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REVIEW

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Scope of diagnosis and determination of pulp vitality for proper pulp therapeutic approach in deciduous teeth

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ABSTRACT

Pulp therapy in deciduous teeth plays a critical role in maintaining dental function, guiding normal occlusal development, and safeguarding the underlying permanent tooth germ. Accurate diagnosis of pulpal status and determination of pulp vitality remain fundamental yet challenging aspects of pediatric endodontic practice, owing to anatomical differences of primary teeth, physiological root resorption, and behavioral limitations in young patients. This review discusses the biological characteristics of the dental pulp in primary teeth and examines current diagnostic approaches used to assess pulpal health and vitality. Clinical signs and symptoms, pain history, intraoral findings, and radiographic features are evaluated in relation to their diagnostic reliability and limitations. The diagnostic value and constraints of conventional pulp vitality tests in primary teeth are reviewed, along with emerging non-invasive techniques aimed at assessing pulpal blood flow. Additionally, key patient-related, behavioral, medical, and dental factors influencing treatment decisions are discussed. Understanding these parameters is essential for selecting appropriate pulp therapeutic interventions, including pulpotomy, pulpectomy, or extraction, while minimizing the risk of adverse effects on permanent successors. A comprehensive and evidence-based diagnostic approach remains necessary for achieving long-term outcomes in pediatric pulp therapy.

KEY WORDS

Deciduous teeth; Pulp health; Pediatric practice; Primary teeth; Pulpotomy; Pulpectomy

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Introduction

Pediatric endodontics focuses on the diagnosis and management of pulpal diseases in primary teeth and immature permanent teeth, with the primary objective of preserving functional teeth until natural exfoliation. Maintaining primary teeth is essential for chewing, speech development, esthetics, and guiding normal occlusal relationships [1]. An equally critical consideration is the protection of the underlying permanent tooth germ from injury or developmental disturbance resulting from pulpal or periradicular pathology. The anatomical characteristics of primary teeth include thin dentinal walls, large pulp chambers, accessory canals, and physiological root resorption [2].

Dental caries remains the most common cause of pulpal pathology in children, despite improvements in preventive strategies and restorative materials. Accurate diagnosis in primary teeth continues to provide significant challenges. Pain does not reflect the extent or reversibility of pulpal inflammation. Young children often provide inconsistent or inaccurate pain records, and parental reports may further limit diagnostic treatment [3]. The proper diagnosis of pulpal pathology and determination of pulp vitality are basics to successful pulp therapy in deciduous teeth. A dependable diagnostic method requires the integration of medical and dental history, clinical examination, and radiographic assessment [4].

This narrative review synthesizes evidence from peer-reviewed literature based on pulp biology, diagnostic criteria, vitality assessment, and treatment planning on primary teeth. Relevant clinical studies, randomized trials, and medical documents published in pediatric dentistry journals and endodontic journals were evaluated. Instead of performing a quantitative meta-analysis, the review performs a descriptive and critical approach aimed at explaining existing research into practical diagnostic records applicable to routine pediatric dental practice [5].

But the available literature and clinical diagnosis have limitations. Many studies rely on retrospective designs or data, reducing the ability to assess long-term outcomes. Variations in diagnostic protocols, treatment methods, and clinician experience further contribute to unpredictability in reported cases.

The objective of this review is to critically evaluate current approaches to diagnosing pulpal pathology and determining pulp vitality in deciduous teeth. It aims to clarify the diagnostic value and limitations of clinical symptoms, radiographic findings, and vitality testing methods, and to examine their influence on treatment planning decisions.

Future developments in the study are expected to prioritize non-invasive methods capable of assessing pulpal vitality. Development in blood flow–based diagnostic techniques and molecular biomarkers may improve diagnostic accuracy and reduce reliance on individual assessments. Well-designed longitudinal studies correlating diagnostic findings with treatment outcomes are required to establish standardized protocols [6].

