

Saving the pulp and essential issues in pulp-capping treatment



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Abstract

Objective: Vitality of the pulp is a major key for the tooth to physiologically function in the mouth. Exposed pulp can be saved by pulp-capping treatment, diminishing the need for more complicated treatments such as root canal or extraction.

Methods: This literature review discuss relevant issues on pulp-capping treatment based on evidence and findings from previous studies to help find ways to achieve more predictable outcomes in pulp-capping

treatment.

Results: Capping of healthy pulp gives very high success rates, whereas capping of inflamed pulp results in lower success rates and less predictable treatment outcomes.

Conclusion: Exposed pulp can be treated successfully as long as conditions are ideal and conducive to the healing of the pulp and dentinal repair is implemented.

Keywords: Pulp capping, Dentinogenesis, Pulp exposure, Pulp inflammation

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Introduction

Vital pulp therapy is a valuable approach to maintain the longevity of the tooth to make it work in a functionally better way in the mouth. Maintaining the vitality of the pulp supports the tooth to continue its role to conserve organizing dentinal structure (secondary or tertiary) and to nourish, protect and innervate the tooth. Healthy pulp protects the tooth from irritating stimulation that endangers the tooth such as caries progression, traumatic force or excessive force. Treatment dealing with a pulp-less tooth will eventually lead the tooth losing these functions, making it more vulnerable to fracture, mostly due to the loss of great amount of tooth structure and the absence of proprioceptive sensors.^{1,2}

An exposed pulp either by degeneration of dentinal structure by caries process or by traumatic injuries will lead to the inflammation of the pulp in its attempt to protect itself. This inflammation could either diminish over time, resulting in the formation of tertiary dentin or became irreversible, leading to pulp necrosis. In the latter situation, treatment such as pulpotomy and complete root canal treatment would be mandatory to prevent any further damage to the periapical area. Even though the pulp has a formative function, meaning that it has the ability to regenerate just like any other tissue, its unique anatomy inside the rigid structure of dentin with small entrance from the apical foramen limits its regeneration ability.³ Therefore, treatment to save the vitality of the pulp would be a more simple treatment to carry out, less time consuming and more economical to the patient.

Treatment to maintain the vitality of the pulp in an exposed pulp or pulp that is only covered with a thin layer of dentin by placing a material on the endangered pulp to stimulate hard-tissue barrier is termed pulp-capping treatment.^{1,2,4} Factors essential to the success of this treatment comprises proper case selection, the right method of pulp-capping treatment, proper pulp-capping material, adequate isolation, pulp-capping techniques and satisfactory final restoration. This literature review will discuss relevant issues and matters in relation to pulp-capping treatment based on evidence from previous studies.

Methods

Dentin-pulp complex reaction to injury

Vital pulp has the ability to defend itself against harmful stimuli, including bacterial toxins, mechanical trauma such as head injury, with support from implementation of techniques generated by cavity preparation, dehydration on dental treatment procedure or traumatic injuries. When these injuries reach the dentinal structure and occur even far away from the pulp, the pulp will react to block the stimuli entering the pulp. Elements that help the dentinal-pulp complex and have a physiological barrier function are the dentinal fluids in the dentinal tubule and the formation of peritubular dentin, which decrease the dentinal permeability and the formation of tertiary dentin. These physiological pulp reactions occur in the attempt to prevent the stimuli to enter the pulp, to retain the vitality of the pulp.¹⁻⁴

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Is pulp-capping a direct method or an indirect method?

Pulp capping can be either carried out by directly placing the material on the exposed pulp (direct pulp capping) or by placing the material upon a thin layer of dentin, leaving the pulp unexposed (indirect pulp capping). The latter is controversial, particularly in cases of deep caries. As we know that complete caries removal is a basic principle in dentistry, dealing in deep caries where removing it would probably expose the pulp raises a question whether to continue removing it or just stop it to prevent jeopardizing the pulp.

