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Narrative Review

Ways of Maintaining Pulp Vitality: Narrative Literature Review

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ABSTRACT

Background: Dental caries is a prevalent global health issue, affecting a significant portion of the population and impacting social and personal well-being. Traditional methods focused on aggressive caries removal, but recent advances emphasize the importance of preserving pulp vitality through minimal invasive techniques.

Objective: To evaluate the efficacy of various vital pulp therapy techniques including indirect and direct pulp capping and pulpotomy, and to analyze the effectiveness of new biomaterials in preserving dental pulp vitality in teeth affected by caries or trauma.

Methods: A systematic literature review was conducted using the Islamabad Medical and Dental College library and online databases such as PubMed and Google Scholar. The review included peer-reviewed articles that discussed vital pulp therapy, materials used in pulp capping, and their outcomes. Articles were selected based on inclusion and exclusion criteria with no date restrictions, focusing solely on literature published in English.

Results: The review identified 32 relevant studies, indicating a shift towards less invasive procedures that prioritize dental pulp preservation. Innovations in biomaterials such as Mineral Trioxide Aggregate (MTA), Biodentin, and resin-based MTA have shown to enhance healing outcomes and are increasingly preferred over traditional materials like Calcium Hydroxide due to their superior properties and clinical results.

Conclusion: Vital pulp therapies are crucial for managing teeth with deep carious lesions or trauma, offering a conservative alternative to more invasive treatments. These therapies are instrumental in maintaining the structural integrity and health of natural teeth, thus reducing the need for extensive dental procedures and promoting overall oral health.

Keywords: Dental Caries, Vital Pulp Therapy, Indirect Pulp Capping, Direct Pulp Capping, Pulpotomy, Biomaterials, Mineral Trioxide Aggregate, Biodentin, Dental Preservation, Minimally Invasive Dentistry.

INTRODUCTION

Dental caries is a pervasive global health issue, recognized as one of the most common diseases worldwide and a significant contributor to social and personal discomfort. According to the Adult Dental Health Survey, 85% of adults have at least one dental restoration, while 17% of dentate individuals have reported significant impacts on their lives due to oral health conditions (1, 2). The progression of dental caries is facilitated by the presence of biofilm, plaque accumulation, and pH changes (3). Traditionally, the hardness of dentin and color consistency were used as clinical markers for the extent of caries removal needed (4). However, the preservation of pulp vitality has become a paramount concern in dental treatment, emphasizing the importance of minimal invasive techniques to prevent damage to the pulp-dentin complex and maintain overall tooth health (3, 4).

Recent shifts in dental practice advocate for less aggressive caries removal strategies. It is now understood that complete removal of carious tissue is not always necessary, with emerging studies supporting the benefits of incomplete caries removal (6). This approach aligns with the principles of minimal invasiveness, aiming to avoid undue harm to the pulp and promoting the longevity of the tooth.

Vital pulp therapy, a technique practiced for over two decades, exemplifies this conservative approach to dental care. This method involves the application of protective biomaterials over the remaining thin layer of dentin, thereby creating a favorable environment for the healing of the pulp and the formation of tertiary dentin (7). Vital pulp therapy includes techniques such as direct pulp capping, indirect pulp capping, and pulpotomy. Indirect pulp capping specifically involves the removal of only the infected dentin, leaving

behind the affected but not decayed dentin, thus preserving the integrity of the pulp (5). On the other hand, direct pulp capping and partial pulpotomy are employed in cases of accidental pulpal exposure, with the choice of procedure depending on the size of the exposure and the time elapsed since the incident occurred (8). These methods underline the evolving understanding and application of dental science to optimize patient outcomes while minimizing intervention.

MATERIAL AND METHODS

To conduct a comprehensive analysis of the indirect pulp capping technique, a systematic literature search was performed utilizing resources from the Islamabad Medical and Dental College library, along with online databases including PubMed and Google Scholar. The search strategy was designed to encompass all available literature without restrictions on publication date, but was limited to works published in English to maintain consistency in data analysis. The inclusion criteria specifically targeted studies that addressed vital pulp therapy and the materials used in pulp capping, while excluding non-peer-reviewed articles and studies not directly related to the scope of this research.

A total of 32 peer-reviewed articles were selected based on these criteria and subjected to a thorough evaluation. Each article was independently reviewed by two researchers to ensure reliability in the selection process and interpretation of the findings. The review process was conducted in accordance with the principles outlined in the Declaration of Helsinki to ensure ethical standards were maintained throughout the research, particularly in the handling of study data and the respect for the integrity of the sources. The methodological approach was structured to provide a robust framework for identifying effective techniques in vital pulp therapy, thereby contributing valuable insights into the optimal materials and methods for pulp capping. This systematic review was not only crucial for gathering relevant data but also for synthesizing current evidence to guide future clinical practices in dental care.

