

# Clinical and Radiographic Evaluation of Direct Pulp Capping Procedures in Permanent Teeth

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**Background:** The dental pulp can be exposed by trauma or during cavity preparation and the decision between pulp capping and root canal therapy is a clinical issue.

The **aim** of this study was to evaluate the outcome of direct pulp capping procedures in permanent teeth.

**Material and methods:** Thirty-nine patients with pulp exposure were evaluated clinical and radiological after direct pulp capping procedure and followed for at least 24 months. The result was considered successful if the tooth tested was vital, without symptoms and no periapical radiolucence.

**Results:** The success rate of direct pulp capping was 58.9%, associated more with mechanical exposure than with carious exposure (83.3% versus 48%,  $p < 0.05$ ) and more with class I occlusal restorations (77.7%) than with proximal restorations (class II 44.4%, class III 41.6%,  $p < 0.05$ ).

**Conclusions:** The success rate of direct pulp capping was 83.3% with mechanical exposure and 48% with carious exposure.

**Keywords:** pulp capping, accidental pulp exposure, clinical outcome

## Introduction

The dental pulp can be exposed by accidental trauma to a tooth or by the dentist during cavity preparation of a carious lesion. When the exposure occurs during dental therapy it can be diagnosed as mechanical or carious. As a rule, the pulp is inflamed in both instances, as the mechanical exposure rarely occurs except during removal of a deep restoration or excavation of deep carious[1].

This clinical situation is characterized by the presence of bacterial contamination and the dentist may choose between vital pulp therapy and endodontic methods. Even today, the subject of vital pulp therapy remains controversial, especially regarding the pulp dressing material that offers the most predictable healing [2–4].

Various methods have been proposed for the treatment of traumatic and carious exposed dental pulps in mature permanent teeth, but many have been based only on clinical experience and their outcomes were not always scientifically validated [1].

The requirements for a successful vital pulp therapy include the following criteria: a non-inflamed pulp, a proper hemorrhage control, the use of a non-toxic capping material and a restoration that provides a tight seal against bacteria.

The most common direct pulp capping agent was calcium hydroxide, which is antibacterial and disinfects the superficial pulp. Due to its high pH, about 12.5, it has a necrotic effect on the superficial tissue layer of the pulp and thus removes a small part that is usually inflamed. Beneath this first layer, the irritation in the pulp is mild and has a stimulating effect on inflammatory response that in the absence of bacteria will heal with a hard tissue barrier. Hard-setting calcium hydroxide pastes are less caustic than pure mixture of calcium hydroxide powder and saline, do not initiate necrosis of the superficial tissue but produces the same type of healing [2].

Recently, mineral trioxide aggregate (MTA) was used in a series of investigations to be biocompatible and to seal pathways of communication between the root canal system and the external surface of the teeth [1,5]. The material is successful because its small particle size, sealing ability, alkaline pH and slow release of calcium ions. Several studies have reported that MTA induces pulpal cell proliferation, cytokine release, hard tissue formation and synthesis of an interface with dentin that resembles hydroxyapatite [6–8].

The purpose of this study is to describe our clinical experience in using MTA and current adhesion technology during direct pulp capping procedures, to define criteria for patients' selection and to present the clinical and radiological results after mid-term follow-up periods.

## Material and methods

we treated a series of 39 patients with a mean age of 24.8 years (10.5–30.9 years) referred to our clinic for dental treatment. In 27 cases the teeth had initial deep carious lesions and no prior restorations and in 12 cases there were traumatic exposures of dental pulp. Prior to this investigation we defined the inclusion and exclusion criteria.

**Inclusion criteria:** clinically and radiological diagnosed carious permanent teeth without any periapical pathology, teeth with accidental pulp exposure, asymptomatic (with no clinical signs of pulpitis).

**Exclusion criteria:** teeth revealing clinical pulp exposure more than 1mm, with abnormal reaction to thermal or electrical stimuli, teeth tender to percussion or with periapical radiolucencies.

An informed consent form was signed by each patient before starting the procedure. All relevant objective tests represented by thermal and electrical pulp test and radiographs were taken preoperatively in every case.

**Table I.** Correlation between the age of the patient and treatment outcome

Age	Success	Failure	Total
10–20	15 (62.5%)	9 (37.5%)	23
21–30	8 (53.3%)	7 (46.7%)	16

p = 0.40

Immediately after accidental exposure of dental pulp a rubber dam was placed in order to isolate the tooth during the pulp capping procedure and a saliva ejector was used to control moisture contamination. The clinical exposure was identified by presence of bleeding or a pink spot on the floor of tooth cavity. We considered only exposures that were not over 1 mm<sup>2</sup> to be candidates for direct pulp capping.

