NEU PRESS

Diş Hekimliği Dergisi

Vol: 6 No: 2 Year: 2024 Review e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.107

When Should Direct Pulp Capping or Pulpotomy Be Preferred In Deciduous Teeth?

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Article Info

Article History

Received: 08.02.2024
Accepted: 30.07.2024
Published: 30.08.2024

Keywords:
Vital pulp therapy,
Direct pulp capping,
Pulpotomy.

ABSTRACT

Dental caries is a serious health problem with too high prevalence among children. It can affect the pulp and lead to infection, fistulas, abscesses, and premature tooth loss. The main purpose of pulp treatment in the primary teeth is to maintain health of teeth and oral tissues, thus, preserving functions of orofacial complex, such as chewing, speaking, and to keep primary teeth in position to maintain the arch size until the permanent teeth erupt. Contemporary pediatric dentistry seeks new materials and strategies to stimulate the regenerative ability of dental tissues. Dentists must be aware of the most suitable treatment choices to keep pulp tissue vitality. Vital pulp therapies (VPT) consist of indirect pulp capping, direct pulp capping, and pulpotomy for the treatment of deep carious lesions in teeth without a history of pain or with reversible pulpitis. VPT is used to treat reversible pulpal inflammation and maintain vitality and functionality of the pulp. Due to its high internal resorption and failure rate, direct pulp capping is still a controversial treatment choice for deep carious lesions. In this review, studies on direct pulp capping and pulpotomy treatments of VPT in primary teeth are presented together.

Direkt Pulpa Kuafajı Mı Yoksa Pulpotomi Mi: Süt Dişlerindeki Derin Çürük Lezyonlarının Tedavisinde Hangisi Daha İyidir?

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 08.02.2024
Kabul Tarihi: 30.07.2024
Yayın Tarihi: 30.08.2024

Anahtar Kelimeler:
Vital Pulpa Tedavileri,
Direkt Pulpa Kuafajı,
Pulpotomi.

ÖZET

Diş çürüğü, pulpa canlılığını etkileyebilen ve sonuçta enfeksiyona, apselere, fistüllere ve bununla birlikte erken diş kayıplarına yol açabilen, çocuklar arasında çok yüksek bir yaygınlık sergileyen, önemli bir sağlık sorunudur. Süt dişlenme döneminde pulpa tedavisinin temel amacı, oro-fasiyal kompleksin çiğneme, konuşma, estetik gibi fonksiyonlarını sürdürmek için dişlerin ve onları destekleyen dokuların sağlığını sürdürmek ve süt dişlerini daimi dişler sürene kadar ark boyutunun korunması için mevcut konumlarında tutmaktır. Modern pediatrik diş hekimliği, diş dokularının rejeneratif kapasitesini uyarmak için yeni stratejiler ve materyaller arar. Diş hekimleri pulpa dokusunun canlılığını korumak için en uygun tedavi seçeneklerini bilmelidir. Vital pulpa tedavileri (VPT), ağrı öyküsü olmayan veya reversibl pulpitisli dişlerdeki derin çürük lezyonlarının tedavisine yönelik indirekt pulpa kuafajı, direkt pulpa kuafajı ve pulpotomiden oluşur. VPT'nin amacı, geri dönüşümlü pulpal inflamasyonu tedavi etmek, pulpa canlılığını ve fonksiyonlarını korumaktır. Süt dişlerinde derin çürük lezyonlarının tedavisinde direkt pulpa kuafajı yüksek internal rezorbsiyon ve başarısızlık oranı nedeniyle hala tartışmalı bir tedavi seçeneğidir. Bu derlemede, süt dişlerinde vital pulpa tedavilerinden direkt pulpa kuafajı ve pulpotomi tedavileri ile ilgili araştırmalar bir arada sunulmuştur.