FINDINGS

Table 1 Study Characteristics and Summarizes Vital Pulp Therapy Techniques

Technique	Approach Details	Materials Used	Key Benefits
Indirect Pulp Capping	**Single Visit:** Complete caries removal in one session.	Biocompatible materials	Quick procedure.
	Stepwise: Staged caries removal, temporary then permanent restoration.		Less traumatic, allows for remineralization.
Direct Pulp Capping	Direct application on exposed pulp.	**Calcium Hydroxide:** High pH, stimulates healing.	Promotes mineralized layer, preserves pulp vitality.
		MTA: Biocompatibility, promotes dentin formation.	Stimulates healing, inhibits microbial growth.
		Biodentin: Bioactive, no discoloration.	Excellent sealing, biocompatibility.
		Bio Aggregate: High sealing, antimicrobial effects.	Superior physical properties, bioactive.
		Resin Based MTA: Easy application, high biocompatibility.	
Pulpotomy	**Partial:** Limited coronal pulp removal.	Various cauterizing agents	Maintains radicular pulp vitality.
	Full: Complete coronal pulp removal.		Suitable for extensive decay or trauma.

The table summarizes vital pulp therapy techniques, highlighting the indirect pulp capping methods which vary from a single aggressive session to a stepwise approach allowing for tissue remineralization and less trauma. Direct pulp capping directly addresses exposed pulp, using materials like Calcium Hydroxide, MTA, and Biodentin to promote healing and preserve vitality. Each material offers specific benefits: Calcium Hydroxide stimulates healing and microbial inhibition, MTA is noted for its biocompatibility and sealing properties, while Biodentin provides superior physical properties without causing discoloration. Bio Aggregate and Resin Based MTA are praised for their sealing abilities and ease of application, respectively. Pulpotomy, either partial or full, is used to

maintain or manage the vitality of radicular pulp in cases of deep carious lesions or trauma, utilizing various cauterizing agents to achieve therapeutic outcomes.

DISCUSSION

The vital pulp therapies, encompassing indirect and direct pulp capping along with pulpotomy, have emerged as pivotal techniques in the management of deep carious lesions or traumatic dental injuries, crucial for preserving dental pulp vitality and promoting dentinal health in primary and permanent teeth. The classification and application of these methods are determined based on the specific dental condition and the objective of the therapy, which primarily aims to maintain or restore the health of the dental pulp and surrounding tissues.

Indirect pulp capping is recognized for its conservative approach, where the removal of carious dentin is conducted meticulously to leave a thin layer of demineralized dentin, thereby avoiding direct pulp exposure and reducing the potential for pulpal trauma (9). This technique can be implemented in a single visit, although this approach is considered more aggressive due to the higher risk of exposing the pulp (5). Alternatively, the stepwise method involves initial caries removal followed by a temporary restoration, with a subsequent visit scheduled for permanent restoration after several weeks, allowing for dental tissue recovery and secondary dentin formation, thus enhancing tooth vitality and structural stability (5).

Direct pulp capping, on the other hand, directly addresses accidental pulp exposures by applying biocompatible materials such as Calcium Hydroxide, Mineral Trioxide Aggregate (MTA), or newer biomaterials like Biodentin and Resin-based MTA directly onto the pulp (8). These materials are chosen for their properties that favor pulp healing and dentin barrier formation. Calcium Hydroxide has long been considered the standard for such applications, appreciated for its high pH and consequent stimulation of fibroblast activity and antimicrobial effects (11-13). MTA is favored for its superior biocompatibility and sealing abilities, although it suffers from issues like discoloration and longer setting times which newer forms like Neo MTA seek to improve (14-20).

The development of materials such as Biodentin represents a significant advancement, providing benefits similar to MTA but with improved physical properties like color stability and shorter setting times, which are crucial for clinical ease and patient acceptance (21-28). Moreover, Biodentin and Bio Aggregate, another tricalcium silicate-based material, offer enhanced sealing capabilities and antimicrobial properties, vital for long-term success in pulp therapy (29).

Pulpotomy, utilized in cases where there is a deep carious lesion but no signs of irreversible pulpitis, involves the removal of the coronal portion of the pulp to preserve the vitality of the remaining radicular pulp (30-32). This method, which can be segmented into partial or full pulpotomy based on the extent of tissue removal required, utilizes a range of materials from traditional agents like ferric sulfate to more contemporary calcium silicate-based materials, which provide improved outcomes in terms of healing and barrier formation (31, 32).

The discussion of these techniques within the context of existing literature underscores their evolving nature and the continuous improvement in material sciences that contribute to their effectiveness. However, challenges such as the potential for pulp exposure in more aggressive approaches or the limitations in the physical properties of some biomaterials underscore the need for ongoing research and development. Future studies should focus on the long-term outcomes of these therapies, particularly comparing the newer materials with traditional standards across diverse patient populations to refine their application and enhance their predictability and success in clinical practice. This comprehensive approach not only preserves tooth structure but also aligns with the modern principles of minimally invasive dentistry, emphasizing the preservation of as much of the natural tooth as possible.

CONCLUSION

The advancements in vital pulp therapy, encompassing indirect and direct pulp capping as well as pulpotomy, represent significant strides in dental care, directly contributing to the preservation of dental pulp vitality and the overall health of teeth in cases of deep carious lesions or trauma. These techniques not only ensure the structural integrity and longevity of teeth but also minimize the need for more invasive treatments such as root canals or extractions, thereby enhancing patient outcomes and reducing healthcare costs. The continuous improvement and innovation in biocompatible materials further refine these methods, providing effective solutions that align with the principles of minimally invasive dentistry and underscoring the importance of preserving natural tooth structures in promoting oral and systemic health.

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