Review Methodology

This narrative review was designed to examine the diagnostic approaches used for assessing pulpal pathology and determining pulp vitality in deciduous teeth, with their clinical application in pediatric dentistry. A comprehensive literature search was performed using biomedical and dental databases, including PubMed/MEDLINE, Google Scholar, and selected

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pediatric dentistry and endodontic journals. The search strategy used a combination of keywords and Medical Subject Headings (MeSH) related to the scope of the review. Boolean operators were used to refine the search and ensure retrieval of relevant literature.

Inclusion criteria

Studies and documents were included in the review:

- Original articles, randomized controlled trials, cohort studies, or well-documented observational studies.
- Review articles, systematic reviews, and meta-analysis.
- Publications evaluating conventional and emerging pulp vitality assessment methods.
- Clinical practice guidelines and consensus documents published by recognized professional bodies.

Exclusion criteria

The following publications were excluded:

- Studies focusing exclusively on permanent teeth.
- Case reports with limited clinical application or insufficient methodological data.
- Studies missing with clear diagnostic criteria.
- Publications with fabricated data or overlapping patient populations.

Data extraction and analysis

Relevant data were extracted independently from articles, focusing on study objectives, diagnostic criteria, clinical and radiographic findings, and reported clinical outcomes. Attention was paid to how diagnostic outcomes were reached and how these influenced treatments such as pulpotomy, pulpectomy, or extraction.

Review Discussion

Dental pulp

Dental pulp as a living, soft tissue present is present in the coronal pulp chamber and root canals of dental region. Structurally, it is made of loose connective tissue, surrounded by the odontoblasts which are responsible for deposition in the dentine region [7]. Blood vessels and nerves enter the pulp through the apical foramen and rarely through lateral or accessory root canals. The major function of the pulp is to form the dentine which makes the basic structure of teeth and provides them with mechanical strength. Dentine deposition continues for months to years before tooth eruption and while the crown of a newly erupted tooth has a mature external form, the pulp within still evolves in completing the tooth development [8].

Diagnosis of pulp pathology

The repercussions of dental caries, dental trauma, structural dental abnormalities, and unwanted iatrogenic trauma make pulp therapy necessary in pediatric dentistry. Preventing or treating pulp inflammation and bacterial penetration into the pulp and periapical tissues is the objective. Endodontic (root canal) treatment or extraction of a permanent tooth with an immature root apex are required when protecting the pulp vitality [9].

In comparison to permanent teeth, the anatomical differences with primary tooth roots, as proximity to the permanent tooth germs, naturally occurring resorption, and the resulting shedding of these teeth, remain in the clinical and lead to modifications of therapeutic principles. Comparing the clinical, radiographic, and histological findings reveal the complexity of interpreting pulp vitality observations [10]. The symptoms are guided by hyperemia or inflammation of the pulp. Although pain is one of the most common reason why young patients seek emergency care, a proper clinical and radiographic examination is necessary to ensure an accurate diagnosis and treatment [11].

Diagnostic procedure

Comprehensive medical history is an essential component of pulpal diagnosis and treatment planning in pediatric dentistry, as systemic conditions may influence therapeutic decisions. Certain medical disorders modify the pulp therapy protocols. In children with bleeding disorders, such as hemophilia, preservation of the affected tooth is often preferred, as extraction may require extensive blood management and possible hospitalization [12]. Similarly, in patients with congenital or acquired cardiovascular abnormalities, the complex root canal anatomy of primary molars and the infection risk may limit the endodontic treatment. In such cases, extraction under appropriate antimicrobial prophylaxis is often considered the safer option [13]. Similarly, children with compromised immune function, including those undergoing treatment for hematological malignancies such as acute leukemia, exhibit reduced healing capacity. For these patients, extraction is generally preferred and should be performed in consultation with the child's attending physician [14].

