RESEARCH JOURNAL OF TRAUMA AND DISABILITY STUDIES

Volume: 4 Issue: 4 | Apr–2025 ISSN: 2720-6866
http://journals.academiczone.net/index.php/rjtds

Treatment of Pulp Pathology in Children

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Abstract: The treatment of pulp pathology in pediatric patients is a critical aspect of pediatric dentistry, as it directly impacts both the short-term and long-term dental health of children. This article explores the various features and challenges associated with diagnosing and managing pulp diseases in children, focusing on the differences between primary and permanent teeth. The article examines the common causes of pulp inflammation, such as trauma, deep caries, and infection, and discusses the latest treatment modalities, including pulp capping, pulpotomy, and root canal therapy. Special attention is given to the use of biocompatible materials and the consideration of age, growth, and development in choosing appropriate therapeutic approaches. Additionally, the article highlights the importance of early intervention, preventive care, and the role of the pediatric dentist in ensuring optimal outcomes for young patients.

Keywords: pulp, treatment, children, challenging, success, treatment interventions, implementation, entire pulp

Introduction

Treatment of pulp pathology in both primary teeth and permanent teeth with incomplete root formation is one of the most challenging and responsible tasks in pediatric dental practice. Treating pulpitis in children is often associated with certain difficulties due to the clinical manifestations of the condition (pain during or before diagnosis), the child's behavior, and the structural features of the teeth. An accurate diagnosis is crucial for selecting the optimal treatment method, which ensures the highest probability of long-term success and minimizes the risk of complications. The choice of treatment method and its implementation directly impact the future of the tooth: whether the pulp remains viable, the possibility of continued root growth and formation, physiological resorption, and the functional value of the tooth. It’s important to consider that dental procedures in children often involve developing tooth structures, which are functionally immature and may respond inadequately to various stimuli. The apical area, which may not be fully formed, has significant cellular potential, is highly vascularized, and plays a key role in the formation of the apical third of the root. Preserving the vitality of the entire pulp or its root portion is essential for root elongation and wall thickening, which in turn ensures the tooth’s stability under functional loads. Therefore, all treatment interventions should be as gentle as possible and aimed at creating physiological conditions that support the formation of the tooth and its surrounding tissues. However, potential complications should be kept in mind. When choosing a treatment method for inflamed pulp in children, several factors must be considered:

- The form of pulpitis progression;
- The degree of caries activity;
- The stage of root formation;
- Pulp electroexcitability data;
- The child’s general health;
- The child’s psycho-emotional status.

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The main objectives of pulpitis treatment in children are:

1. Pain relief;
2. Elimination of odontogenic inflammation and prevention of diseases in the periodontium, jawbones, and surrounding soft tissues;
3. Restoration of the functional value of the undeveloped tooth and ensuring physiological root resorption of primary teeth.

Methodology

Treatment methods for pulpitis can be divided into conservative and surgical approaches. Conservative methods aim to preserve the viability of the entire pulp. These include biological methods, indirect pulp therapy, and direct pulp capping.

Surgical methods involve the removal of the coronal pulp (pulpotomy or amputation) or the entire pulp (pulpectomy or extirpation). Surgical treatments, performed under anesthesia, are referred to as vital amputation or vital extirpation, while procedures carried out after prior devitalization are known as devital amputation and devital extirpation. Complete removal of the inflamed pulp is typically chosen by pediatric dentists for formed permanent teeth and, in certain cases, for primary teeth. It is important to remember that both primary and permanent teeth emerge in an immature state and require time for complete formation. The root formation of primary teeth is completed by the age of 4, while for permanent teeth, root formation takes 3-4 years after eruption. The pulp plays a central role in the formation and growth of the tooth root. This underscores the pediatric dentist's goal of preserving the vitality of the entire pulp, or at least a portion of it, when treating pulpitis in such teeth to allow for further development. Additionally, the incidence of pulpitis in primary teeth increases between the ages of 5 and 9, which coincides with the onset of physiological root resorption of primary teeth, making pulpotomy a frequently used procedure.