To cite this article: Belevcikli M., Çakır E. When Should Direct Pulp Capping or Pulpotomy Be Preferred In Deciduous Teeth? NEU Dent J, 2024;6:232-40. https://doi.org/10.51122/neudentj.2024.107

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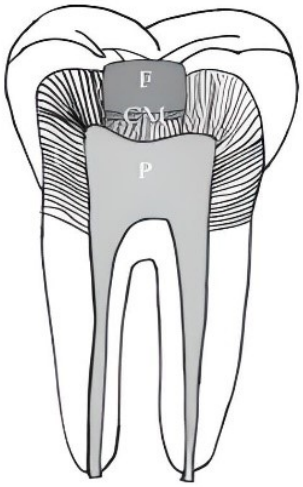
INTRODUCTION

The prevelance of dental caries is high in children, which can have an impact on pulp vitality and lead to infection, fistulas, abscesses, and premature tooth loss.[1] Due to the lack of access to dental treatment, lack of oral hygiene education, and the absence of symptoms of the tooth, treatment is usually performed when the dental caries reaches a profound and cavitated stage that involves the pulp, depending on the degree of progression.[2] Health of teeth and oral tissues in the primary teeth is maintained by pulp treatment to preserve orofacial complex functions, including speaking, chewing, and maintaining primary teeth in their current position and arch size until the permanent teeth erupt.[3]

The evaluation of primary teeth's pulp therapy is relies on clinical and/or radiographic evidence.[4] The absence of any signs or symptoms, such as abscess, swelling, pain, sensitivity to percussion, fistula, and excessive mobility of the tooth, determines clinical success. Periapical and/or radicular radiolucency, absence of phatological root resorption and cystic growth, primary tooth exfoliation and normal physiological resorption, healthy supporting tissues, normal development and eruption of permanent tooth are the basis for measuring radiographic success.[5] The criteria mentioned are not a reliable indicator of treatment success. Histological evidence is the most trustworthy indicator of a pulp treatment's failure or success. Clinical judgment is based on preset standards, but histological investigation remains the ultimate gold standard for determining pulp state.[6] Modern pediatric dentistry seeks novel materials and strategies that can stimulate the regenerative capacity of dental tissues, and dentists must be aware of the most suitable treatment options to maintain pulp vitality.[7]

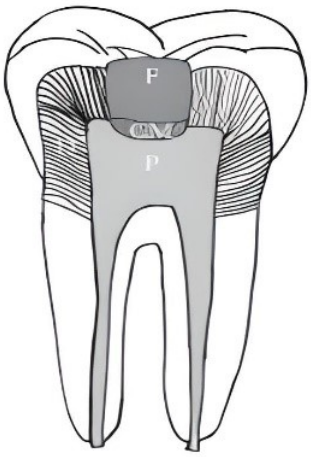
Vital pulp therapies (VPT) include direct pulp capping, indirect pulp capping, and pulpotom for treating deep carious lesions without reversible pulpitis or a history of pain (Figures 1,2 and 3).[8] Reversible pulpitis describes mild to moderate inflammation of the pulp caused by noxious stimuli, in which the pulp can return to a non-inflamed state after removal of the stimuli.[10] The discomfort experienced when a cold or sweet stimulus is applied disappears a few seconds after the stimulus is removed.[10] The purpose of VPT is maintain pulp vitality and function and to treat reversible pulpal inflammation.[11]

Figure 1: Schematic representation of indirect pulp capping in primary teeth



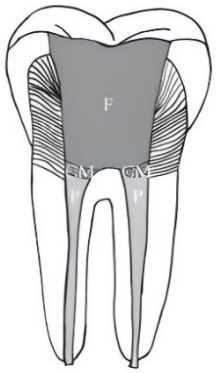
(D = Dentin; P = Pulp; CM = Covering material; F = Filling).

Figure 2: Schematic representation of direct pulp capping in primary teeth



(D = Dentin; P = Pulp; CM = Covering material; F = Filling).

Figure 3: Schematic representation of pulpotomy in primary teeth



(D = Dentin; P = Pulp; CM = Covering material; F = Filling).

Vital pulp therapies

VPT aims to preserve and maintain damaged pulp in cases where the pulp hasn't become necrotic and/or degenerated due to caries, trauma, or restorative processes. [12] The treatment methods used in VPT are determined by the exposure of dental pulp. VPT's success is related to appropriate vascularization, which is essential for the vitality of the pulp and, particularly, the active formation and function of odontoblasts.[13]

Indirect pulp capping

Indirect pulp capping (IDPC) is done on a tooth with deep carious lesion approaching the pulp, but there are no symptoms or signs of pulpal degeneration.[14] In the case of pulpal degeneration, the pain usually persists after the cause is eliminated, but can be increased by heat, and sometimes cold is good. However, continued cold can aggravate the pain. The pain is usually defined as sharp piercing or shooting, and is often severe.[10]

