

Narrative Review

Ways of Maintaining Pulp Vitality: Narrative Literature Review

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Conflict of Interest: None.

Baig I., et al. (2024). 4(1): DOI: <https://doi.org/10.61919/jhrr.v4i1.742>

ABSTRACT

Background: Dental caries and traumatic injuries pose significant challenges to preserving the vitality of the dental pulp, with implications for tooth survival and overall oral health. Traditional approaches to managing these conditions have evolved, reflecting advancements in dental materials and a better understanding of pulp biology.

Objective: This review aims to elucidate the effectiveness and implications of various vital pulp therapy techniques—indirect pulp capping, direct pulp capping, and pulpotomy—in preserving pulp vitality amidst dental caries and traumatic injuries.

Methods: A comprehensive literature search was conducted across both physical libraries and online databases, including PubMed and Google Scholar, focusing on peer-reviewed articles that discuss vital pulp therapy techniques and the materials used. A total of 32 articles were selected based on predefined inclusion and exclusion criteria.

Results: The review identifies indirect pulp capping, particularly the stepwise approach, as the most conservative method, offering significant benefits in terms of promoting natural healing processes and reducing the risk of pulp exposure. Direct pulp capping, utilizing materials such as Mineral Trioxide Aggregate (MTA) and Biodentin, demonstrates a high success rate in forming a protective barrier over exposed pulp tissue, thus preserving pulp vitality. Pulpotomy, indicated for more severe cases, also shows promising results in maintaining the vitality of the remaining pulp tissue, with materials like MTA and Biodentin playing pivotal roles. The evolution of dental materials, including bioactive silicates and resin-based MTA, has significantly contributed to the success of these therapies.

Conclusion: Vital pulp therapies, leveraging contemporary materials and techniques, offer effective strategies for preserving pulp vitality in teeth affected by caries or traumatic injuries. The choice of technique and material is crucial, with indirect pulp capping, direct pulp capping, and pulpotomy each serving distinct clinical scenarios. These therapies not only support the structural integrity and health of the tooth but also align with the principles of minimally invasive dentistry.

Keywords: Vital pulp therapy, Indirect pulp capping, Direct pulp capping, Pulpotomy, Dental caries, Traumatic dental injuries, Mineral Trioxide Aggregate, Biodentin.

INTRODUCTION

The global prevalence of dental caries and its profound impact on the social well-being of individuals highlight the urgency for effective management strategies that preserve the vitality of the tooth. Dental caries, recognized universally as a significant health issue, detrimentally affects the quality of life of a vast portion of the population, with studies indicating that up to 85% of adults harbor at least one restoration, and 17% of dentate individuals report significant life disruptions due to oral health conditions (1, 2). The pathogenesis of dental caries involves the dynamic interplay of biofilm formation, plaque accumulation, and pH alterations, which collectively facilitate the disease's progression (3). Traditionally, the clinical approach to caries removal prioritized the hardness of dentin and color consistency as benchmarks (4). However, the preservation of pulp vitality has emerged as a paramount objective, underpinning the shift towards minimally invasive treatments designed to mitigate damage to the pulp-dentin complex and safeguard dental health (5).

The evolution of caries management techniques reflects a pivotal shift in treatment paradigms, with a growing body of evidence challenging the necessity of complete carious lesion removal. Contemporary research supports the practice of incomplete caries removal, a strategy that aligns with the principles of minimal intervention and aims to avert the potential harm associated with

conventional, more invasive approaches (6). Within this context, vital pulp therapy represents a cornerstone of modern endodontic treatment, boasting over two decades of clinical application. This method encompasses a spectrum of procedures, including direct and indirect pulp capping, as well as pulpotomy, which collectively strive to maintain pulpal health through the strategic application of protective biomaterials. These materials facilitate the healing process and encourage the formation of tertiary dentin by creating a favorable environment over the thin remaining dentin (7). Indirect pulp capping is distinguished by the selective removal of infected dentin while preserving the affected but not infected layer, thereby minimizing the risk of further pulpal insult. Conversely, direct pulp capping and partial pulpotomy are employed in cases of accidental pulpal exposure, with the choice of technique influenced by the extent of the exposure and the elapsed time since the incident (5, 8).

