© Borgis Nowa Stomatol 2018; 23(1): 38-41 DOI: https://doi.org/10.25121/NS.2018.23.1.38

Malwina Kolasa[1], *Joanna Szczepańska[2]

Direct pulp capping in permanent teeth in children – types of pulp exposure, therapeutic indications. Part I

[1]Doctoral studies, Department of Developmental Age Dentistry, Medical University of Łódź
Head of Department: Professor Joanna Szczepańska, MD, PhD
[2]Department of Developmental Age Dentistry, Medical University of Łódź
Head of Department: Professor Joanna Szczepańska, MD, PhD

Keywords

direct capping, biological treatment, immature permanent teeth, calcium hydroxide, dentin bridge

Summary

Direct pulp capping, as a method allowing the preservation of viable and healthy pulp, is a key element in the treatment of immature permanent teeth. Maintaining pulp vitality is a condition for continuous root development, which is important for long-term maintenance of the tooth in the oral cavity. Therefore, the maintenance of vital pulp should be one of the main goals in the treatment of young permanent teeth and biological treatment is particularly recommended in such cases. Since young pulp has a great regenerative potential, the success rates of direct pulp capping are high. Therapeutic indications for this method include traumatic and mechanical exposure of either healthy or reversibly inflamed pulp. Accurate assessment of the clinical condition of the tooth is crucial for the choice of the most appropriate treatment option. Another crucial issue is proper understanding of the mechanisms that occur in the pulp as a result of treatment. Choice of a therapeutic agent, such as commonly used non-setting calcium hydroxide or MTA is also essential. However, other, less popular preparations should be also considered.

Introduction

Preservation of vital pulp is one of the most important goals of dental treatment. Certain clinical situations, such as accidental pulp exposure or damage during dental cavity preparation and traumatic pulp exposure (Ellis class III fracture), pose a real threat for the maintenance of a crucial pulp parameter, i.e. viability. This is particularly important for immature permanent teeth as healthy pulp is necessary for the continuation of proper root development. Therefore, the maintenance of vital pulp should be one of the main goals in the treatment of young permanent teeth. Direct pulp capping, which yields good results in up to 90% of cases, is one of the methods for the biological treatment of permanent teeth (1). In addition to aseptic conditions and properly performed procedure, the ability to identify indications that justify the use of this technique as well as the choice of a therapeutic agent that is most likely to ensure therapeutic success are conditions for the clinical success of this method. Materials such as non-setting calcium hydroxide or MTA (1, 2) are commonly used for this purpose; however, other, less popular preparations should be also considered. Proper understanding of the mechanisms that occur in the pulp as a result of treatment is also crucial.

The aim of the paper is to present, based on a literature review, the types of pulp exposure and therapeutic indications for direct pulp capping in permanent teeth, with particular emphasis on the developmental age.

The goals of biological pulp treatment

The aim of biological treatment is to maintain healthy, vital pulp in a situation of a probable loss of pulp vitality due to external factors. The maintenance of healthy pulp is of key importance for immature teeth due to its role in the continuous apexogenesis, i.e. physiological root development (3). Immature tooth roots are characterised by thin walls, wide apexes and incomplete length (4). After eruption, it takes three to four years for the root crowns to fully develop (5). Pathological changes that occur in the pulp before apexogenesis completion inhibit the process of root formation, which significantly weakens the tooth and worsens its prognosis. Therefore, biological treatment is particularly recommended in immature permanent teeth.

Vital and healthy pulp is a barrier that prevents microorganisms from invading the body, thus not only protecting the periapical tissues from infection, but also preventing the development of odontogenic infections in distant organs (6). Furthermore, a tooth not subjected to endodontic treatment is more likely to remain in the oral cavity compared to a tooth devoid of vital pulp, which is more fragile and susceptible to mechanical damage. It was demonstrated that the periodontin of an endodontically treated tooth shows weaker stimuli reception compared to a viable tooth; therefore, such a tooth is more exposed to higher chewing forces (7). The economic factors are also important – biological methods are relatively easy and inexpensive as opposed to endodontic treatment, after which prosthetic crown restoration is often needed (8).