Indirect pulp treatment is preferred if the cavity is large and the pulp is not exposed.[15] To prevent pulp exposure, this method involves removing large caries and leaving enough caries on the pulp horn to prevent exposure. The cavity is typically sealed with a biocompatible material, and the liner is placed on the remaining decayed dentin to enable the pulp to repair itself.[15] The liner materials consist of resin-modified glass ionomer cement (RMGIC), glass ionomer cement (GIC), calcium hydroxide ($Ca(OH)_2$), and adhesive resin.[2]

Direct pulp capping

Direct pulp capping (DPC) is applied to teeth where the healthy pulp is mechanically or accidentally exposed during cavity preparation or trauma. The tooth should be free of oral contaminants and asymptomatic, with an exposure area of a pinpoint size.[14]

DPC is a conservative treatment option for reversible pulpitis. Direct pulp capping is to keeps pulp vitality by incentivizing young, healthy pulp to form a repairable dentin-like bridge in pulp exposure area.[16]

A biocompatible restorative material is immediately sealed on exposed pulp during direct pulp treatment to prevent further damage and stimulate pulp cells' regeneration potential. Direct pulp treatment is a method that is both minimally invasive, economical, and relatively straightforward.[16] Calcium hydroxide, mineral trioxide aggregate (MTA), bioactive glass, calcium enriched mixture (CEM), enamel matrix derivative (EMD), and simvastatin are used for DPC in primary teeth.[17]

Pulpotomy

Pulpotomy is a clinical procedure that is widely accepted for treating decayed pulp in primary teeth that are not symptomatic. The treatment is determined by the healing capacity of radicular pulp tissue after removing affected or infected coronal pulp.[14]

Various techniques and materials are used in primary tooth amputation treatment applications. Formocresol, glutaraldehyde, MTA, ferric sulfate, calcium hydroxide, amputation applications with electrosurgery, laser-assisted amputation applications, and applications with biological materials (bone morphogenic protein and enriched collagen solutions) are among the options.[18]

DPC of primary teeth is a controversial treatment method and has a low success rate for primary teeth.[14] The high failure rate of DPC is due to undifferentiated mesenchymal cells that can differentiate into odontoclasts, which can lead to internal resorption.[14] Biological distinction between primary and permanent teeth is a higher amount of undifferentiated mesenchymal stem cells in primary teeth.[19] Internal resorption and unsuccess of direct pulp treatment can be caused by the differentiation of these cells into odontoclasts.[16] Understanding mechanisms that prevent, control, and regulate internal resorption can help preserve the primary tooth until the time of exfoliation.[7]

According to studies by the American Academy of Pediatric Dentistry (AAPD),[2] Agamy et al.,[20] Maroto et al.,[21] and Tuna et al.,[19] direct pulp therapy is advised for primary teeth when biological conditions are optimal and when minimal pulp exposure (1 mm or less) occurs. However, it isn't advised in situations when pulp exposure happens after the removal of caries from primary teeth since in these situations, nearly all of the exposed pulps are already damaged by caries.[2]

Due to the restricted use of DPC, the AAPD clearly stated that carious pulp exposure in primary teeth isn't advised.[22] Sujlana et al.[23] noted that this treatment "was literally removed from the repertoire of therapeutic procedures for primary teeth". However, compared to immature or mature permanent teeth, use of DPC in primary teeth is more constrained, and research has shown that it is less effective than pulpotomy.[24-26] In a meta-analysis and systematic review by Coll et al.[27] of VPT, they concluded that after 24 months, pulpotomy with IDPC and different materials for treatment of deep carious in primary teeth is supported by quality of literature evidence and highest level of success. Success rates for DPC and IDPC at 24 months were 88.8% and 94.4%, respectively, whereas the success rate for all pulpotomies in a total of 1,022 primary teeth was 82.6%. Although pulpotomy and IDPC have higher success rates than DPC, these conclusions are based on less reliable literature information.