The nuanced understanding of dental caries pathophysiology and the development of minimally invasive techniques underscore the progress in endodontic therapy. The emphasis on preserving pulp vitality through methods such as vital pulp therapy reflects a holistic approach to dental care, prioritizing long-term tooth health over immediate cosmetic or structural restoration. This narrative literature review aims to delineate the various strategies for maintaining pulp vitality, elucidating the theoretical underpinnings, clinical applications, and outcomes of these approaches in the context of the broader goal of enhancing patient quality of life through improved oral health management.

MATERIAL AND METHODS

To systematically investigate the efficacy and outcomes of indirect pulp capping techniques within the domain of vital pulp therapy, a meticulous search strategy was employed, leveraging both physical and digital scholarly resources. The initial phase of literature acquisition involved the Islamabad Medical and Dental College library, providing access to an extensive collection of medical and dental journals. Complementing this, a targeted search through online databases, including PubMed and Google Scholar, was conducted to ensure a comprehensive exploration of the subject matter. This search was confined to literature published in English, without imposing any restrictions on the publication date, to encapsulate the entire spectrum of available evidence on the topic.

The inclusion criteria were rigorously defined to encompass studies that specifically addressed vital pulp therapy, with a particular focus on materials utilized in indirect pulp capping procedures. This criterion was pivotal in delineating the scope of the review, ensuring the relevance and specificity of the literature to the research question. Exclusion criteria were also established to refine the search results further, although not explicitly detailed in the provided methodology, typically involving the omission of studies not directly related to the research question or failing to meet predefined quality or relevance standards.

Following the application of these criteria, a total of 32 peer-reviewed articles were deemed eligible for inclusion in the review. Each article underwent a thorough evaluation to ascertain its contribution to understanding the effectiveness, material preferences, and clinical outcomes associated with indirect pulp capping. This evaluation process, although not described in detail, presumably involved assessing the studies' methodologies, results, and relevance to the research objectives.

The methodology section outlines a structured approach to literature review, leveraging both physical library resources and online databases to compile a comprehensive body of evidence on indirect pulp capping techniques. The emphasis on peer-reviewed literature, combined with explicit inclusion and exclusion criteria, underscores the review's commitment to scientific rigor and relevance. However, for enhancement and adherence to high standards of academic reporting, this section could benefit from additional details on the search strategy (e.g., specific search terms, databases beyond PubMed and Google Scholar), the exclusion criteria, and the evaluation process for the identified literature. These enhancements would further augment the replicability and transparency of the research methodology, aligning with best practices in scholarly research.

RESULTS

To synthesize the main findings from the descriptions of the various pulp capping techniques and materials, let's organize the information into a thematic table. This table will categorize the information based on the technique (Indirect Pulp Capping, Direct Pulp Capping, Pulpotomy), further dividing it into sub-categories where applicable (such as Single Visit vs. Stepwise for Indirect Pulp Capping), and listing the materials used for Direct Pulp Capping:

Table 1: Techniques and Materials in Pulp Therapy

Technique	Sub-Category	Description	Materials Used
Indirect Pulp Capping	Single Visit	Caries removed in one appointment, leaving a thin layer of dentin above the pulp, sealed with a biocompatible material. Ideal for minimal to moderate lesions.	Not specified
	Stepwise	Involves two or more visits. Initial caries removal leaves behind some decay and a temporary sealant. After a period, the procedure is completed. Favors deep lesions to allow for natural healing and dentin formation.	Not specified
Direct Pulp Capping	N/A	Used when the dental pulp is exposed. Aims to promote healing and barrier formation at the site of exposure.	Calcium Hydroxide, Mineral Trioxide Aggregate (MTA), Biodentin, Bio Aggregate, Resin Based MTA
Pulpotomy	N/A	Removal of a portion of the diseased pulp with the goal of preserving the remaining healthy pulp tissue. Often used in primary teeth or teeth with immature roots.	Not specified

This table simplifies the complex information surrounding pulp therapy techniques and materials, facilitating an easier comparison and understanding of the various approaches and their indications.

