

Review Article

The impact of pulpotomy on the long-term prognosis and survival of young permanent teeth

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ABSTRACT

This review explores the impact of pulpotomies on the long-term prognosis and survival of primary and young permanent teeth. Pulpotomy is a vital pulp therapy procedure aiming to preserve pulp health and functions. The review covers various vital pulp therapy techniques, including indirect pulp treatment, direct pulp treatment, partial pulpotomy, and full pulpotomy. Apexogenesis, a procedure promoting root end formation, is also discussed. Long-term success in endodontic therapy requires an effective coronal seal to prevent microleakage and bacterial ingress into root canals. The study's methodology involved a comprehensive literature search to gather information on pulpotomy's effects on tooth prognosis and survival. Factors influencing the success of vital pulp therapy, such as the size of the exposure, the state of the pulp, and the choice of capping material, are analyzed. Bacterial contamination is identified as a crucial factor affecting the therapy's prognosis. Strategies to improve pulp healing and treatment outcomes are explored, offering insights into clinical decision-making for pulpotomy procedures.

Keywords: Pulpotomy, Long-term prognosis, Survival, Primary teeth, Young permanent teeth, Apexogenesis

INTRODUCTION

To preserve the pulp's health and vitality, treatment for pulp exposure should promote the regeneration of pulp tissue and assist in the creation of reparative dentin.¹ Procedures for pulpotomy comprise removing local irritants and applying a protective agent to the pulp, directly or indirectly.² These procedures must be followed by a tight-sealed restoration that is covered to stop

microorganisms from leaking out of the restoration-dentin contact. Vital pulp therapy is used for treating reversible pulpal damage and to encourage root development, apical closure, and complete root canal treatment.³ Indirect pulp treatment, direct pulp treatment, partial pulpotomy, and full pulpotomy are important pulp therapy methods for vital primary and permanent teeth. One such procedure called a pulpotomy, aims to preserve the pulp and its functions, including proprioception, innervation, and

vascularization.⁴ Pulpotomy treatment's main objective is to remove the damaged coronal pulp tissue so that the unaffected radicular pulp tissue may continue to function properly until the tooth is ready to exfoliate spontaneously.⁵ In the past, medications were first used to try to keep the damaged primary tooth in place with the intention of mummifying the residual pulp. New products have been evaluated over time and with ongoing studies, both *in vitro* and *in vivo*, with results that are different from mummification. These new approaches have made it possible to categorize pulpotomy procedures by the purpose of treating patients with these various materials. In today's world of conservative dentistry, clinicians focus on techniques that do not invade the pulp space or minimally invade the space and have the objective of maintaining pulp vitality in its entirety, allowing the tooth to heal. Such are indirect pulp treatment as well as those techniques that only partially remove the affected tissue, like partial pulpotomy. In young permanent teeth, a pulpotomy is classically undertaken to promote apexogenesis.

Apexogenesis is a term used to describe a vital pulp therapy procedure aimed at promoting the natural physiological growth and formation of the root end.⁶

The objective of the study was to promote root development and apical closure. Pulpotomy techniques include coronal, cervical, and full pulpotomies. To achieve long-term success in endodontic therapy, it is essential to establish a proper coronal seal that effectively prevents microleakage and the entry of oral bacteria into the root canals.

METHODS

This study is based on a comprehensive literature search conducted on July 29, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database.

To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point.

We looked for valuable information in papers that discussed the impact of pulpotomy on the long-term prognosis and survival of primary and young permanent teeth. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

The goal of therapy after pulp exposure is to get the pulp wound to heal to keep a tooth that is still functional with a healthy pulp.⁷ Reversible pulpal damage is the target of vital pulp treatment. There is a difference in outcome between treating an inflamed and a noninflamed pulp.⁶ The chance for a successful outcome is markedly higher in the

non-inflamed pulp exposed by trauma than in the inflamed pulp exposed during caries excavation.

The pulp must be healthy or not inflamed enough to continue the inflammatory response for the therapy to be successful. A variety of vital pulp therapy methods, including partial pulpotomies, complete pulpotomies, direct pulp treatments, and indirect pulp treatments, for primary and permanent teeth. Primary teeth with decay, young people, immature permanent teeth, and adult teeth with traumatic pulp exposure have all been considered candidates for pulpotomy as a final therapy.⁸

Partial pulpotomy

The glossary of the American Association of Endodontists defines partial pulpotomy as a procedure where a small portion of the vital coronal pulp is removed to protect and maintain the remaining coronal and radicular pulp tissues. This technique aims to support ongoing physiological development and the formation of the root end.⁹ Teeth with traumatic pulp exposure in children and young adults can be effectively treated (96%) with partial pulpotomy and calcium hydroxide.¹⁰

