Pulpotomy as an alternative to root canal treatment in mature permanent teeth with closed apex: A review

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(Received: November 2019 Revised: April 2020 Accepted: May 2020)

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ABSTRACT

The dental pulp plays an important role in prognosis of tooth, which is often ignored. Traditional school of thought is that, vital pulp therapeutic procedures should only be carried out in teeth with signs and symptoms of reversible pulpitis or to use pulpotomy, only in primary teeth or young permanent teeth with immature apices. Acknowledging to the inherent healing potential of an infection free pulp, with better understanding of biological mechanisms and with the advent of new materials, a new treatment paradigm in endodontics oriented towards preservation and tissue regeneration has evolved, which aims towards the preservation of vitality of pulp rather than to replace it with an inert material. Preservation of healthy vital pulp plays an important role in treatment outcome as it is proven to show successful results. This review article highlights the importance of pulpotomy in mature permanent teeth as an alternate to root canal treatment.

Keywords: Pulpotomy; pulp capping; permanent teeth; root canal treatment; vital pulp therapy.

INTRODUCTION

Root canal treatment for teeth with vital pulp demonstrates a favorable success rate of 100% if performed to high standards. However, epidemiological studies reveal a high incidence of technically inadequate root canal fillings and high percentage of apical periodontitis in root-filled teeth, which may favor more conservative approaches for the management, inflamed vital pulps, including partial or complete pulpotomy. Additionally, vital radicular pulps maintain their protective stress reducing damping effect and preserve the mechano-receptor function of the dental pulp, which may reduce the incidence of tooth fracture from over loading (1).

Clinical signs and symptoms such as the degree and characteristics of pain do not reflect the actual histological status and subsequently the healing potential of the inflamed pulp (1). Histological studies found inflammation to be confirmed to the area next to the carious exposure and not extending beyond 2 mm from the exposure site, radicular pulp was rarely inflamed. It is impossible histologically to classify accurately the pulpal condition of all painful teeth or to clearly demarcate between savable and non-savable pulps. Chronic partial pulpitis was present in 88% of painful cases and partial necrosis in 92% of the cases without correlation between the nature or the character of pain and the histological diagnosis. Pain was actually, present in 40% of the cases with savable pulps. Therefore, if the infected and most severely inflamed tissue is removed and the pulp is dressed in an adequate material, the conservation of a remaining healthy pulp is possible (2).

Through history and clinical tests, it is possible only to indicate the probable state of the pulp, while the final diagnosis can be only after histological examination. The clinical diagnosis of irreversible pulpitis corresponded to the histological diagnosis for the condition in 84.4% of cases. In these teeth, areas of necrosis were observed in the coronal pulp with varying extent (2). Whereas, it was infrequent to observe uninflamed pulp with normal architecture in the contralateral pulp horn where the histological diagnosis in the remaining 15.6% was actually reversible pulpitis.

Proper case selection and treatment protocols are a key to the success of vital pulp therapy. In teeth with irreversible pulpitis, pulpal conditions have little chance to revert to normal only by removal of irritants. Most of the cases require partial or total excision of the affected pulp tissue (3). The ability to control the bleeding after amputation of the infected pulp tissue has been proposed as in the indicator for the extent of the inflammation and the healing potential of the remaining pulp tissue.

Inclusion and outcome criteria of pulpotomy procedure (4):

Inclusion criteria

- Permanent teeth with deep caries and subsequent pulp exposure.
- Tooth should be vital on cold testing.
- Vital bleeding pulp tissue should be present in all canals after complete pulpotomy.
- Diagnosis is either reversible or irreversible pulpitis with or without periapical rarefaction.
- The tooth is restorable and frees from advanced periodontal disease.

- Soft tissues around the teeth are normal with no swelling or sinus tract.
- Hemostasis should be achieved after complete pulpotomy.
- The patient has non-contributory medical history.

