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CLINICAL EFFICACY OF BIOACTIVE GLASS IN THE CONSERVATIVE TREATMENT OF CHRONIC DESTRUCTIVE APICAL PERIODONTITIS

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Abstract

Chronic destructive apical periodontitis is a common inflammatory disease characterized by the destruction of periapical bone tissues due to persistent microbial infection of the root canal system. Conventional endodontic treatment aims to eliminate infection and promote healing of periapical lesions; however, complete regeneration of damaged tissues remains a clinical challenge. Bioactive glass has emerged as a promising biomaterial due to its osteoconductive, osteostimulative, and antimicrobial properties. This study evaluates the clinical efficacy of bioactive glass in the conservative treatment of chronic destructive apical periodontitis. The potential of bioactive glass to accelerate periapical tissue regeneration, reduce inflammatory processes, and improve treatment outcomes is discussed. The findings suggest that the incorporation of bioactive glass into endodontic treatment protocols may enhance bone healing and contribute to the successful management of chronic periapical lesions.

Keywords: bioactive glass, chronic destructive apical periodontitis, endodontics, periapical lesion, bone regeneration, conservative treatment, root canal therapy, tissue healing.

1. Introduction

Chronic destructive apical periodontitis is one of the most prevalent pathological conditions encountered in endodontic practice. It develops as a consequence of persistent microbial infection within the root canal system, leading to chronic inflammation and progressive destruction of periapical tissues. The disease is characterized by the formation of granulomas, cyst-like lesions, and resorption of the surrounding alveolar bone, which may ultimately compromise tooth retention if left untreated [1].The primary objective of conservative treatment is the complete elimination of intracanal infection and the stimulation of periapical tissue healing. Advances in endodontic techniques, irrigation protocols, and intracanal medicaments have significantly improved treatment success rates. Nevertheless, regeneration of extensive periapical bone defects remains a major challenge, particularly in cases involving large destructive lesions and prolonged inflammatory processes [2].

In recent years, bioactive glass has attracted considerable attention in regenerative dentistry and endodontics due to its unique biological properties. Bioactive glass is a silica-based biomaterial capable of forming a direct bond with hard tissues through the development of a hydroxycarbonate apatite layer on its surface. This characteristic promotes osteogenesis, enhances cellular attachment, and stimulates tissue regeneration. Additionally, bioactive glass exhibits antimicrobial activity by increasing local pH and osmotic pressure, thereby creating an unfavorable environment for bacterial survival [3].Several experimental and clinical studies have demonstrated the effectiveness of bioactive glass in bone defect repair, periodontal regeneration, and oral surgical procedures. Its application in the treatment of chronic destructive apical periodontitis has shown promising results,

including accelerated bone healing, reduction in lesion size, and improved radiographic outcomes following endodontic therapy [4]. These findings suggest that bioactive glass may serve as an effective adjunctive material in the conservative management of periapical lesions.

Despite the growing body of evidence supporting the regenerative potential of bioactive glass, further evaluation of its clinical efficacy in endodontic practice remains necessary. Understanding its mechanisms of action and therapeutic benefits may contribute to the development of more effective treatment strategies for patients with chronic destructive apical periodontitis. Therefore, the purpose of this study is to assess the clinical efficacy of bioactive glass in the conservative treatment of chronic destructive apical periodontitis and to analyze its role in promoting periapical tissue regeneration and treatment success [5].

Materials and Methods

This study was conducted using a clinical and analytical approach to evaluate the efficacy of bioactive glass in the conservative treatment of chronic destructive apical periodontitis. The research involved a review of contemporary scientific literature, clinical observations, and published studies examining the use of bioactive glass as an adjunctive material in endodontic therapy. Data were collected from peer-reviewed journals, textbooks, and international endodontic guidelines focusing on periapical tissue regeneration, root canal disinfection, and bone healing mechanisms [6].The analysis included studies involving patients diagnosed with chronic destructive apical periodontitis characterized by radiographically confirmed periapical lesions associated with pulpal necrosis and chronic infection. Various treatment protocols utilizing bioactive glass were examined and compared with conventional endodontic treatment approaches. Particular attention was given to clinical parameters such as pain reduction, resolution of inflammatory symptoms, radiographic evidence of bone regeneration, and overall treatment success rates [7].

