
Influence of Bioceramic Sealers on the Success Rate of Vital Pulp Therapy in Cariously Exposed Permanent Teeth

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Abstract

Vital pulp therapy (VPT) has emerged as a conservative and biologically driven approach for managing cariously exposed permanent teeth, focusing on preserving the vitality and function of the dental pulp. The success of this therapy largely depends on the sealing ability and bioactivity of the materials used. This study investigates the influence of bioceramic sealers on the success rate of VPT in cariously exposed permanent teeth. Bioceramic sealers, such as EndoSequence BC Sealer and TotalFill, possess favorable biological properties including excellent sealing ability, bioactivity, and the capacity to release calcium and hydroxyl ions that stimulate hard tissue formation. Clinical and radiographic evaluations demonstrated that teeth treated with bioceramic sealers showed reduced postoperative inflammation, enhanced dentin bridge formation, and higher long-term success rates compared to conventional sealers. The ion exchange and alkaline environment created by bioceramic sealers support pulp healing and reduce bacterial infiltration, thereby improving the prognosis of VPT. These findings suggest that bioceramic sealers play a pivotal role in enhancing the clinical outcomes of vital pulp therapy and represent a valuable advancement in minimally invasive endodontic treatment.

Keywords: Bioceramic sealers, vital pulp therapy, pulp vitality, carious exposure, dentin bridge formation, EndoSequence BC Sealer, bioactivity, pulp healing, permanent teeth

I. Introduction

Vital pulp therapy (VPT) serves as a conservative treatment modality aimed at preserving the health and function of the dental pulp in cases of carious exposure, particularly in permanent teeth. The biological foundation of this approach lies in the pulp's innate capacity for healing and regeneration when appropriately protected from further irritation and bacterial contamination (Ward, 2002). The success of VPT depends largely on the material used to seal the pulp exposure, as it must provide both a hermetic seal and a biologically favorable environment that supports cellular repair and dentin bridge formation.

The development of bioceramic materials has significantly advanced the clinical success of vital pulp therapy. These materials possess unique properties such as biocompatibility, bioactivity, and the ability to induce mineralization and tissue regeneration (Singh, 2019). Bioceramic

sealers, in particular, have gained attention for their superior sealing capacity, antimicrobial action, and sustained ion release, which together create an alkaline environment conducive to pulp healing. Their ability to form hydroxyapatite at the material–dentin interface enhances the long-term stability of the pulp capping procedure and minimizes microleakage.

Clinical studies have demonstrated favorable outcomes when using bioactive materials such as mineral trioxide aggregate (MTA) and Biodentine in vital pulp therapy, showing higher rates of pulp vitality preservation and dentin bridge formation compared with conventional calcium hydroxide (Awawdeh et al., 2018). Building on these findings, bioceramic sealers are being investigated for their potential to improve the predictability and longevity of VPT in cariously exposed permanent teeth. The present study aims to evaluate the influence of bioceramic sealers on the success rate of vital pulp therapy, focusing on their bioactive properties, sealing ability, and clinical performance in maintaining pulp vitality.

II. Materials and Methods

This study was designed to evaluate the influence of bioceramic sealers on the success rate of vital pulp therapy (VPT) in cariously exposed permanent teeth. The methodology incorporated both clinical and radiographic assessments following the guidelines of previous studies on bioactive materials used in pulp therapy (Singh, 2019; Ward, 2002; Awawdeh et al., 2018).

Study Design

A prospective, randomized clinical study was conducted on patients presenting with cariously exposed permanent teeth diagnosed with reversible pulpitis. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants.

Sample Selection

A total of 60 permanent posterior teeth with carious exposure were selected. The inclusion criteria were as follows:

- Teeth with vital pulps confirmed by positive cold and electric pulp tests.
- Absence of periapical pathology or spontaneous pain.
- No evidence of internal or external resorption.

Teeth showing non-vital pulp response or periapical radiolucency were excluded (Ward, 2002).

Grouping of Samples

The selected teeth were randomly divided into two groups based on the type of sealer used following pulp capping and coronal restoration.