Types of pulp exposure depending on the aetiological factor

The main causes of vital pulp exposure include caries, mechanical factors and injuries (9). If dental exposure forms during carious cavity preparation before complete carious tissue removal, it is qualified as carious pulp exposure. According to the definition proposed by the American Association of Endodontists, mechanical pulp exposure is an "accidental exposure of the pulp by hand- or engine-driven dental instruments in the absence of dental caries. If aseptic conditions are maintained, the underlying pulp usually does not become inflamed or infected" (10). Traumatic pulp exposure is due to tooth fracture as a result of mechanical injuries. These are particularly common among young people, and thus usually affect permanent teeth with incomplete root development. If pulp viability is maintained, this type of injury is classified as Ellis class III fracture. In the case of pulp necrosis as a result of trauma, i.e. Ellis class IV fracture, apexification is the treatment of choice for teeth with incomplete formation of the root apex.

Methods for the biological treatment of pulp

Biological treatment options include indirect or direct pulp capping and crown pulp amputation. The first treatment modality is used in a situation when no pulp exposure occurred, while the two latter methods are used to maintain exposed pulp vitality. According to the definition proposed by the American Association of Endodontists, indirect pulp capping involves placing dental material on a small amount of demineralised dentin, which when removed could expose pulp. Coronal pulp amputation, i.e. pulpotomy, is a surgical removal of the coronal portion of vital pulp to maintain the viability of the remaining root. Cvek's partial pulpotomy, which involves only partial removal of the coronal pulp, is the variant of pulpotomy (10).

Direct pulp capping involves placing dental material directly over either mechanically or traumatically exposed pulp tissue (10). Although it is clearly stated by the American Association of Endodontists that this treatment option should be used only in mechanical or traumatic pulp exposure, some authors use this method also in carious pulp exposure (11-13).

The clinical condition of pulp and the symptoms reported by the patient should be primarily considered before deciding on direct pulp capping as treatment success depends on these factors. The treatment should be followed by regular follow-up visits to monitor the progress of treatment and detect symptoms indicating possible treatment failure. According to the European Association of Endodontists, the following features are indicative of positive treatment outcomes: normal response to stimuli (if the test can be performed), absence of pain or other symptoms, radiographically confirmed dentin bridge and continuous development of the root apex, absence of clinical and radiological signs of internal resorption or inflammation of the periapical tissues (14). According to the same guidelines, a follow-up visit should take place not later than 6 months after treatment, and then at regular intervals.

Therapeutic indications for direct pulp capping

Direct capping may be used only for healthy or reversibly inflamed pulp. Since the inflammatory response of the pulp occurs already when the carious process involves the superficial dentin layer, direct capping of fully healthy pulp is very rare and a clear verification indicating that the pulp is completely healthy is clinically impossible. Traumatic pulp exposure, when dental pulp is virtually free of inflammation, which allows for high success rates after direct pulp capping in mechanical injuries, is an exception (15).

Pulp viability is the most important parameter to indicate successful direct pulp capping. Dental response to a stimulus should be appropriate and it should retreat immediately after stimulus elimination. Furthermore, the tooth should not be painful either at present or in the past.

Direct capping of carious pulp exposure formed as a result of e.g. cavity preparation prior to total removal of carious dentin yields significantly lower success rates compared to the same method used in non-carious pulp exposure (16). According to guidelines, direct pulp capping is a treatment of choice in mechanical or traumatic pulp exposure with maintained pulp viability and the absence of carious dentin in the affected tooth. It is recommended in the guidelines of the European Association of Endodontists to use capping only in injured pulp without the presence of infected dentin, protecting the tooth against infection using dental dam (14). However, some of researchers use direct capping also in carious pulp exposure (11-13). Barthel et al. (11) investigated a 5- and 10-year perspective of success rates for

direct pulp capping after carious exposure. The rates were 37 and 13%, respectively, which was low compared to studies evaluating non-carious pulp exposure. As shown in a systematic review performed by Aguilar and Linsuwanont (17) based on 1950-2010 literature, the failure rate at 3 years after direct capping of carious pulp exposure was 72.9%. Such a large discrepancy between different studies may result from the fact that it is not possible to precisely determine the state of cariously exposed pulp. Pulpotomy or partial pulpotomy, which, after 3 years, produced success rates of 99.3 and 99.4%, respectively, seem to be better treatment options for this type of clinical cases (17). Large differences in the results and opinions of various authors suggest that the problem of direct capping of carious pulp exposure requires further research.