Cvek pulpotomy is another name for the operation. Inflammation reached 1.5 mm to 2 mm into the pulp at the 48-hour mark but only 0.8 mm to 2.2 mm after one week, according to research by Cvek and colleagues examining the depth of inflammatory responses in adult monkey pulps exposed by fracture or cavity preparation.¹¹ Calcium hydroxide must thus come into contact with non-inflamed tissue that is positioned around 2 mm of pulp underneath the exposure site to be effective. Fuks and colleagues achieved a 94% success rate for partial pulpotomies on 63 teeth with various types and degrees of traumatic damage in 1987.¹²

Complete pulpotomy

The coronal pulp is removed during a pulpotomy while keeping the radicular pulp. This procedure can be used in one of three ways: by keeping the radicular pulp healthy, rendering it inactive, or by promoting tissue regeneration and healing at the site of radicular pulp amputation.⁵ To prevent salivary germs from contaminating the pulp chamber, techniques include anaesthesia using the preferred method and isolating the tooth, ideally with a rubber dam. After that, clean up any cavities before going into the pulp chamber.

Long-term success in endodontic therapy requires a coronal seal to prevent microleakage and the ingress of oral bacteria into the root canals. If the carious tooth is not restorable, it should be extracted. Pulpotomy and pulpectomy procedures require significant access cavity preparations, which have the potential to weaken the axial walls of the treated tooth. In general, full coverage restoration with a preformed metal crown or a composite resin crown is recommended.¹³

Factors affect long-term prognosis and survival of primary and young permanent teeth treated by pulpotomy

In evaluating the success of vital pulp therapy in permanent teeth, dentists should schedule regular patient follow-ups. While it may not be possible to determine histologic success, clinical success is assessed by the absence of any clinical or radiographic indications of pathology and the observation of ongoing root development in teeth with incomplete root formation.⁶

Behavioural factors

Effective endodontic treatment requires a high level of patient compliance. If a child is unable to cooperate with pretreatment diagnostic procedures, including radiographs, they are unlikely to cope with complex endodontic and associated restorative procedures. Where cooperation cannot be obtained or is fragile, it is reasonable to consider the elective use of general anaesthesia, or even elective extraction of the affected tooth rather than complex endodontic and restorative procedures.¹³

Size of exposure

The prognosis for vital pulp treatment might be affected by the extent of the carious pulpal exposure. This is because, generally, the larger the exposure, the greater the bacterial penetration of the pulp.¹⁴ Also, the larger the exposure, the harder it is to seal. Long-term success is certainly less predictable with large carious exposures than with small carious exposures.¹⁵ It has been proposed that vital pulp therapy be limited to exposures less than 2 mm in diameter.¹⁴

State of the pulp

The inflammatory status of the cariously exposed pulp is a major determining factor in the success of vital pulp therapy. The pulp's capacity to recover from its inflammatory condition determines whether vital pulp treatment will be effective.⁶ Ideally, the status of the pulp should be known before therapy is started.¹⁶ The diagnosis of pulpal inflammatory status is based on subjective signs and symptoms, which are inconsistent, unreliable and do not correlate well with actual histologic data.¹⁷ Mass and Zilberman proposed that an ultimate pulpal diagnosis be made immediately after removing 2-3 mm of the pulp during a partial pulpotomy procedure.¹⁴ A continuously bleeding pulp wound would contraindicate vital pulp therapy. Using this criterion, a success rate of 91.4% was attained after a minimum of 12 months following partial pulpotomy in young permanent molars with carious exposure. Caliqkan's research demonstrated that this irreversible pulpitis might be confined to the coronal pulp, as evidenced by the vitality of the radicular pulp and the resolution of radiographic periapical issues following full coronal pulpotomy with a calcium hydroxide dressing.¹⁸ The dangers of dystrophic calcification of the root canals and the prevention of later root canal treatment, if

necessary, must be considered with the use of this technique.

Extra-pulpal blood clot

Stanley concluded that the control of bleeding and the contact of calcium hydroxide with pulp tissue seems to have an influence on the success of the procedure.¹⁹ Excessive bleeding usually indicates a hyperaemic pulp with little chance of recovery.¹⁵ If clinical success is expected, bleeding from exposed pulp tissue should be minimal and stop soon after the exposure. Studies have shown that the persistence of the coagulum clot can have a negative impact on pulp healing.²⁰ Thus, it is necessary to remove it before placing any definitive seal. Additionally, the presence of dentine chip fragments, dead cells, bacteria, and restorative material particles at the wound site can also hinder pulp healing. To address these issues, a five percent sodium hypochlorite solution can be used to chemically remove the blood coagulum at the exposure-pulp interface, stop pulp hemorrhage, and eliminate most dentine chips, bacteria, and damaged pulp cells. Importantly, the use of sodium hypochlorite will not cause harm to normal underlying tissues.

