

REVIEW ARTICLE

**Advancements in Vital Pulp Therapy: A Comprehensive Review****¹Dr. Radhika Charhate, ²Dr. Vandana Gade, ³Dr. Priyanka Masram, ⁴Dr. Yasmeen Chaudhary, ⁵Dr. Priyanka Chaware**

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ABSTRACT

This comprehensive review article examines the latest advancements in vital pulp therapy, a transformative approach in modern dentistry. It explores techniques like direct and indirect pulp capping, pulpotomy, apexogenesis, and regenerative endodontics. The review investigates innovative materials, regenerative approaches, and compares clinical outcomes. The findings underscore vital pulp therapy's pivotal role in preserving dental vitality, promoting regenerative healing, and shaping the future of dental care.

Key words: vital pulp therapy, dental pulp, pulp capping, pulpotomy, regenerative endodontics, Bioactive materials

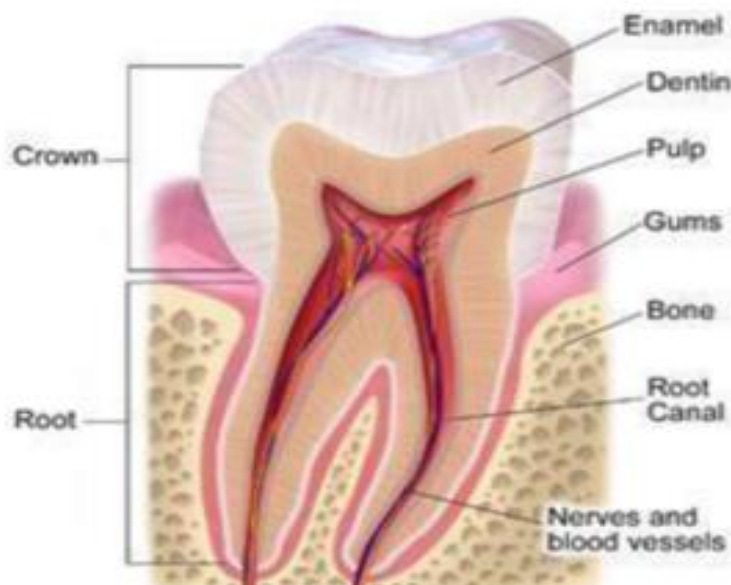
DOI: 10.48047/ecb/2022.11.12.143**INTRODUCTION**

Vital pulp therapy has emerged as a transformative approach in modern dentistry, revolutionizing the management of dental pulp injuries and infections. Vital pulp therapy (VPT) is a crucial and evolving aspect of modern dentistry aimed at preserving the vitality and function of the dental pulp. Unlike traditional root canal treatments that involve complete pulp removal, VPT seeks to maintain the health of the pulp tissue when affected by injury or infection. This article explores the significance of vital pulp therapy, its various techniques, indications, and outcomes.¹

With a focus on the future of vital pulp therapy, this review explores regenerative endodontics as a promising frontier, outlining its potential in restoring the function and vitality of infected or necrotic pulp tissue. Additionally, it assesses the application of tissue-engineering approaches, growth factors, and stem cells, evaluating their role in promoting pulp regeneration and healing.¹

UNDERSTANDING THE DENTAL PULP

The dental pulp is a vital component of the tooth, comprising nerves, blood vessels, and connective tissue. Its role is to provide nourishment to the tooth during development and maintain its vitality throughout its lifespan. However, dental caries, trauma, or other factors can lead to pulp inflammation, necessitating timely intervention.²



TYPES OF VITAL PULP THERAPY

DIRECT PULP CAPPING

Indicated for small pulp exposures due to caries or minor trauma.

The exposed pulp is covered with a biocompatible material to encourage healing and dentin formation.

Direct pulp capping (DPC) is considered to be one efficient, conservative treatment option . During this procedure, after caries excavation, a dental biomaterial is placed directly over the exposed dental pulp. This helps to promote the mineralized tissue formation that is ubiquitously used to protect the vitality of the dental pulp.³



INDIRECT PULP CAPPING

Used when the carious lesion is deep and close to the pulp, but there is no pulp exposure.

A medicament is applied over the carious dentin to promote reparative dentin formation and protect the pulp.

In the case of indirect pulp capping, where the cavity preparation is in close proximity to the pulp but with no visible exposure, various one- and two-stage protocols have been advocated. With two-stage or stepwise caries removal techniques.⁴

All carious dentin typically is removed from the walls and dentino-enamel junction of the cavity preparation.