Plenty of studies showed that using a cariostatic material over the remaining dentin with a small amount of caries lesion brings almost the same result compared to those that consider complete removal of caries.^{5,6} It should be remembered that damaged odontoblast cells in the predentin layer that lie between the dentin and pulp will reduce the ability of the pulp to form a barrier as their origin between these two tissues, because odontoblasts are not capable of performing cell division to replace their broken cells.⁷ Precluding the pulp from exposure also diminishes the possibility of uncontrolled bleeding, which also obstructs the pulp-capping material from adhering to the exposed site.^{1,8,9} Another advantage of indirect pulp capping is the prevention of intruding dentinal chip from penetrating into the exposed pulp, which can lead to continuous inflammation of the pulp.¹⁰

In some situation, pulp expose cannot be avoided and traumatic injuries often lead to direct exposed pulp or deep caries under active progression that cannot be left without removal or iatrogenic faults that occur during the preparation are some of the reasons. First attempt in these cases with proper case selection should be maintaining the vitality of the pulp by direct pulp capping. Case selection for pulp capping includes the following criteria: vital pulp with no spontaneous pain in history examination and normal pulp response to thermal stimuli, meaning the absence of prolonged pain on hot/cold stimuli that do not linger after the stimuli is removed. If there is no evidence of odontogenic periapical lesion from radiograph, bacteria can be excluded from the affected site and properly sealed with adequate restoration.^{1,2}

The survival of the pulp after pulp capping, particularly in direct pulp capping, is greatly affected by the elimination of the source of irritation and contamination control by satisfactory isolation technique to prevent saliva contamination and inflammation of the pulp from the infected dentin in deep caries cases, bleeding control and proper restoration with tight seal.^{1,2,5,11} Factors to be considered in pulp-capping treatment includes:

Elimination of irritants

Caries is a demineralized enamel/dentin with many bacteria and their by-products that can act as stimuli to pulpal inflammation. In deep caries or in cases where the pulp is exposed due to caries progression, these injuries can enter the pulp resulting in destructive inflammatory breakdown and impede the healing of the pulp.¹¹ Even when caries through a slow-pace progression the pulp also has its unique mechanism in hindering these injuries, pulp defends itself mainly by decreasing the dentinal permeability, which blocks the bacteria or toxin to reach the pulp and production of tertiary dentin.¹² In this case, indirect pulp capping could be considered the best treatment option to preclude the damaging of the odontoblast which plays a crucial role in the formation of tertiary dentin.^{12,13} Unexposed pulp with slight inflammation by traumatic injuries or caries still have good potential to be repaired.¹⁴ However, soft, moist and active caries should not be left in the cavity, as this not only contributes to bacterial infection but also leads to excess moisture interfering with the setting and adherence of the capping material.

Another common approach to deep caries is the stepwise excavation method, which is actually a procedure where deep caries is removed in a stepwise fashion to avoid pulp exposure by iatrogenic means. After the first attempt, the cavity is lined by a capping material and then closed with the restoration process. After some time, the cavity is reopened and the excavation of caries is continued on a harder dentin or in active caries lesion.¹⁵⁻¹⁷ This is similar to indirect pulp capping in a sense because the indirect pulp capping deliberately leaves the infected dentin permanently below the final restoration. This approach is more likely used in young permanent dentition because the regenerative ability of these teeth is higher.^{14,15}

Satisfactory isolation

Proper isolation while doing pulp capping treatment is an absolute prerequisite, this can be achieved by rubber dam placement.¹⁸ Re-walling or building an artificial wall on severely broken tooth with loss of dentinal walls is mandatory to prevent leakage by saliva or gingival exudates. If the tooth has an old restoration, removal of the old restoration or any defective filling will also remove any source of bacterial infection. Removed filling should then be replaced with new restoration before initiating the capping treatment.¹⁹ This will also help the rubber dam clamp to be placed with a better contact to the tooth structure.

Sterile instruments are also important to carry out aseptic treatment; instruments used to removed caries and infected dentin should not be used to

deliver the capping materials and care should be taken during the procedure to avoid contamination of the parts of the instrument.¹⁹ This includes the cotton pellets that we used to control pulpal bleeding or drying the cavity prior to capping placement. As stated by Stockton²⁰ the major cause of continuous pulpal inflammation and pulp necrosis after treatment is non-sterile instruments or procedure.