Success criteria

- No history of spontaneous pain or discomfort except for the first day after treatment.
- No tenderness on palpation or percussion and the tooth is functional.
- Normal mobility and probing depth.
- Soft tissues around the teeth are normal with no swelling or sinus tract.

Radiographic criteria

- No pathosis evident on radiograph such as root resorption, furcal or new periapical pathosis.
- Reduction of PAI score or complete radiographic healing (PAI Score 1 or 2) if periapical rarefaction present preoperatively.

Introduction to vital pulp therapies

Vital pulp therapy is defined as a treatment, which aims to preserve and maintain pulp tissue that has been compromised but not destroyed by caries, trauma or restorative procedures in a healthy (5). It has been recommended that vital pulp therapies should be performed only in young patients because of the high healing capacity of pulp tissue compared to older patients (6). Since the evidence regarding the effect of the patients age and the status of the root apex on the outcome of vital pulp therapy, did not indicate that this treatment could not be performed successfully in old patients and based on the premise of the innate capacity of pulp tissue for repair in the absence of microbial contamination, preservation of the pulpally involved permanent tooth is also considered (7).

Another important benefit for preservation of vital pulp is the protective resistance to mastication forces compared with a root canal filled teeth (8). It is reported that survival rate of endodontically treated teeth is not as good as vital teeth especially in molars (9). Therefore, the vital pulp should be preserved if possible.

One of the most important issues in vital pulp therapy is the status of the pulp tissue. The problem is how we can accurately assess the status of the pulp. The clinical signs and symptoms such as sensibility and pain testing do not reflect the exact pulpal condition (10, 11). Several studies have reported the successful outcomes in the treatment of vital teeth with cariously exposed pulp or with signs and symptoms of irreversible pulpitis and periapical lesions (12-15). The degree of pulpal bleeding during the procedure may be a better indicator of pulpal inflammatory status. Increased bleeding on site of exposure that is difficult to stop, suggest that the inflammatory response extends deeper into the pulp tissue and the treatment procedure should be modified, for example by shifting from direct pulp capping to partial pulpotomy (12).

Additionally, other factors may affect the success of vital pulp therapy. The presence of adequate blood supply is required for the maintenance of pulp vitality (16). In addition, the presence of a healthy periodontium is necessary for the success of vital pulp therapy and teeth with moderate to severe periodontal disease are not suitable candidates for the treatment (17). Suitable candidates for vital pulp therapy include teeth in which an appropriate coronal seal can be provided. The prognosis is significantly reduced in cases with inadequate coronal seal and subsequent bacterial leakage (18). Control of hemorrhage and suitable dressing material are also necessary for the successful vital pulp therapy (12).

Various vital pulp therapies

Indirect pulp capping

It is a procedure in which carious dentin closest to the pulp, is preserved to avoid pulp exposure and is covered with a biocompatible material. It is done in two treatment approaches they are: a) incomplete caries removal with no re-entry. b) Stepwise or two-step excavation. The main goal of the treatment is to remove caries adjacent to pulp as much as possible with avoiding pulp exposure (19).

Direct pulp capping:

Direct pulp capping is defined as treatment of a mechanical or traumatic vital pulp exposure by sealing the pulpal wound with a biomaterial placed directly on the exposed pulp to facilitate formation of reparative dentin and maintenance of vital pulp (20).

Pulpotomy

Basically, carried out with two treatment approache, Partial and Full or complete pulpotomy. Asgary and Ahmadayar reported that in order to achieve improved treatment outcomes of direct pulp capping for a cariously exposed pulp using miniature pulpotomy technique where in which minimal removal of infected dentin or injured pulp tissue is removed not exceeding 1 mm at the exposure site (21). This type of vital pulp therapy creates a clean surgical wound and enhances interaction of pulp capping agent at the undifferentiated mesenchymal or dental pulp stem cell interface.

Partial pulpotomy:

It is defined as the surgical removal of the coronal pulp tissue to preserve the remaining portion of the coronal and radicular pulp. It has advantages compared to direct pulp capping such as removal of superficially inflamed pulp tissue and provide space

for the dressing material, which gives opportunity to seal the cavity (22).