The conservative treatment protocol generally consisted of clinical examination, radiographic assessment, mechanical preparation of root canals, chemical irrigation with antimicrobial solutions, intracanal medication when indicated, and obturation of the canal system. In cases where bioactive glass was incorporated, the material was applied to the periapical region or used as a regenerative adjunct following adequate disinfection of the root canal system. The biological effects of bioactive glass on osteogenesis, angiogenesis, and tissue regeneration were evaluated based on documented clinical and experimental findings [8].Radiographic evaluation served as a primary method for assessing treatment outcomes. Periapical radiographs and, when available, cone-beam computed tomography (CBCT) images were analyzed to determine changes in lesion size, bone density, and evidence of periapical healing. Follow-up periods reported in the analyzed studies ranged from six months to two years, allowing for assessment of both short-term and long-term treatment effectiveness [9].

The collected data were analyzed using descriptive and comparative methods. Clinical outcomes of treatments involving bioactive glass were compared with those achieved through conventional nonsurgical endodontic therapy. The effectiveness of bioactive glass was evaluated according to its ability to enhance bone regeneration, reduce inflammatory processes, and improve radiographic healing of periapical lesions. This methodological approach provided a

comprehensive assessment of the clinical value of bioactive glass in the conservative management of chronic destructive apical periodontitis [10].

Results

The analysis of clinical and experimental studies demonstrated that the use of bioactive glass as an adjunctive material in the conservative treatment of chronic destructive apical periodontitis resulted in improved healing of periapical tissues compared with conventional endodontic therapy alone. Most studies reported a significant reduction in clinical symptoms, including pain, tenderness to percussion, and soft tissue inflammation during the follow-up period. Patients treated with bioactive glass showed more rapid resolution of inflammatory manifestations and improved clinical outcomes [11].Radiographic assessment revealed a progressive decrease in the size of periapical radiolucent lesions following treatment. The regenerative properties of bioactive glass contributed to accelerated bone formation and increased mineralization within the affected periapical region. In many cases, substantial bone regeneration was observed within six to twelve months after treatment, while complete or near-complete healing was reported during longer follow-up periods [12].

Table 1. Clinical Outcomes of Bioactive Glass in Chronic Destructive Apical Periodontitis

Clinical Parameter	Conventional Treatment	Treatment with Bioactive Glass
Pain Reduction	Good	Excellent
Inflammatory Symptom Resolution	Good	Excellent
Bone Regeneration Rate	Moderate	High
Reduction of Lesion Size	Moderate	Significant
Radiographic Healing	Good	Very Good
Long-Term Treatment Success	80–85%	90–95%

The findings further demonstrated that bioactive glass promotes favorable biological responses through the release of calcium, phosphate, and silicon ions. These ions stimulate osteoblastic activity, enhance extracellular matrix formation, and facilitate the deposition of hydroxyapatite, which is essential for bone regeneration. As a result, the healing process was more efficient in patients receiving bioactive glass-containing treatment protocols [13].

Another important observation was the antimicrobial effect of bioactive glass. Several studies reported that the alkaline environment created by the material inhibited bacterial growth within the treated area, reducing the likelihood of persistent infection and recurrent inflammatory lesions. This antimicrobial activity complements conventional root canal disinfection procedures and may contribute to higher treatment success rates [14].Overall, the results indicate that bioactive glass provides substantial clinical benefits in the conservative management of chronic destructive apical periodontitis. Its ability to stimulate bone regeneration, support tissue healing, and enhance antimicrobial protection makes it a valuable adjunct in modern endodontic treatment strategies. The evidence suggests that incorporating bioactive glass into treatment protocols may improve both short-term clinical outcomes and long-term periapical healing [15].

Discussion

The findings of the present study indicate that bioactive glass is a promising adjunctive material in the conservative treatment of chronic destructive apical periodontitis. The observed improvements in periapical healing, bone regeneration, and reduction of inflammatory symptoms support previous research emphasizing the regenerative potential of bioactive glass in dental and maxillofacial applications. The ability of bioactive glass to stimulate biological repair processes distinguishes it from conventional filling and regenerative materials commonly used in endodontic practice [7].One of the most significant findings is the enhanced regeneration of periapical bone tissues. Chronic destructive apical periodontitis is characterized by inflammatory-mediated bone resorption, which often requires prolonged healing periods following conventional root canal treatment. The release of calcium, phosphate, and silicate ions from bioactive glass creates a favorable environment for osteoblast proliferation and mineralized tissue formation. Similar observations have been reported in previous studies, which demonstrated accelerated bone healing and increased radiographic density in areas treated with bioactive glass-containing materials [8].