Pulpal bleeding control

Bleeding control before applying the capping material is a key step to have good adaptation of the material to the open pulp.^{9,21} Poor blood-clot formation affects the pulp's healing process due to chronic inflammation of the pulp.²¹ Excessive bleeding after a pulp exposure might indicate a moderate to heavy pulpal inflammation, which consequently minimizes the pulp's healing potential. Blood contamination at the site of exposure also compromises the sealing properties of the material and final restoration, and in such cases, the outcome of the treatment will be questionable.

An exposed pulp that is indicated for direct pulp-capping treatment is the small, exposed pulp, which is usually known as the pin-point lesion or a small scar on the surface of the pulp. This normally does not lead to heavy bleeding such as in the case of pulpotomy. If it is only a small bleeding, it can be controlled by pressing a sterile cotton pellet soaked in saline water to the bleeding site with firm pressure.^{18,22} Sodium hypochlorite can also be used with more effective results in controlling the bleeding and as a disinfecting agent. The concentration used for this purpose ranges from 0.12–5.25%, and this solution is most commonly used.^{18,23}

Pulp-capping materials and restoration

Pulp-capping procedure aims to save the vitality of the pulp, mainly by the formation of hard-tissue barrier over the injured pulp and damaged dentin. Consequently, the capping material plays an essential role in achieving this purpose. To be able to repair itself and generate a hard-tissue barrier, the pulp must eventually stop the inflammation of the pulp and continue to regenerate itself by stimulating its cells at the injured site and organize a dentinal bridge.²⁴ To repair the damaged odontoblast and heal the injury of the pulp, an ideal capping material should be able to stimulate the dentinogenic potential of the human dental pulp cells or dental pulp stem cells (DPSCs). Currently, calcium hydroxide is generally used for pulp capping, which has been evaluated by many long-term studies whose results were acceptable. However, improvements in dental material and bioceramics have led to many promising capping agents other than calcium hydroxide and we consider discussing this matter in more

detail in future studies focusing specifically on the advances made in the field of development of pulp capping materials.

Restoration covering the capping material must have an excellent sealing ability to provide a safer healing process and avoid contamination. Poor sealing capacity of temporary restoration not only takes part in contamination prevention but also renders the setting of the capping material resulting in the dissolution of the material.^{18,19} A retrospective study focusing on direct pulp-capping outcome showed that placing a direct permanent restoration over temporary restoration increases the success rate to 80.8% versus the success rate achieved at 47.3% with the use of temporary sealing ($p < 0.01$). Class I occlusal restoration also revealed a higher success rate (83.3%) than other proximal, multiple-surface restorations (class II 56.1%, class III

58.8%, mesial-occlusal-distal 28.6%).²⁵ **Treatment outcomes**

Capping of healthy pulp gives very high success rates, whereas capping of inflamed pulp results in lower success rates and less predictable treatment outcomes. However, it must be noted that the repair of the pulp involves the consideration of several key factors, including moderate inflammation, commitment of adult reserve stem cells, their proliferation and terminal differentiation.²⁶ All together, inflammation is part of the desired event to promote pulp cell migration, proliferation and differentiation for pulp repair. This is mainly held by odontoblast, a very fundamental cell in dentinogenesis. Having said that odontoblast is a post-mitotic cell, this part is carried out by odontoblast-like pulpal stem cells forming a different dentin as its origin with a bore atubular structure than those that have been formed by primary odontoblast.²⁴ Critical review of molecular and cellular mechanism in regards to pulp repair will be discussed in further studies.

Direct pulp capping is also more likely to be successful on mechanical exposure of pulp injuries that occur because of caries progression.^{25,27} Other factors such as age, sex, location and tooth position did not lead to significant outcomes.²⁵ A systematic review illustrating direct pulp capping outcome showed that, overall, the success rate with pulp-capping treatment ranged from 72.9% to 99.4% as observed over time >6 months–1 year 87.5%, >1–2 years 95.4%, >2–3 years 87.7% and >3 years 72.9%.²⁷

Conclusion

Proper case selection, aseptic management,

outcomes in pulp-capping treatment. Exposed pulp can be treated successfully as long as conditions are ideal and conducive to the healing of the pulp and dentinal repair is implemented.

Conflict of Interest

The authors report no conflict of interest.

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