Dental history, particularly the assessment of pain, presents a significant diagnostic challenge in young patients. Pain may originate from pulpal, periapical, or periodontal tissues, and its characteristics play a critical role in determining disease severity and urgency of care. Accurate pain assessment should include the nature of the stimulus, location, intensity, duration, frequency, and relieving or aggravating factors [15]. However, preschool-aged children often have limited ability to articulate symptoms, and parental reports may be inconsistent or underestimated. Importantly, the absence of pain does not exclude pulpal inflammation, as advanced pulpal necrosis or chronic infection may remain asymptomatic [16].

Clinically, it is crucial to differentiate between evoked and spontaneous pain. Evoked pain, triggered by thermal, chemical, osmotic, or mechanical stimuli, typically subsides upon removal of the stimulus and does not necessarily indicate irreversible pulpal damage. In contrast, spontaneous pain, occurring without provocation and often intensifying in the evening, is strongly associated with extensive pulpal inflammation, internal resorption, and irreversible pulpitis. Such cases frequently require pulpectomy or extraction based on clinical and radiographic findings [17].

Clinical parameters

Cavity size

A study on small cavities in primary molars revealed evidence of partial inflammation in the pulp horns. The radiographic depth of caries in these cavities reaches the inner dentin half. This was more common in class II cavity than in class I cavity cases. However, clinical and radiographic-based restorations can reverse such inflammation [18].

Edema

Edema is a significant clinical indicator of advanced pulpal pathology and is commonly associated with pulpal necrosis

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and the spread of infection outside the pulp chamber. Intraoral edema results from the infiltration of inflammatory biomolecules into the surrounding intraosseous and soft tissues. In anterior primary teeth, pulpal infection typically spreads through the root apex, whereas in primary molars, the presence of accessory canals and furcation pathways causes dissemination of inflammatory molecules through the interradicular region. The diffusion of infection frequently occurs toward the buccal or labial cortical plates, with lingual or palatal extension being rare [19].

Despite the presence of edema, vital pulp tissue may persist in one or more root canals, mainly in multirooted primary teeth. Therefore, local anesthesia is essential before initiating endodontic intervention. In the absence of timely treatment, increasing tissue pressure leads to spontaneous drainage of purulent material, often through the formation of a sinus tract adjacent to the attached gingiva [20].

Extraoral edema represents a more severe infection like facial or cervical cellulitis, accompanied by regional lymphadenitis. In the mandible, such swelling is associated with septic necrosis of the first or second primary molars, while in the maxilla, infection from the first primary molar may extend toward the infraorbital region. Cutaneous drainage of pus in permanent teeth is rare in primary dentition due to anatomical and developmental factors [21].

Percussion

Pain caused on percussion indicates inflammation of the periodontal supporting tissues and may be associated with widening of the periradicular space on radiographic examination. Such teeth are often tender on occlusion. In pediatric patients, percussion should be performed gently, as excessive force may increase anxiety [22].

Root canal obliteration

When tertiary dentin is produced, pulp tissue is majorly reduced, indicating a pulp reaction leading to trauma or long-term carious lesions. After injury, anterior primary teeth undergo pulp removal, and after pulpotomy, posterior primary teeth undergo root canals. Monitoring teeth becomes important, but it does not indicate treatment being ineffective [23].

Internal root resorption

When internal resorption affects the mesial and/or distal root canals, it can be viewed radiographically but in the early stages, it affects the lingual or buccal sides. Therefore, pre-existing resorption foci cannot be excluded when treating a symptomatic pulp. After pulpotomy or pulp capping, internal resorption is a sign of therapeutic failure. Extraction is still the safest course of action, notwithstanding reports of successful root canal treatments [24].

External root resorption

Pathological resorption can be examined with radiographic images of primary molar roots. As primary molars have short distal buccal roots than distal buccal ones the location of succeeding premolars influences the resorption of mandibular primary molar roots. External root resorption may occur in association with pathologic bone resorption at the primary molar bifurcation/trifurcation point. Therefore, extracting the primary tooth is the right course of action [25].