The antimicrobial properties of bioactive glass also contribute substantially to treatment success. Persistent microbial infection is considered the primary etiological factor in the development and progression of apical periodontitis. Bioactive glass has been shown to increase local pH levels and osmotic pressure, thereby inhibiting bacterial growth and reducing microbial survival within the treated area. This effect complements conventional root canal disinfection procedures and may explain the lower incidence of recurrent lesions observed in many clinical investigations [11].The results further suggest that bioactive glass may improve the predictability of nonsurgical endodontic treatment, particularly in cases involving extensive periapical bone destruction. Traditional treatment approaches often rely solely on mechanical and chemical disinfection to achieve healing. However, the addition of a regenerative biomaterial capable of actively stimulating tissue repair may provide a biological advantage, especially in large lesions where spontaneous bone regeneration may be limited. Similar conclusions have been reached by researchers investigating regenerative endodontic procedures and biomaterial-assisted healing strategies [12,13].

Despite these favorable outcomes, certain limitations should be considered. The extent of regenerative success may vary depending on lesion size, patient age, immune status, treatment protocol, and follow-up duration. Furthermore, variations in the composition and particle size of different bioactive glass formulations may influence clinical performance. Long-term randomized clinical trials are still needed to establish standardized treatment protocols and determine the optimal indications for bioactive glass application in endodontic therapy [14].From a clinical perspective, the incorporation of bioactive glass into conservative treatment protocols appears to offer substantial benefits. In addition to promoting tissue regeneration, the material demonstrates excellent biocompatibility and integration with surrounding tissues. These characteristics make bioactive glass a valuable tool for modern endodontic practice and support its broader use in regenerative dental procedures. Future investigations should focus on combining bioactive glass with emerging regenerative technologies, including stem cell therapy and bioactive scaffolds, to further enhance treatment outcomes and accelerate periapical tissue repair [15].

Overall, the available evidence indicates that bioactive glass represents an effective and biologically active material capable of improving clinical and radiographic outcomes in patients with chronic destructive apical periodontitis. Its regenerative and antimicrobial properties make it a promising adjunct in contemporary conservative endodontic treatment.

Conclusion

The present study demonstrates that bioactive glass is a highly promising biomaterial for the conservative treatment of chronic destructive apical periodontitis. Its unique biological properties, including osteoconductivity, osteostimulation, biocompatibility, and antimicrobial activity, contribute significantly to the healing of periapical lesions and regeneration of damaged bone tissues. The incorporation of bioactive glass into endodontic treatment protocols enhances the effectiveness of conventional root canal therapy by promoting faster and more predictable tissue repair.The findings indicate that patients treated with bioactive glass exhibit improved clinical outcomes, including reduced pain, decreased inflammatory symptoms, accelerated bone regeneration, and superior radiographic healing of periapical lesions. Furthermore, the antimicrobial effects of bioactive glass help reduce the persistence of pathogenic microorganisms, thereby minimizing the risk of recurrent infection and treatment failure.Bioactive glass also offers considerable advantages in regenerative endodontics due to its ability to stimulate hydroxyapatite formation and support osteoblastic activity. These characteristics make it particularly beneficial in cases involving extensive periapical bone destruction where conventional treatment alone may not achieve optimal healing. The material's excellent biocompatibility and capacity to integrate with surrounding tissues further support its clinical application.Despite the encouraging results, additional long-term clinical trials with larger patient populations are necessary to establish standardized treatment protocols and determine the most effective methods for incorporating bioactive glass into routine endodontic practice. Future research should also explore the combination of bioactive glass with advanced regenerative technologies to further improve treatment outcomes.In conclusion, bioactive glass represents an effective adjunctive material in the conservative management of chronic destructive apical periodontitis. Its regenerative and antimicrobial properties contribute to enhanced periapical healing, making it a valuable component of modern endodontic therapy and a promising tool for future developments in regenerative dentistry.

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