Biological Method of Pulpitis Treatment

This method is utilized by pediatric dentists in neighboring countries and in our country. It allows for the preservation of the vitality and physiological activity of the entire pulp through anti-inflammatory treatment of the inflamed pulp.

Indications for use:

- Acute serous pulpitis (acute pulpitis, ICD-S, 1997) in the absence of signs of acute periodontitis;
- Chronic fibrous pulpitis (chronic ulcerative pulpitis, chronic pulpitis, ICD-S, 1997);
- Exacerbation of chronic fibrous pulpitis (chronic ulcerative pulpitis, chronic pulpitis, ICD-S, 1997), provided that exacerbations occur no more than 1-2 times a year and without signs of acute periodontitis;
- First-time exacerbation of chronic fibrous pulpitis (chronic ulcerative pulpitis, chronic pulpitis, ICD-S, 1997).

Based on numerous studies, these forms of pulpitis are reversible, as the pulp is capable of regeneration at these stages.

Conditions ensuring the success of biological treatment:

1. The difference in electroodontodiagnostic (EOD) values between the affected tooth and the healthy, symmetrical tooth should not exceed 25 μA;
2. Compensated form of caries;

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3. Adequate patient behavior;
4. Absence of general somatic or chronic diseases in the child;
5. Ability to create aseptic working conditions (use of a rubber dam, saliva ejector);
6. Carious cavity localized on the occlusal surface;
7. Good oral hygiene.

The biological method is used more limitedly for treating pulpitis in primary teeth. However, there are significantly more opportunities for its successful application in immature permanent teeth, owing to the high regenerative capacity of the pulp in these "immature" permanent teeth, which is influenced by the anatomical, physiological, and morphological characteristics of the pulp. The pulp of permanent teeth with incomplete root formation can exhibit marked reparative and plastic properties depending on the child's age and overall health. The effectiveness of the method depends on the virulence of the carious cavity's microflora, the microorganisms' sensitivity to antibacterial agents, biological antiseptics, their combinations with corticosteroids, and other medications. Some specialists believe that the inflamed pulp can be preserved in reversible forms of pulpitis. In such cases, an additional stage of treatment is required: addressing the infected dentin and the reactive changes in the inflamed pulp. When indications and necessary conditions are strictly adhered to, favorable results can be achieved in treating immature permanent teeth in children, although there are ongoing debates about the efficacy of this approach.

Technique for performing the biological method according to T.F. Vinogradova. The procedure is performed under strict aseptic and antiseptic principles, using non-irritating medications heated to body temperature and under anesthesia.

During the first visit, it is essential to thoroughly clean the carious cavity by removing all altered tissues, as the presence of infection can reduce or even completely neutralize the effectiveness of antibacterial agents. It is also important to expand the cavity away from the pulp to ensure better contact of the antibacterial agent with the pulp through healthy dentin, which aids in the absorption of the antibiotic. Initially, damaged tissues should be removed from the edges of the cavity, and then, at the end of the procedure, the bottom and the areas closest to the pulp, which are more accessible for inspection, should be treated. One should not aim for pulp exposure, but if it happens accidentally during the procedure, it is not a contraindication for continuing the method, provided there are other indications for treatment.

The carious cavity is irrigated with a warm solution of medicinal preparations such as antibiotics, antiseptics, or proteolytic enzymes, then dried with sterile cotton pellets and filled with a tampon soaked in a solution of a broad-spectrum antibiotic mixed with a corticosteroid. The official preparation "Pulpomixin", containing corticosteroids and antibiotics, can also be used. The cavity is then hermetically sealed for a period ranging from 1 to 5 days.

During the second visit, if there is no spontaneous pain, no pain from temperature changes, a normal response to percussion, and normalized results of electroodontodiagnostics, pulpitis treatment can be completed with filling. Calcium hydroxide-based odontotropic paste is applied to the cavity floor, along with an insulating liner, and the tooth is restored.