The cavities were rinsed with saline using 2 cc disposable syringes and dried with sterile cotton pellets and the MTA white or grey mixture, according to the manufacturer, s instructions (ProRoot MTA, Dentsply Tulsa Dental, USA) was places with gentle pressure on the top of the exposure and covered with a glass ionomer cement as temporary restoration.

All the cases were examined clinically at each visit with objective tests and questions relevant to pain and discomfort for a period of not less than 24 months.

Teeth that were found vital by electrical and thermal tests, with no signs or symptoms of pulpitis (spontaneous pain) or percussion sensitivity were considered successful. On the other hand, those that showed no reaction to vitality tests, with a history of pain and tenderness to percussion associated or not with periapical radiolucency were considered failures.

The results were analyzed by descriptive statistics and significance of p values obtained by applying chi-square test. Any significant effects on the outcome of the treatment related to age, tooth location, type of exposure and class of restoration was evaluated and a “p” value < 0.05 was considered statistically significant.

## Results

The results of our study are presented in Tables I to IV, which describe the correlations between outcome of the procedure related to age of the patient, tooth location, type of pulp exposure and class of dental restoration, respectively.

More teeth with mechanical exposures than carious exposures demonstrated successful treatment outcome and

**Table III.** Correlation of type of pulp exposure and treatment outcome

Exposure	Success	Failure	Total
Carious	13 (48%)	14 (52%)	27
Mechanical	10 (83.3%)	2 (16.7%)	12

p = 0.04

**Table II.** Correlation between tooth location and treatment outcome

Tooth location	Success	Failure	Total
Upper jaw	10 (55.5%)	8 (44.5%)	18
Lower jaw	13 (61.9%)	8 (38.1%)	21

p = 0.40

teeth with class I occlusal restoration were frequently included in healthy group compared with those with class II or III restorations.

Analysis of the data shows that there is no significant relationship between the pulp capping procedure and patient’s age and tooth location. On the other hand, there were differences regarding success of treatment and type of pulp exposure and class of dental restoration.

Pulpal exposure resulted in some degree of hemorrhage in all cases; the exposures varied from 0.25 to 1.5 mm in diameter and the operator placed gray MTA in 25 cases and white MTA in 14 cases, according to indications.

## Discussions

Dental pulp is a highly vascularized tissue with a great potential for healing; as it performs many functions throughout tooth life, every effort should be made in order to preserve its vitality. Direct pulp capping procedures represent the dressing of an exposed pulp in order to maintain its integrity and function and several factors are involved in the prognosis: materials used, micro-leakage, size of exposure, contamination of cavity prior to this procedure [1, 2].

Indications for pulp capping include recent traumatic exposure (< 24 hours) or mechanical non-carious exposure during cavity preparation. Pulp capping should be considered only in the treatment of immature permanent teeth or for teeth that will not serve as abutment for a fixed partial denture. Mature teeth with inflamed pulps or with carious exposure should not be treated by this method [6, 7]. Preoperative tooth sensitivity has been considered as a contraindication to pulp capping, but this concept is not supported by scientific evidence.

Most of the patients in our group were between 10–20 years because direct pulp-capping is known to be more successful in young individuals, with a high cell population in the pulp which offers the best condition for healing. The best results were noted where there was a mechanical exposure (83.3%), less than 1 mm<sup>2</sup> which comes to the clinic within 24 hours from trauma; in this situation the bacterial

**Table IV.** Correlations between class of restoration and treatment outcome

Class	Success	Failure	Total
Class I	14 (77.7%)	4 (22.3%)	18
Class II	4 (44.4%)	5 (55.6%)	9
Class III	5 (41.6%)	7 (58.2%)	12

p = 0.02

invasion of the tissue is minimal and the procedure can be performed on a dental pulp without inflammation.

The results of our study showed that the age of the patient did not influence the final result, which is in agreement with other previous investigations [9–11]. The influence of marginal seal and subsequently, the prevention or reduction in microleakage may explain the higher success rate of pulp capping in Class I restorations, compared to Class II and III. Probably this influence is due to the length of the margin between the tooth structure and the restoration interface, in that the longer the margin the greater the incidence of microbial invasion from oral cavity to pulp chamber.

Although there were only a small number of cases, the results of this study in which we used MTA as a direct pulp-capping agent demonstrate that by this technique we can obtain long-term favorable results.

Since our study did not have a control group, the results provide, within the limitations of this investigation, a relatively low level of scientific evidence. However, the outcomes suggest that MTA is a more predictable pulp-capping material than calcium hydroxide.

The physical characteristics and bioactive properties of MTA were a critical contributing factor to the success of this study [4, 5, 12].

## Conclusions

The success of pulp capping procedures requires several conditions: control of hemorrhage, the use of a material well tolerated by dental pulp and a bacteria tight seal. In addition, the indication must be restrained to recent trau-

matic or mechanical exposure in mature permanent teeth with simple restorative needs. Careful attention to diagnostic criteria and treatment procedures should result in many successful outcomes.

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