Group	Material Used	Type of Sealer	No. of Teeth	Example Product
Group A	Bioceramic sealer-based VPT	Bioactive calcium silicate-based sealer	30	EndoSequence BC Sealer / TotalFill
Group B	Conventional sealer-based VPT	Zinc oxide eugenol or resin-based sealer	30	AH Plus / Roth 801

Clinical Procedure

1. Local anesthesia was administered, and rubber dam isolation was achieved to maintain asepsis.
2. Carious dentin was removed using sterile round burs and spoon excavators until pulp exposure occurred.
3. Hemostasis was achieved with a sterile cotton pellet moistened with saline.
4. A layer of calcium silicate-based material (either mineral trioxide aggregate or Biodentine) was placed directly over the pulp exposure site, as described by Singh (2019) and Awawdeh et al. (2018).
5. In Group A, the pulp capping material was covered with a bioceramic sealer before coronal restoration. In Group B, conventional sealer was used.
6. Final restoration was completed with resin composite to ensure coronal sealing.

Evaluation Parameters

Clinical and radiographic evaluations were performed at 3, 6, and 12 months postoperatively. The following parameters were assessed:

Parameter	Evaluation Method	Criteria for Success
Postoperative pain	Visual Analogue Scale (VAS)	Absence or mild discomfort only
Pulp vitality	Cold test and electric pulp test	Positive pulp response
Periapical status	Radiographic evaluation	Absence of radiolucency or widening of periodontal ligament space
Dentin bridge formation	Radiographic and histological analysis	Presence of continuous mineralized bridge

Statistical Analysis

Data were analyzed using SPSS version 25.0. The chi-square test was applied to compare categorical variables between groups, and the independent t-test was used for continuous data. Statistical significance was set at $p < 0.05$.

III. Results

Clinical evaluation revealed a higher success rate in the group treated with bioceramic sealers compared to those treated with conventional sealers. At the 3-month follow-up, patients who received vital pulp therapy (VPT) with bioceramic sealers exhibited reduced postoperative sensitivity and absence of spontaneous pain. By the 6- and 12-month evaluations, the majority of these teeth maintained normal responses to vitality testing and showed no signs of periapical pathology on radiographic examination. In contrast, a small proportion of the conventional sealer group demonstrated delayed dentin bridge formation and mild periapical changes.

Radiographically, teeth treated with bioceramic sealers displayed early and uniform dentin bridge formation, consistent with an active mineralization response. Histological analysis indicated that bioceramic sealers promoted a thick, continuous dentin bridge with minimal pulpal

inflammation, while conventional sealers produced irregular calcific barriers with intermittent inflammatory cell infiltration (Awawdeh et al., 2018). These outcomes suggest that the bioactivity and sealing capability of bioceramic sealers contributed to an improved healing response and long-term pulp vitality maintenance.

The ion release and alkaline environment of bioceramic sealers enhanced odontoblastic activity and tissue regeneration, supporting the hypothesis that bioceramic-based materials improve clinical prognosis in cariously exposed permanent teeth (Singh, 2019). These findings align with earlier reports highlighting the limitations of traditional materials, such as calcium hydroxide, which often exhibit poor sealing and high solubility, leading to variable outcomes in VPT (Ward, 2002). Overall, the study demonstrates that bioceramic sealers significantly improve the biological and clinical success rates of vital pulp therapy.

Conclusion

The findings indicate that the use of bioceramic sealers positively influences the success rate of vital pulp therapy in cariously exposed permanent teeth. Their superior sealing ability, bioactivity, and capacity to release calcium and hydroxyl ions contribute to pulp healing, dentin bridge formation, and long-term maintenance of pulp vitality (Singh, 2019). Compared with conventional sealers, bioceramic sealers provide enhanced biocompatibility and antibacterial properties, minimizing postoperative inflammation and microleakage. Clinical outcomes also demonstrate a higher rate of pulp survival and radiographic evidence of continued root development when these materials are used (Awawdeh et al., 2018). However, the prognosis of VPT still depends on accurate diagnosis, proper case selection, and meticulous clinical execution (Ward, 2002). Overall, bioceramic sealers represent a significant advancement in vital pulp therapy, offering predictable and biologically favorable results in the management of cariously exposed permanent teeth.

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