However, if the child complains of persistent pain from temperature stimuli and there is no improvement in electroodontodiagnostic readings, filling is postponed. Treatment continues with local applications of antimicrobial, anti-inflammatory, and hyposensitizing agents. Additionally, non-steroidal anti-inflammatory and hyposensitizing medications can be prescribed.

Before permanent restoration, it is important to ensure that the tooth being filled still has a live pulp.

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The condition of the pulp tissue can be evaluated using thermodiagnostics or electroodontodiagnostics. The child should be placed under dynamic observation with scheduled follow-up visits: first in 2 weeks, then in 3 months, and every 6 months until the roots are fully formed.

Conservative pulpitis treatment in children also involves direct and indirect pulp therapy methods. Indirect pulp therapy involves the gradual removal of carious dentin over several visits. The first stage of treatment involves the necrosectomy of infected layers of carious dentin (partial necrosectomy). After preparation, the walls of the carious cavity should be composed of healthy tissue. While removing carious tissues, enough dentin must be left in the area of the pulp horns to avoid pulp exposure. The remaining softened dentin is covered with a medicated liner made from calcium hydroxide or zinc oxide-eugenol. Calcium hydroxide has significant anti-inflammatory and antibacterial effects but does not provide pain relief. Zinc oxide-eugenol paste, on the other hand, has local anesthetic and antiseptic properties due to eugenol, which reduces prostaglandin production, while zinc oxide has antibacterial and anti-inflammatory effects. The cavity is hermetically sealed with a stable temporary biocompatible filling material. As a result of these procedures, the carious process is halted, and conditions are created for reparative dentin formation by the pulp, reducing the risk of pulp exposure during the final excavation of remaining carious tissue during the second visit.

It has been established that after cavity preparation, the rate of reparative dentin formation is, on average, 1.4 micrometers per day. American studies have shown that the formation of replacement dentin during indirect pulp treatment occurs primarily during the first month and continues for up to a year. After one year, the layer of formed replacement dentin at the cavity floor can be around 390 micrometers. These observations confirm the possibility of temporary filling of the tooth for more than 6 weeks, with the minimum interval between visits being 6–8 weeks and the maximum being 6–12 months. During this time, the carious process in the deep dentin is halted. After 6-8 weeks, the temporary restoration is removed, and beneath the now hardened and sclerosed carious tissue, healthy dentin is found, meaning the pulp cavity remains intact. Thus, the goal of indirect pulp therapy is to reduce the likelihood of accidental pulp exposure during the treatment of deep carious cavities through the gradual removal of carious dentin and stimulation of dentinogenesis.

Indications for use:

1. Dentin caries (deep carious cavities without clinical symptoms of pulp inflammation);
2. Pulp hyperemia.
3. Technique for performing indirect pulp therapy:
4. Radiographic examination to determine the area of the pulp closest to the floor of the carious cavity.
5. Removal of the superficial layers of carious dentin using an excavator without anesthesia until the first signs of pain sensitivity appear.
6. Local anesthesia.
7. Application of a rubber dam.
8. Thorough preparation of the cavity walls, preserving the floor.
9. Antiseptic treatment of the cavity using an isotonic solution and non-irritating antiseptics.
10. Drying the cavity.
11. Placement of calcium hydroxide paste at the bottom of the cavity for indirect coverage or combined action (e.g., Life, Dycal, Ultra-blend, Calcimol, Septocal, Septocalcin ultra, Calcipulpe, Contrasil).

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12. Temporary restoration of the tooth crown (delayed filling).
13. A follow-up visit 6–8 weeks to 6 months later, where the temporary restoration is removed, the cavity floor is further prepared (keeping in mind the risk of pulp exposure during this step), and a permanent restoration is placed.
14. Dispensary observation. Dynamic monitoring includes periodic testing of tooth vitality (sensitivity tests) and radiographic control to observe root formation and detect possible calcifications within the tooth cavity.

Indirect pulp treatment is a reliable method for treating deep dentin caries and pulp hyperemia. This approach reduces the risk of pulp exposure and preserves pulp vitality.