Bone radiolucency

Unlike permanent molars, which develop periapical lesions, radiolucency caused by pulp infection always appears at the bifurcation location. The bifurcation dentin of primary molars possesses several accessory root canals, which are linked to this. The thickening of the periodontal gap and lamina resorption are the first steps in radiolucency. Pulpectomy has a high success rate when the radiolucency is low, however in cases of severe bone resorption, empirical studies suggest extraction [26].

Depth of carious lesion

If buccal or lingual cavities are not involved, radiography can be used to detect proximity to the pulp. If the lesion is close to the pulp, then all the infected dentins may be removed, exposing the pulp. In addition to providing alternatives for pulpotomy or pulp capping, the pain history helps in evaluating the pulp condition [27].

Factors and Considerations in Treatment Planning

Treatment planning for pulp therapy in deciduous teeth extends beyond diagnosis of pulpal status and occlusal considerations. A comprehensive evaluation must add to the child's general health, cooperative ability, behavioral profile, and the potential treatment impact on the developing permanent dentition. An essential question in every case is whether the tooth can be managed conservatively under local anesthesia or whether sedation, general anesthesia, or extraction represents a more predictable and safer option [28]. Preservation of primary teeth is particularly valuable for second primary molars, especially when pulp exposure occurs before or during eruption of the permanent first molar. However, when pulpal necrosis or apical or interradicular periodontitis poses a risk to the permanent teeth, extraction is often the preferred treatment [29].

Medical considerations

Medical history is mandatory to initiate pulp therapy. Successful endodontic treatment depends on the patient's capacity for normal wound healing and immune response. Children with significant immunosuppression, such as those undergoing oncological treatment or with uncontrolled systemic diseases, are inappropriate candidates for pulp therapy [30].

Certain systemic conditions represent contraindications to conservative pulp treatment. Children with congenital cardiac abnormalities who are at risk for infective endocarditis should be free from oral infection. Therefore, primary teeth expressing signs of infection are extracted under appropriate antimicrobial prophylaxis [31]. Similarly, children with compromised healing potential, such as those with uncontrolled diabetes, may not respond favorably to endodontic procedures. But well-controlled diabetic patients and those receiving long-term corticosteroid therapy for asthma generally do not require modification of pulp treatment decisions [32].

Indications and special clinical situations

Bleeding disorders, including hemophilia, should not automatically contraindicate pulp therapy. With current management protocols involving regular clotting factor replacement, treatment decisions should be based on dental criteria rather than the bleeding disorder. In cases of oligodontia or ectodermal dysplasia, treatment decisions must align with the overall orthodontic plan. Some situations require early extraction of primary teeth to facilitate space closure, while others require long-term retention of primary

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teeth in the absence of permanent successors. In asymptomatic cases, interdisciplinary consultation is recommended before definitive treatment [33].

Behavioral factors

Children who cannot tolerate diagnostic procedures such as radiographic examination are difficult to manage complex endodontic and restorative treatments. When cooperation is limited or unstable, the use of general anesthesia may be considered. In selected cases, extraction may be preferable to prolonged endodontic procedures that could negatively affect the child's dental experience. Effective pain control is essential during pulp therapy. Despite adequate local anesthesia, breakthrough pain may occur, particularly during pulp chamber entry. Inhalation sedation, when used alongside local anesthesia, can enhance patient comfort and cooperation. Strict isolation using a rubber dam is mandatory to ensure patient safety and prevent contamination [34].

Dental and occlusal factors

Endodontic decisions should be made within the occlusal development and space maintenance. Premature loss of primary teeth may result in space loss, delayed eruption, or ectopic eruption of permanent successors. Elective extraction may be considered within three years of expected exfoliation, as accelerated eruption follows. Long-term success of pulp therapy depends on achieving an effective coronal seal. Teeth that are structurally unrestorable should be extracted. Because pulpotomy and pulpectomy weaken tooth structure, full-coverage restorations, such as preformed metal or composite crowns, are generally recommended [35].