Failure to recommend DPC for primary teeth was associated with a reported risk of internal root resorption, unsatisfactory success rates, and poor prognosis in literature, possibly due to high cellular content of primary tooth pulp (mainly mesenchymal cells) that tends to differentiate into odontoclasts versus irritants.[16] However, various studies reported that pulp inflammation, calcification, acute abscesses, and periapical bone loss, can occur following the treatment.[23,25,28]

According to specific research, primary teeth DPC with pulp exposure and intact dentin produces excellent results since primary tooth pulp cells have a well-known capacity for healing, negating the necessity for more extreme or invasive procedures (such as pulpotomy).[27,29,30]

Dimitraki et al.[31] reported that DPC showed good radiographic and clinical success rates (75%) in their study in which they compared DPC with pulpotomy. They stated that compared to pulpotomy, DPC showed lower clinical success (pulpotomy 87.5% vs DPC 75%), but a higher radiographic success rate (pulpotomy 68.8% vs DPC 75%), due to the not high quality of evidence. It was stated that DPC is not inferior to pulpotomy in radiographic and clinical success rates (provided that the pulp condition is diagnosed carefully). DPC is a more time-saving treatment and conservative pulpotomy, which might be more comfortable for children.[32]

However, some studies that only recommend DPC when physiological exfoliation of the affected tooth is expected within 1 or 2 years.[33] According to these studies, treatment should be undertaken after careful clinical and radiographic investigations to confirm that pulpitis is reversible, using strict and specific diagnostic criteria and proven capping materials.[26]

Various materials were proposed for DPC in primary teeth treatment.[17] In their

comprehensive review and meta-analysis of the various agents employed in DPC, Schwendicke et al.[34] concluded that there is indequate evidence to accept or reject any particular substance for primary teeth's DPC.

Chronic pulp inflammation and internal resorption were reported as common results when $Ca(OH)_2$ was used as a DPC agent.[35] It was reported that the success rates of $Ca(OH)_2$ in pulp treatment of primary teeth vary considerably, from 53% when $Ca(OH)_2$ powder is used compared with 100% of fast-setting calcium hydroxide (Dycal). Furthermore, in treatments with Dycal, the success rate of DPC was reported to be 70–100% with follow-up periods of up to 24 months.[32] Conversely, it was stated that $Ca(OH)_2$ has several disadvantages as a DPC agent.[32] Therefore, the long-term efficacy of $Ca(OH)_2$ was questioned by factors, such as its tendency to cause internal root resorption, its failure to bond to dentin, its slow stimulation of dentin bridge formation, and the fact that the morphological structure of the dentin bridge is highly permeable due to the tunnel defect.[36] Primary tooth pulp/dentin complex can be repaired and regenerated, albeit with no systemic side effects and low toxicity, because to of new and improved bioactive and biocompatible DPC agents.[37,38] These materials are currently preferred in place of the conventional DPC agent, such as Ca(OH)2, which is regarded as the industry standard for pulp treatment.[19,23]

According to findings from studies included in systematic review by Garrocho-Rangel et al.,[39] many of the recently introduced and evaluated regenerative materials showed promising potential for DPC treatment of primary teeth. Clinically and histologically tested in this study, MTA showed high success rates ranging from 90–100%.[39] The success rates of these agents, which have a bright future in DPC treatment of primary teeth, are influenced by the substance's inherent qualities (such as an antibacterial effect, the preservation of pulp tissue integrity, or minimal cytotoxicity), as well as by its biocompatibility with the pulp of primary teeth.[36] These findings imply that MTA might be a suggested primary teeth DPC material due to its potential for stimulation and sufficient sealing ability for pulp and bone/peridontal tissues healing.[36,40] MTA is expensive, difficult to manipulate, takes a long time to cure, and discolors teeth, among other drawbacks.[41]

Twenty-one healthy children aged 5–8 years with asymptomatic vital pulp exposure and at least two decayed second primary molars, at least two-thirds of root length, were included in study conducted by Ghajari et al.[30] CEM and MTA were used for DPC and patients were followed for 20 months. As a result of this randomized controlled trial, it was shown that CEM group's two cases and MTA group's only one case failed. Therefore, the success of MTA and CEM was 95% and 81%, respectively. Ghajari et al. also reported that the cases did not fail due to internal resorption. They explained this by assuming that, under the pulp conditions, inflammatory mediators could cause mesenchymal cells to differentiate into the odontoclasts responsible for resorbing dentin, changing the environment from one of inflammation to one of reparation, and that CEM and MTA could circumvent this issue.