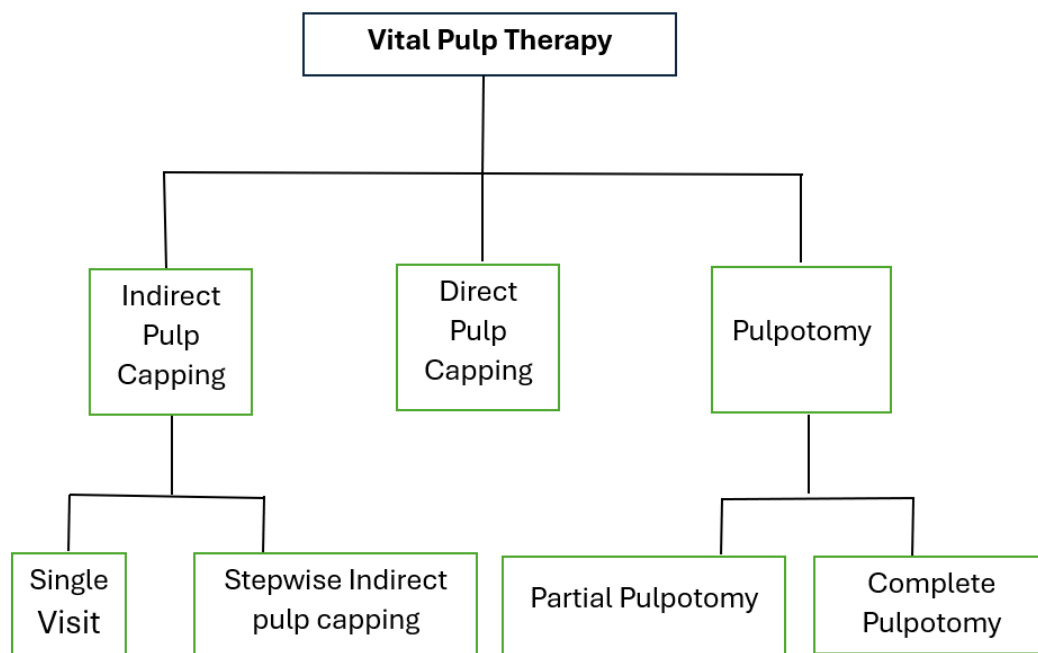


Figure 1 Classification of vital pulp therapy.

DISCUSSION

The discussion on various pulp therapy techniques and materials delineates the nuanced approaches to preserving dental pulp vitality amidst carious lesions or traumatic injuries. Each technique—indirect pulp capping, direct pulp capping, and pulpotomy—serves a specific clinical scenario, with their efficacy heavily influenced by the choice of biomaterials, which have evolved significantly over time. This method is distinguished by its

conservative nature, aiming to minimize pulp exposure during caries removal. It encompasses two sub-techniques: single visit and stepwise indirect pulp capping. The single visit approach, though efficient, carries a higher risk of pulp exposure due to the complete removal of caries in one session, making it a more aggressive strategy (5). Conversely, the stepwise method adopts a more cautious progression, initially removing necrotic dentin and covering the soft dentin with a biocompatible material for a period before completing the restoration, thereby promoting natural healing and reducing the risk of adverse outcomes (5).

Direct pulp capping addresses accidental pulp exposure by applying a biomaterial directly onto the exposed pulp, fostering the formation of a mineralized barrier and preserving pulp vitality (8). The evolution of materials used for this purpose—from calcium hydroxide, historically revered as the gold standard, to modern alternatives like Mineral Trioxide Aggregate (MTA) and Biodentin—reflects significant advancements in enhancing tissue response, pulpal healing, and dentin regeneration (10-28). Pulpotomy involves the removal of coronal pulp to preserve the vitality of the remaining radicular pulp, particularly in cases of deep carious lesions without signs of irreversible pulpitis (30, 31). The technique is further divided into partial and full pulpotomy, depending on the

extent of coronal pulp removal. The selection of agents for pulpotomy, including ferric sulfate, formocresol, and calcium silicates like MTA and Biodentin, is critical for achieving the desired therapeutic outcomes (31, 32).

Across these therapies, the choice of biomaterial plays a pivotal role, with each material offering distinct advantages and limitations. Calcium hydroxide, once the cornerstone for pulp capping, has been partially superseded by materials like MTA, Biodentin, and bioaggregate, which offer superior biocompatibility, sealing properties, and less severe inflammatory responses. Notably, innovations such as resin-based MTA and advancements in bioactive materials have further expanded the arsenal available for vital pulp therapies, catering to the specific needs of each clinical scenario.

CONCLUSION

It is drawn from this discussion emphasizes the value of vital pulp therapies in managing deep carious lesions or traumatic injuries, particularly for teeth with open apices. These therapies not only facilitate apex development and dentin preservation but also align with the principle of minimally invasive dentistry. The gradual preference shift towards less invasive techniques like indirect pulp capping, followed by direct pulp capping and pulpotomy, underscores a broader trend in dental care towards preserving natural tooth structure and function while minimizing intervention.

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