Kakehashi et al. (18) conducted an experiment, which demonstrated that pulp non-infected with microorganisms is able to close the exposure with hard tissue without the need to cover it with medicinal agents and that the presence or absence of microorganisms is the main determinant of pulp healing capabilities. This suggests that the choice of therapeutic agent is a less important key element for pulp repair as opposed to the maintenance of full pulp sterility. For this to be possible, it is important to perform capping only in traumatic or mechanical pulp exposure, use dental dam or other methods protecting against infection as well as ensure immediate, well-sealed closure of the cavity with material that minimises the risk of microleakage along the edge of the filling. The use of preparation which shows low pulp toxicity and, at the same time, exhibits proper adhesion to dental tissues is one of the challenges of contemporary dentistry.

The intensity of pulp bleeding after its exposure and the possible bleeding control before applying a therapeutic agent is another parameter affecting the therapeutic success. It is important for two reasons. First, intense bleeding that lasts longer than 10 minutes as well as bleeding that is difficult to control may indicate extensive pulp inflammation, which is a contraindication for the discussed therapeutic procedure. On the other hand, the absence of bleeding after pulp exposure may indicate necrosis (4). Furthermore, a direct pulpal contact with the drug substance, which would be impossible in the case of a clot present at the site of exposure, is necessary. Bleeding should be controlled using sterile cotton wool soaked in physiological saline. If this produces no satisfactory effect, 1.5-6.0% sodium hypochlorite, which is considered to be an effective agent ensuring hemostasis in the exposed pulp before pulpotomy or direct capping, may be used. Its short-term action has no negative effects on the differentiation of pulp cells or formation of reparative dentin (4). Furthermore, the agent has antibacterial activity, is likely to have beneficial effects on the healing processes and, similarly to $Ca(OH)_2$, it induces the release of dentin growth factors owing to its high pH values.

It is postulated by some researchers that direct capping method should be used only for pulp exposure less than 1 mm^2 in size. According to Willershausen et al. (19), there is a close, directly proportional relationship between the size of exposure and treatment failure rates. Stanley (20), in turn, claimed that the size of exposure not necessarily determines the ability of pulp to form dentin bridges providing that the procedure is performed appropriately. This is confirmed by some of other researchers, who believe that direct capping may be also used in pulp exposures greater than 1 mm^2 (21).

It is a common opinion that the method of direct capping is particularly recommended for young patients. The procedure is widely considered in the case of teeth with incomplete apical development due to the greater regenerative potential of pulpal tissue compared to mature teeth as well as the necessity to preserve vital pulp in order to enable further growth of the root. According to some publications, a relationship may be found between patient's age and treatment failure rates. Willershausen et al. (19) found in their study that the majority of cases requiring endodontic treatment after direct pulp capping occurred in the age groups of 50-59 years and 60-69 years. No statistically significant differences in treatment failure rates were found in other groups (19). Marques et al. (13) observed treatment failure only in patients above 40 years of age, with 100% success rates in patients below this age. Other studies found that the highest percentage of positive treatment outcomes was reported for the youngest (< 18 years) and the oldest (> 85 years) patients (22). According to some authors, there is no correlation between patient's age and treatment success rates (16).

Willershausen et al. (19) observed a correlation also between the group of teeth treated with direct pulp capping and treatment success rates. The authors found that the prognosis was better for incisors compared to other groups of teeth. This is probably due to the fact that these are mostly traumatic exposures, which are usually associated with higher success rates.

Marques et al. (13) searched for a correlation between successful direct pulp capping in carious exposure and the site of cavity. The authors showed that the success rates were more common in the case of occlusal surface cavities (100%) rather than contact surface cavities (89.7%). Furthermore, this method was associated with slightly better prognosis when used in primary caries (94.7%) rather than secondary caries (88.9%).