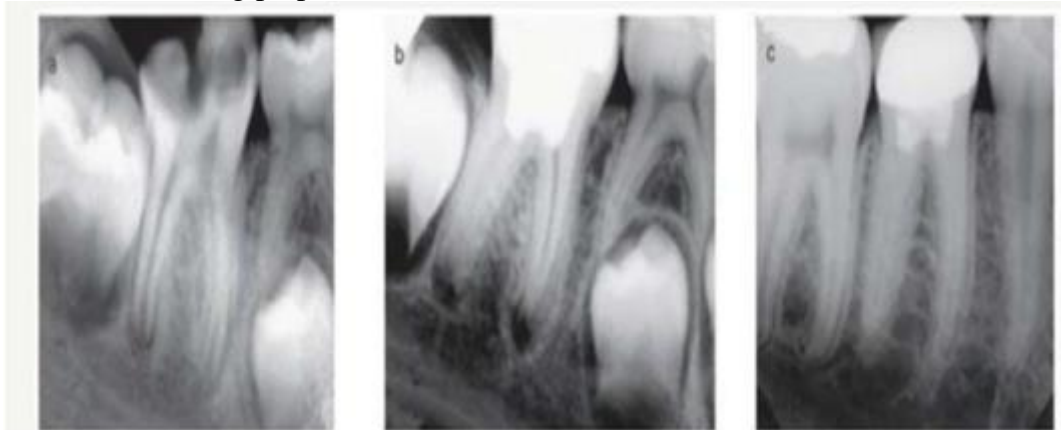
A layer of deep carious dentin, which is usually discolored but firm, may be left on the floor of the preparation if its removal might cause a pulp exposure. Typically, a liner is then placed.⁴



PULPOTOMY

Commonly performed in primary teeth with extensive caries or trauma.

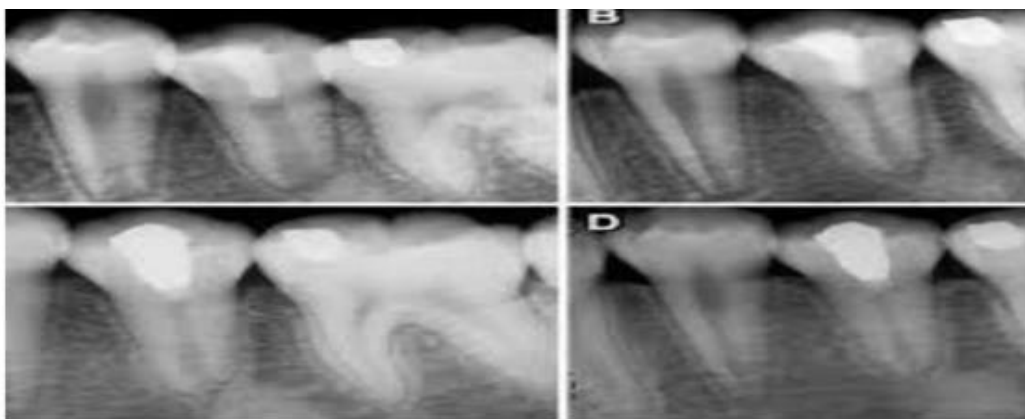
The coronal pulp is removed while maintaining the root pulp vitality, and a medicament is applied to the remaining pulp tissue.⁵



APEXOGENESIS

Indicated in young permanent teeth with incomplete root development and pulp exposure due to trauma.

The vital pulp is preserved, allowing the root to continue growing, and the injured pulp heals over time.⁶



REGENERATIVE ENDODONTICS

An advanced VPT technique aimed at restoring the damaged pulp tissue.

The root canal is cleaned, disinfected, and a scaffold is introduced to encourage pulp regeneration.⁶

ADVANTAGES OF VITAL PULP THERAPY

Preserves natural tooth structure and maintains the tooth's functional longevity.

Avoids the need for more invasive and costly treatments like root canal therapy or tooth extraction.