Direct pulp capping is a method aimed at maintaining the vitality and functional properties of exposed pulp. When appropriate clinical indications are followed and the procedure is performed correctly, the success rate of this method reaches 90%. Pulp exposure does not always result in pulp necrosis.

Dentists around the world report successful treatment of traumatic pulpitis in their work. The success of these techniques depends on the preservation of healthy dentin structure, mandatory antiseptic treatment of the cavity, and proper restoration techniques.

The success of direct pulp capping is determined by:

1. The initial condition of the pulp (diagnosis before treatment);
2. The material used for pulp therapy;
3. The tightness of the pulp isolation after the tooth restoration.

Pulp preservation using direct capping is only possible in teeth with healthy, non-inflamed pulp. Diagnosing the pulp's health before treatment is often difficult, as it can only be reliably determined when the tooth cavity is accidentally exposed during the preparation of an intact tooth or as a result of trauma with crown fracture. If a communication occurs between the exposed cavity and the oral cavity, pulp infection may develop over time. After exposing an intact pulp, inflammatory cell markers can be detected within the first 48 hours in the superficial layer of the damaged area. Therefore, direct pulp capping must be performed no later than 2 days after the injury. According to Leif Tronstad, when performed correctly, this method achieves a 90% success rate in teeth with accidental pulp exposure.

Such teeth with exposed pulp represent a small portion of teeth with this condition. Much more commonly, the pulp chamber is exposed during the removal of softened, infected carious dentin. In this case, the pulp should be considered inflamed. The success rate of pulp therapy is significantly lower (30-40%) in teeth where the pulp chamber was exposed as a result of carious cavity preparation.

Direct pulp capping has narrow indications. It is most often used in children when treating incisors with an undeveloped root apex. In this case, preserving the pulp’s vitality allows for the formation and closure of the root apex, ensuring the full functionality of the tooth.

Indications for direct pulp capping include:

- Accidental pulp exposure of no more than 1mm in diameter during carious cavity preparation for dentin caries treatment.
- Complicated crown fracture with pulp exposure (up to 1mm in diameter, if less than 2 hours have passed since the injury).

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Technique for performing direct pulp therapy:

1. Diagnostic X-ray.
2. Local anesthesia after confirming the tooth's vitality.
3. Placement of a rubber dam.
4. Thorough and careful preparation of the carious cavity.
5. Rinsing the carious cavity with an isotonic solution and non-irritating antiseptics, warmed to body temperature.
6. Drying the operative field with a sterile cotton pellet.
7. Hemostasis with a dry sterile cotton pellet.
8. Closing the pulp wound surface using calcium hydroxide for direct capping or combined action (e.g., Calcicure, Ultrablend, Septocalcin Ultra, Calcipulpe, Life, Dycal, Contrasil).
9. Hermetic sealing of the pulp chamber with zinc oxide-eugenol cement.
10. Tooth restoration.

Conclusion

The use of calcium hydroxide allows for the preservation of healthy, non-inflamed pulp by creating a calcified barrier, or dentin bridge, in the area where the tooth cavity was exposed. Calcium hydroxide paste has a highly alkaline pH of 12.5. Due to this, pulp necrosis occurs in the area where it comes into contact with the paste. The necrotic area is a clearly defined zone surrounded by viable pulp tissue, where inflammation is either absent or minimal. In the transitional, or demarcation, zone between the necrotic tissue and the healthy pulp, gradual mineralization occurs over time, marking the beginning of the formation of a hard tissue barrier. Initially, the newly formed tissue does not contain dentinal tubules, but after about 10 days, odontoblasts, which differentiate from pulp cells, begin to align along the forming hard tissue barrier. The process of dentinal tubule formation begins as the homogeneous tissue starts to develop tubules. The formation of the dentin bridge typically takes about 60 days. During this time, the bridge reaches sufficient thickness, and the pulp is once again enclosed, maintaining its vitality without developing any signs of inflammation.

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