Conclusions

Direct pulp capping allows the maintenance of vital pulp in the case of its exposure, which is of particular importance in immature permanent teeth. Both, the decision to perform direct capping as well as the success of procedure require knowledge of the therapeutic indications for this method.

Conflict of interest

None

Correspondence

*Joanna Szczepańska
Zakład Stomatologii Wieku Rozwojowego
Uniwersytet Medyczny w Łodzi
ul. Pomorska 251, 92-213 Łódź
tel. +48 (42) 675-75-16
joanna.szczepanska@umed.lodz.pl

submitted:
12.02.2018
accepted:
5.03.2018

References

1. Arabska-Przedpełska B, Pawlicka H: Współczesna endodoncja w praktyce. Wyd. I. Bestom, Łódź 2011.
2. Hilton TJ, Ferracane JL, Mancl L: Comparison of CaOH with MTA for direct pulp capping: a PBRN randomized clinical trial. J Dent Res 2013; 92: 16-22.
3. American Academy of Pediatric Dentistry: Guideline on pulp therapy for primary and immature permanent teeth. Pediatr Dent 2014; 36: 242-250.
4. Bogen G, Chandler NP: Pulp preservation in immature permanent teeth. Endod Topics 2012; 23: 131-152.
5. Torabinejad M, Abu-Tahun I: Management of teeth with necrotic pulps and open apices. Endod Topics 2012; 23: 105-130.
6. Piekoszewska-Ziętek P, Turska-Szybka A, Olczak-Kowalczyk D: Infekcje zębopochodne – przegląd piśmiennictwa. Nowa Stomatol 2012; 2: 120-134.
7. Komabayashi T, Zhu Q: Innovative endodontic therapy for anti-inflammatory direct pulp capping of permanent teeth with a mature apex. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010; 109: 75-81.
8. Schwendicke F, Stolpe M: Direct pulp capping after a carious exposure versus root canal treatment: a cost-effectiveness analysis. J Endod 2014; 40: 1764-1770.
9. Komabayashi T, Zhu Q, Eberhart R, Imai Y: Current status of direct pulp-capping materials for permanent teeth. Dent Mater J 2016; 35: 1-12.
10. American Association of Endodontists: Glossary of endodontic terms. 7th ed. Chicago 2003.
11. Barthel CR, Rosenkranz B, Leuenberg A, Roulet JF: Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. J Endod 2000; 26: 525-528.
12. Çalışkan MK, Güneri P: Prognostic factors in direct pulp capping with mineral trioxide aggregate or calcium hydroxide: 2- to 6-year follow-up. Clin Oral Invest 2017; 21: 357-367.
13. Marques MS, Wesselink PR, Shemesh H: Outcome of direct pulp capping with mineral trioxide aggregate: a prospective study. J Endod 2015; 41: 1026-1031.
14. European Society of Endodontology: Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. Int Endod J 2006; 39: 921-930.
15. Simon S, Smith AJ, Lumley PJ et al.: The pulp healing process: from generation to regeneration. Endod Topics 2012; 26: 41-56.
16. Al-Hiyasat AS, Barrieshi-Nusair KM, Al-Omari MA: The radiographic outcomes of direct pulp-capping procedures performed by dental students: a retrospective study. JADA 2006; 137: 1699-1705.
17. Aguilar P, Linsuwanont P: Vital pulp therapy in vital permanent teeth with cariously exposed pulp: a systematic review. J Endod 2011; 37: 581-587.
18. Kakehashi S, Stanley HR, Fitzgerald RJ: The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1965; 20: 340-349.
19. Willershausen B, Willershausen I, Ross A et al.: Retrospective study on direct pulp capping with calcium hydroxide. Quintessence Int 2011; 42: 165-171.
20. Stanley HR: Pulp capping: conserving the dental pulp – can it be done? Is it worth it? Oral Surg Oral Med Oral Pathol 1989; 68: 628-639.
21. Matsuo T, Nakanishi T, Shimizu H, Ebisu S: A clinical study of direct pulp capping applied to carious-exposed pulps. J Endod 1996; 22: 551-556.
22. Raedel M, Hartmann A, Bohm S et al.: Outcomes of direct pulp capping: interrogating an insurance database. Int Endod J 2016; 49: 1040-1047.