Diagnosis during intervention

In many cases, definitive diagnosis can only be established after direct pulp exposure. The size of the exposure and the nature of hemorrhage provide valuable diagnostic information. Rapid hemostasis recommends limited inflammation and supports pulpotomy, whereas persistent bleeding indicates inflammation extending into the root canals, favoring pulpectomy. Continuous hemorrhage over several minutes reflects hyperemic pulp tissue. The use of vasoconstrictors within the pulp chamber should be avoided, as it interferes with accurate assessment of pulpal inflammation [36].

Limitations and Future Scope

Limitations

As a narrative review, it does not follow a systematic review or meta-analytical framework, which may limit reproducibility and introduce a degree of selection bias in the inclusion of literature. Although research studies, clinical trials, and guideline documents were carefully evaluated, the absence of quantitative selection criteria limits the ability to assess the relative strength across studies [37].

The diagnosis of pulpal status in primary teeth is challenging due to the limited availability of histological validation of clinical and radiographic findings. Ethical constraints prevent routine histopathological examination, resulting in reliance on indirect diagnostic indicators that may not consistently present pulpal vitality. Variability in study designs, diagnostic thresholds, and outcome measures further complicates the comparison of reported findings [38].

Also, the available clinical studies are retrospective or have short follow-up periods , limiting insight into the long-term outcomes of pulp therapy in deciduous teeth. Differences in treatment protocols, and restorative approaches also contribute to heterogeneity in reported success rates. Additionally, behavioral factors unique to pediatric patients, including limited cooperation and subjective pain reporting, restrict the reliability of symptom-based diagnostic criteria [39].

Future scopes

Future research should prioritize the development of objective, non-invasive diagnostic tools capable of accurately assessing true pulpal vitality in primary teeth. Techniques that evaluate pulpal blood flow, tissue oxygenation, or biochemical markers of inflammation hold promise for improving diagnostic precision and reducing reliance on subjective clinical tests. Standardization of diagnostic protocols across clinical research is essential to enhance comparability and clinical applicability [40].

Long-term prospective studies with standardized outcome measures are required to establish evidence-based guidelines for pulp therapy in deciduous dentition. Such studies should correlate clinical and radiographic findings with treatment outcomes to refine diagnostic. Additionally, further investigation in primary pulp tissue study to different therapeutic involvements may support the development of minimally invasive treatment strategies [41].

Conclusion

This review prioritizes the role of accurate diagnosis and evidence-based treatment planning in the management of pulpal diseases in deciduous teeth. The anatomical and physiological characteristics of primary teeth, combined with behavioral challenges in pediatric patients, make assessment of pulpal status difficult. Clinical indicators such as pain characteristics, percussion sensitivity, edema, and cavity extent, along with furcation radiolucency, root resorption, and proximity of carious lesions to the pulp, provide essential diagnostic guidance. An interpretation of clinical and radiographic findings therefore remains essential to differentiate reversible from irreversible pulpal pathology. Conventional pulp vitality tests demonstrate limited reliability in children, as they primarily assess neural response and are influenced by anxiety and cooperation, highlighting the need for careful interpretation. Preservation of primary teeth is required to maintain functionality, occlusal stability, and normal eruption of the permanent teeth, provided there is no risk to the developing permanent tooth germ. Future advancements in pediatric endodontics should focus on the development of objective, non-invasive diagnostic tools capable of assessing true pulpal vitality, along with standardized diagnostic criteria and long-term prospective clinical studies. Such advancements will improve diagnostic accuracy, refine treatment protocols, and enhance the long-term success of pulp therapy in primary teeth.

Disclosure Statement

The author does not have conflict of interest in this research.

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