Choice of capping material

The choice of a capping material can influence the success of vital pulp therapy.¹⁴ Since the 1930s, calcium hydroxide has been the worldwide standard for direct pulp capping.²⁰ This opinion has been based on the premise that calcium hydroxide was unique in its ability to stimulate dentine bridge formation. More recently, it has been demonstrated that a variety of materials are physiologically compatible with exposed pulps and allow for the creation of dentine bridges in favourable environments.⁶ The ideal medicament for pulp dressing after pulpotomy should be non-toxic, and possess antimicrobial activity and an anti-inflammatory potential to control pre-existing inflammatory states and surgically induced inflammation.²¹ Cox and associates, investigated the biocompatibility of silicate cement, zinc phosphate cement, amalgam, and composites on monkey pulps, with and without an additional surface seal of zinc oxide-eugenol.²² Their results suggest that the ability of these materials to stop bacterial leaking is more important for the healing of dental pulp exposures than the kind of pulp capping material used. As long as bacterial contamination is removed, even inert materials like Teflon exhibit pulpal healing when employed as a direct pulp capping material.⁶ Studies have demonstrated that Mineral Trioxide Aggregate (MTA) possesses a high level of biocompatibility and effectively prevents both dye and bacterial leakage.^{23,24} Pitt Ford et al used MTA as a pulp capping material on 12 mechanically exposed pulps of monkeys, and all but one showed pulpal healing and dentine bridge formation adjacent to the pulp.²⁵ Torabinejad et al speculate this is due to MTA's sealing ability, biocompatibility, alkalinity, or other properties associated with this material.²³ Based on these results,

MTA has been considered a suitable pulp capping material.²³⁻²⁵

Dycal and Life, among other calcium hydroxide cement, have demonstrated satisfactory results and are associated with dentine bridge formation across pulp exposures.⁶ The choice of calcium hydroxide formulation may impact the location of dentine bridge formation, with cement forms promoting direct bridge formation against the capping material, while paste or powder formulations result in a necrotic layer between the bridge and the capping material. Lower pH, hard-setting, and commercial calcium hydroxide cement have been recommended to avoid the negative side effects observed in inorganic calcium hydroxide formulations.¹⁹

Bacterial contamination

Bacterial contamination is the main factor that determines the prognosis of vital pulp therapy.²⁶ Bacterial contamination of the pulp can occur directly through caries or exposure to salivary contamination. Following caries removal and the aseptic removal of superficial pulp, it is important to control bacterial contamination of the pulp by microleakage at the tooth restoration interface.²⁷ Cox et al showed that three weeks after placing restorations over a pulp exposure, pulpal reorganization and hard tissue repair were observed when a surface seal was applied to prevent marginal leakage.²² However, in the absence of this surface seal, severe pulpal inflammation and necrosis were observed, often accompanied by the presence of bacteria at the interface between the pulp and restoration. Barthel et al found that placement of a definitive restoration within the first two days after carious pulp exposure contributed significantly to the survival rate of these teeth.²⁸ Partial pulpotomy improves pulp sealing by creating a retentive cavity for the capping and restorative material.¹⁴ The long-term prognosis and the ability to restore a tooth are the over-riding factors when assessing whether vital pulp therapy should be undertaken.²¹ The amount of crown destruction usually associated with pulp exposure in an immature molar means that the tooth involved would require significant restorative maintenance in the long term. Extraction and orthodontic treatment may be preferable.

CONCLUSION

This comprehensive review explores the impact of pulpotomy on the long-term prognosis and survival of primary and young permanent teeth, emphasizing the significance of vital pulp therapy in preserving pulp health and functions. The study covers various pulp therapy techniques, such as indirect and direct pulp treatment, partial pulpotomy, and full pulpotomy, including apexogenesis to promote root end formation. The success of endodontic therapy hinges on achieving an effective coronal seal to prevent bacterial ingress into root canals. Factors like the size of the exposure, the state of the pulp, and the choice of capping material play crucial roles in

determining treatment outcomes. Bacterial contamination emerges as a key determinant of therapy prognosis. This review provides valuable insights for clinicians to make informed clinical decisions and optimize the success of pulpotomy procedures in preserving tooth vitality.

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