Among other relevant materials, CEM is regarded as a superior substitute Ca(OH)2 and MTA because of its various benefits, including its calcium enriched mixture, hydroxyapatite/ hard tissue biostimulation, antibacterial effect, impermeability, and fast setting time, with a reported success rate of 85–100%.[42] Comparing MTA and CEM, it was shown that during the 9-month follow-up, both substances displayed comparable high clinical and radiographic efficacy.[30]

It is debatable whether bonding systems should be used as a pulp coating material to primary teeth.[43] Some authors agree with the use

of these materials as a biocompatible procedure based on the formation of a hybrid layer on pulp that allows hermetic sealing and adhesion between the dentin-pulp complex and the resin.[35] However, they do not advise its usage as a DPC agents because to of the toxic nature of adhesive resin's constituents (mostly monomers), their tendency to shrinkage, the absence of dentin bridge formation, bleeding, and an inflammatory reaction that seriously jeopardizes pulp healing.[44,45] In studies evaluating the success rates of different DPC agents, clinically varied between 62% and 100%, and radiographically ranged between 53% and 100%, regardless of the agent used. According to the data, MTA had the greatest value for both radiographic and clinical success at 100% for both.[19,26,43] It has been reported that teeth with/without reversible pulpitis pain show comparable success after 12 months of treatment with IDPC or calcium silicate pulpotomy, and factors such as coronal pulp removal methods; irrigation solution; method of controlling bleeding; base on MTA; treatment in one or two sessions; anterior or posterior teeth have little or no effect on the success of MTA pulpotomy.[46] A recent meta-analysis reported that the success of indirect pulp therapy or pulpotomy with calcium silicate cement was better than that of direct pulp closure and other pulpotomies with moderate certainty based on 24 months of evidence.[47] The 2024 clinical practice guideline Recommendations for the use of vital pulp therapies in deciduous teeth: clinical practice guidelines for VPT in deciduous teeth with deep caries states that pulpotomy using indirect pulp therapy or calcium silicate cement (mineral trioxide aggregate [MTA] or Biodentine®) is more successful than DPC and other pulpotomies.[46] The different materials do not affect the success of IDPC (high certainty) or DPC (very low certainty) at the end of 24 months. Calcium silicate cement pulpotomy is strongly recommended over formocresol, ferric sulphate, zinc oxide eugenol pulpotomy and other pulpotomies with high certainty based on 24-month data. It has been reported that pulpotomy is statistically significantly better than pulpectomy for vital primary incisors with deep caries.[46] The type of final restoration used on the treated primary tooth may have an impact on DPC success rates also the careful identification of pulp state. Due to the outstanding complete coverage protection and hermetic features of the crown, it has been demonstrated that immediate cover of stainless steel crown considerably improves the success of decaying primary teeth's pulp treatment.[28,48] The success of primary teeth DPC is strongly correlated with the absence of microbial contamination from the microleakage restoration margin and the maintenance of healthy pulp in the exposure area.[49]

CONCLUSION

DPC remains a controversial treatment option for primary teeth' deep carious lesions because of its high internal resorption and failure rate. DPC can be applied as an alternative to pulpotomy if the tooth will exfoliate physiologically within 1–2 years, since the conversion potential of undifferentiated mesenchymal cells to odontoclasts in pulp of aged primary teeth is lower than that of pulp of young primary teeth. It is known that with the right case selection for DPC in deciduous teeth, vital deciduous tooth pulp has the biological capacity to heal. DPC can be applied when biological conditions are optimal, pulp exposure is minimal, and there is no contamination with caries. There is no evidence of any superior material for DPC to maintain pulp health in primary teeth. However, $Ca(OH)_2$ and adhesive systems appear to be more likely to fail. Therefore, another more reliable and biocompatible agents such as MTA, CEM, emdogain, calcium sulfate, and simvastatin might be better options. The treatment option for deep decayed primary

teeth, should be determined by considering all of these conditions.

Ethical Approval

Ethics committee approval was not required in this study.

Financial Support

The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: MB, EÇ. Data collection and processing: MB, EÇ. Analiysis and interpretation: MB, EÇ. Literature Review: EÇ. Writing: MB, EÇ.

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