Reduces the risk of post-treatment complications, such as root fractures or loss of tooth support.⁷

INDICATIONS AND CONTRAINDICATIONS

VPT is most effective in young teeth with open apexes, allowing for better healing and continued root development.⁷

It may not be suitable for teeth with extensive pulp pathology, such as irreversible pulpitis or necrosis. Vital pulp therapy (VPT) continues to advance in dentistry, various materials are being researched and introduced to enhance treatment outcomes and patient comfort. Here are some of the latest materials used for vital pulp therapy:

MATERIALS USED IN VITALPULP THERAPY

BIOACTIVE MATERIALS

Bioactive materials have gained popularity in VPT due to their ability to interact with the dental tissues and promote healing. Calcium hydroxide and mineral trioxide aggregate (MTA) are widely used bioactive materials in VPT. They have excellent biocompatibility, antibacterial properties, and promote dentin bridge formation, which is crucial for pulp preservation.⁸

BIODENTINE

Biodentine is a newer bioactive material that has shown promising results in vital pulp therapy. It is a calcium silicate-based cement that offers excellent sealing ability and stimulates pulp cell proliferation. Biodentine can be used for direct pulp capping, pulpotomy, and as a base/liner under restorations.⁸



TRICALCIUM SILICATE CEMENTS

Apart from MTA, newer tricalcium silicate cements like BioRoot RCS and EndoSequence Root Repair Material (ERRM) are being developed and tested for vital pulp therapy. These materials exhibit improved handling characteristics and biocompatibility compared to traditional MTA.⁹



CALCIUM-ENRICHED MIXTURE (CEM) CEMENT

CEM cement is another innovative material used in VPT. It contains calcium oxide, calcium phosphate, and calcium sulfate, providing excellent sealing ability and regenerative potential. CEM cement is used in pulp capping, pulpotomy, and apexogenesis procedures.⁹

DENTIN-PULP COMPLEX REGENERATIVE MATERIALS

Regenerative endodontic techniques aim to restore the function and vitality of damaged dental pulp. Several materials, such as platelet-rich plasma (PRP), platelet-rich fibrin (PRF), and stem cell-based materials, are being explored for their regenerative potential in VPT.¹⁰

MATURE TOOTH PULP CAPPING MATERIALS

For mature teeth with carious exposures or traumatic pulp exposures, innovative materials like TheraCal LC, a resin-modified calcium silicate-based liner, have been introduced. These materials provide long-term sealing and help in dentin remineralization.⁹



LIGHT-CURABLE PULP CAPPING MATERIALS

Light-curable pulp capping materials like TheraCal PT emerging as efficient alternatives to traditional calcium hydroxide liners. They offer faster setting times and simplified application procedures.¹¹



NANOMATERIALS

Nanotechnology is making its way into dental materials, including those used in VPT. Nanoparticles of various materials are being incorporated into existing materials to enhance their mechanical properties, antimicrobial activity, and regenerative potential.

It's important to note that while these materials show promising results, ongoing research is continuously refining their properties and clinical applications. As with any dental procedure, appropriate case selection, precise technique execution, and adherence to evidence-based guidelines are essential for successful vital pulp therapy outcomes. Dentists should stay updated with the latest research and advancements in materials to provide the best possible care to their patients.¹¹

TISSUE ENGINEERING APPROACH IN VITAL PULP THERAPY

Tissue engineering is an innovative approach in vital pulp therapy that aims to regenerate damaged or infected dental pulp tissues. Instead of traditional methods that involve the removal of the pulp (e.g., root canal treatment), tissue engineering seeks to restore and revitalize the pulp, allowing the tooth to maintain its natural function and vitality. This advanced technique holds great promise for preserving natural teeth and promoting regenerative healing within the dental pulp.¹²

The tissue engineering approach in vital pulp therapy typically involves the following steps:

PULP TISSUE EVALUATION

Before beginning the tissue engineering process, a thorough evaluation of the damaged pulp tissue is essential. This involves assessing the extent of inflammation, infection, and the potential for regeneration based on the patient's age, the tooth's development, and overall health.¹²

PULP TISSUE REMOVAL AND STERILIZATION

Any infected or inflamed pulp tissue is carefully removed from the pulp chamber. The goal is to create a sterile environment that promotes tissue regeneration and prevents the spread of infection.¹²

SCAFFOLD PLACEMENT

A scaffold or matrix is introduced into the pulp space. The scaffold serves as a three-dimensional framework that supports the growth of new pulp tissue. It can be made from biocompatible materials, such as synthetic polymers or natural substances like collagen, to facilitate cell adhesion and growth.¹²

GROWTH FACTOR APPLICATION

Growth factors, which are biologically active molecules, are applied to the scaffold. These growth factors stimulate stem cells within the pulp and guide them to differentiate into functional pulp cells, including odontoblasts, which are responsible for dentin formation.¹²