Full or complete pulpotomy:

It is defined as the surgical removal of entire coronal portion of the vital pulp to preserve the vitality of the remaining radicular portion. This treatment approach is indicated when it is predicted that the inflammation of the pulp tissue has extended to deep levels of the coronal pup. The cellular and molecular mechanism of dentin bridge formation after pulpotomy is similar to reparative dentinogenesis following direct pulp capping. After the removal of the coronal pulp, hemostasis must be achieved and the biomaterial is placed over the remaining pulp tissue (23).

Dressing materials or pulp covering agents

Most popularly used and successful reports elicited for pulpotomy are mostly by biodentin (24).

Calcium hydroxide

Its advantages are antimicrobial characteristics owing to its high alkaline PH and the irritation of the pulp tissue that stimulates the pulp defense and repair. It has ability to extract growth factors and bioactive dentin matrix components from mineralized dentin can induce dentin regeneration at the site of pulpal exposure. Conversely, calcium hydroxide is extremely toxic to cells in tissue culture. It can degrade and dissolve beneath restorations and has high disintegration rate as not suitable as pulpotomy agent (25).

Resin modified glass ionomer cement and adhesive resins

Stimulate intense immune and inflammatory responses, hence not suitable as pulpotomy agents (26).

Mineral trioxide aggregate

Mineral trioxide aggregate has been shown to induce the recruitment and proliferation of undifferentiated cells and their differentiation to odontoblast like cells (27). Dental pulp like cells demonstrated higher activation levels in direct contact with mineral trioxide aggregate could lead to faster and more predictable formation of dentinal bridge and more effective pulpal repair (28). Histologically the calcified bridge formed in contact with mineral trioxide aggregate is thicker with less pulpal inflammation compared to calcium hydroxide (29). However, mineral trioxide aggregate has some drawbacks such as difficult handling properties, long setting time, high cost and the discoloration potential of the tooth (30).

Bioceramics

Endosequence root repair material, bioaggregate, biodentin, and many other bioceramic products have been introduced out of which biodentin proved successful for pulpotomy procedures. Biodentin when placed in direct contact with pulp, during pulp exposure can positively influence healing by enhancing the proliferation, migration and adhesion of human dental pulp stem cells (31).

Calcium enriched mixture

Calcium enriched mixture was comparable to that of mineral trioxide aggregate and superior to calcium hydroxide. Studies on complete pulpotomy treatment using calcium enriched mixture, mineral trioxide aggregate, calcium hydroxide have shown that compared to calcium hydroxide, samples in the calcium enriched mixture group exhibited lower inflammation, improved quality or thickness of calcified bridge, superior pulp vitality status and morphology of odontoblast cells (32).

Other bioactive materials

Enamel matrix derivates, propolis have proved to be beneficial to pulp. However, for a definite conclusion about these materials, further investigation is needed (33).

CONCLUSION

Following any pulpal exposure, it is always beneficial to preserve the vitality of an exposed pulp rather replacing it with an inert material. A vital, functioning pulp is capable of initiating severe defense mechanisms to protect the body from bacterial invasion. From the clinical point of view, the vitality of the dental pulp of an aged individual to be weaker than that of a young person. In the future, more efficient wound dressings containing perhaps growth factors, together with improved local antimicrobial and anti-inflammatory materials will combine with improved sealing ability of restorative materials, to preserve the vitality of the cariously exposed pulp in permanent teeth.

Major limitations in the success of vital pulp therapy in cariously exposed permanent teeth exist mainly due to the lack of predictability and long-term success, which greatly influence the decision-making. Usually it is unreliable primarily due to the difficulty of accurately diagnosing the ability of the pulp to repair. However, due to the lack of long-term success, these cases have to be monitored on a regular basis to avoid unnoticed necrosis of the pulp with invasion of bacteria into the root canal system.

CONFLICT OF INTEREST

No conflicts of interest.

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