in diagnostic technologies have transformed contemporary cariology by enabling identification of early demineralization before cavitation develops, thereby facilitating non-invasive management and remineralization therapy. Laser fluorescence devices, transillumination systems, and digital imaging techniques significantly improve diagnostic sensitivity and treatment precision. Minimally invasive restorative approaches preserve healthy tooth structure and reduce biological trauma associated with conventional aggressive cavity preparation. Selective caries removal supports preservation of remineralizable dentin and maintenance of pulpal vitality while effectively controlling microbial infection. Adhesive restorative systems eliminate the need for extensive mechanical retention and permit highly conservative cavity designs. Bioactive restorative materials provide additional therapeutic advantages through fluoride release, antibacterial effects, calcium-phosphate ion exchange, and stimulation of mineralized tissue repair. Glass ionomer cements and resin-modified glass ionomers remain particularly valuable because of their chemical adhesion and long-term preventive properties. Nanocomposites and glomer materials provide improved aesthetic integration, mechanical strength, and marginal stability within minimally invasive restorations. The results additionally demonstrate that patient education, dietary modification, oral hygiene instruction, and regular preventive monitoring remain essential components of successful caries management. Despite substantial progress in preventive and restorative dentistry, several challenges persist including management of high-risk patients, recurrent demineralization, dietary noncompliance, socioeconomic barriers, and long-term durability of adhesive restorations. Future scientific research increasingly focuses on regenerative dentistry, nanotechnology-based preventive systems, antimicrobial peptides, salivary biomarkers, probiotics, smart biomaterials, and artificial intelligence-assisted diagnostics aimed at improving prediction, prevention, and biological management of dental caries. Integration of preventive medicine, minimally invasive restorative concepts, digital diagnostics, and advanced biomaterials therefore represents the future direction of therapeutic dentistry and contributes significantly to enhancement of oral health-related quality of life.

5. Conclusion

Modern methods for prevention and treatment of dental caries significantly improve preservation of natural dental tissues, reduction of disease progression, maintenance of pulpal vitality, and long-term oral health outcomes. Contemporary preventive strategies including fluoride therapy, fissure sealants,

oral hygiene programs, dietary counseling, antimicrobial interventions, and remineralization therapies effectively reduce incidence and severity of carious lesions. Advanced diagnostic technologies facilitate early detection of demineralization and enable implementation of conservative non-invasive therapeutic approaches. Minimally invasive restorative procedures preserve healthy enamel and dentin while reducing postoperative complications and improving patient comfort. Bioactive restorative materials provide favorable antibacterial properties, remineralization potential, fluoride release, and durable adhesion contributing to successful long-term rehabilitation. Continued development of preventive dentistry, adhesive technologies, regenerative biomaterials, and personalized therapeutic protocols will further improve effectiveness of caries management and contribute substantially to preservation of natural dentition and enhancement of quality of life. Modern methods for prevention and treatment of dental caries significantly improve preservation of natural dental tissues, reduction of disease progression, maintenance of pulpal vitality, and long-term oral rehabilitation. Contemporary preventive strategies including fluoride therapy, fissure sealants, oral hygiene programs, dietary modification, antimicrobial interventions, and remineralization systems effectively reduce prevalence and severity of carious lesions. Advanced diagnostic technologies facilitate early detection of demineralization and allow implementation of conservative non-invasive therapeutic procedures before extensive tissue destruction develops. Minimally invasive restorative approaches preserve healthy enamel and dentin while reducing postoperative complications and improving patient comfort. Bioactive restorative materials provide favorable antibacterial properties, fluoride release, remineralization potential, and durable adhesion contributing significantly to successful long-term rehabilitation and prevention of recurrent caries. Continued advancements in preventive dentistry, biomaterials science, regenerative technologies, digital diagnostics, and personalized therapeutic protocols will further improve effectiveness of caries management and contribute substantially to preservation of natural dentition and enhancement of patient quality of life.

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