CELL SEEDING (OPTIONAL)

In some cases, exogenous pulp stem cells or dental pulp stem cells from the patient can be cultured and then introduced into the scaffold to accelerate tissue regeneration.¹²

SEALING AND RESTORATION

The scaffold is sealed and covered with a biocompatible material to protect the regenerating pulp tissue. The tooth is then restored with a suitable restorative material to ensure a proper seal and functional occlusion.¹²

MONITORING AND FOLLOW-UP

Patients are closely monitored through regular follow-up appointments to assess the progress of tissue regeneration and the success of the vital pulp therapy.¹²

BENEFITS OF TISSUE ENGINEERING IN VITAL PULP THERAPY

Promotes natural pulp healing and regeneration.

Preserves the vitality and function of the dental pulp.

Reduces the need for more invasive procedures like root canal treatment or tooth extraction.

Minimizes the risk of complications and subsequent treatments.

It's important to note that tissue engineering in vital pulp therapy is an evolving field, and more research is needed to optimize the technique and improve its long-term success rates. However, this promising approach holds great potential for revolutionizing the treatment of dental pulp injuries and infections, leading to improved outcomes and better patient care in the future.¹²

OUTCOMES OF VITAL PULP THERAPY

The outcomes of vital pulp therapy can vary depending on several factors, including the type of treatment performed, the extent of pulp damage, the materials used, and the patient's overall oral health. Here are some common outcomes associated with different vital pulp therapy techniques:

DIRECT PULP CAPPING

Successful direct pulp capping results in a healing response within the dental pulp.

The pulp remains vital, and a dentin bridge forms at the site of exposure, sealing off the pulp chamber. However, there is a risk of treatment failure if the pulp becomes irreversibly inflamed or infected, leading to the need for root canal therapy.³

INDIRECT PULP CAPPING

Indirect pulp capping aims to protect the pulp from further damage and promote natural healing.

Success is evidenced by reparative dentin formation and the absence of symptoms over time.

However, if the carious lesion progresses and affects the pulp, root canal therapy may become necessary.⁴

PULPOTOMY

A successful pulpotomy leads to preservation of the radicular pulp and continued root development in primary teeth. The tooth remains functional and asymptomatic. Failure can result from persistent symptoms or radiographic evidence of pulpal or periapical pathology, requiring further treatment.⁵

APEXOGENESIS

Apexogenesis allows the immature permanent tooth's root to continue developing and form a complete apex. This treatment preserves the vitality of the pulp and supports proper tooth maturation. The success of apexogenesis is evident when the tooth maintains its function and shows continued root growth.⁶

REGENERATIVE ENDODONTICS

Regenerative endodontics aims to restore the pulp tissue and promote root development in immature teeth with infected or necrotic pulp. Successful regenerative endodontics results in continued root growth and thickening of the dentinal walls. However, the success rates of this technique may vary, and not all cases will achieve full pulp regeneration.⁶

Overall, the success of vital pulp therapy is influenced by early diagnosis, proper case selection, precise technique execution, and appropriate materials. It's essential for dentists to carefully evaluate each case and consider the potential risks and benefits of each treatment option. If vital pulp therapy is successful, patients can retain their natural teeth and avoid the need for more invasive procedures like root canal therapy or tooth extraction. Regular follow-up and monitoring are crucial to assess the treatment's long-term success and address any potential complications promptly.

CONCLUSION

Vital pulp therapy stands as a pivotal advancement in modern dentistry, offering a more conservative and proactive approach to managing dental pulp injuries and infections. The various techniques available, including direct and indirect pulp capping, pulpotomy, apexogenesis, and regenerative endodontics, cater to a wide range of clinical scenarios, providing dentists with valuable treatment options to preserve the vitality of the dental pulp.

By embracing vital pulp therapy, dental professionals can effectively retain the natural dentition, promote regenerative healing within the pulp, and alleviate the need for more invasive procedures such as root canal therapy or tooth extraction. The use of innovative materials, including bioactive substances and tissue-engineering approaches, further enhances the success rates and outcomes of these treatments.¹³

It is essential for dental practitioners to remain vigilant in their case selection, meticulous in their execution, and committed to ongoing research to stay at the forefront of this rapidly evolving field. Proper patient education about the importance of timely intervention and regular dental check-ups can contribute to the early detection and successful management of pulp injuries, leading to better long-term oral health.¹³

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