

# Effect of Calcium Hydroxide on Deep Caries Dentin: A Clinical Study

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## ABSTRACT

**Objective:** The aim of this study was to evaluate the clinical efficacy of calcium hydroxide on arresting deep carious lesions in permanent teeth. **Methods:** A total of 190 patients aged between 15 and 55 years old were selected for this clinical study. Calcium hydroxide was applied to fully matured permanent anterior or posterior teeth clinically and radiographically after 2 weeks, 3–4 weeks, 3 months, 6 months, and 1-year follow-up. **Results:** The overall survival rate was 89.4%. The findings of this study showed that calcium hydroxide is effective in arresting deep carious lesions and formation tertiary dentine as well as preservation teeth vitality. **Conclusion:** Calcium hydroxide is effective in reducing the risk of pulp exposure in deep carious lesion.

**Key words:** Calcium hydroxide, deep caries, restorative treatment

## INTRODUCTION

Calcium hydroxide has been used for many years in dentistry for many purposes including pulp capping to induce dentin bridge formation,<sup>[1,2]</sup> fostering apical closure of permanent teeth,<sup>[1,3,4]</sup> and promoting resolution of periapical and resorptive lesions<sup>[2,5]</sup> and as an interappointment disinfectant in the root canal space.<sup>[2,4,6]</sup> While research has not yet determined the exact mechanism of action, several theories have been proposed.<sup>[5-8]</sup> Diffusion of hydroxide ions through dentinal tubules can elevate dentinal pH to as high as 11 in some locations and may contribute to several of its anticipated actions through DNA damage or protein denaturation. Dissolution of necrotic material, neutralization of acid, and remineralization of tooth structure through the release of calcium ions may also contribute to the beneficial effects of calcium hydroxide. Despite these clinical successes, reports have surfaced correlating intracanal

placement of calcium hydroxide with an increased incidence of tooth fracture, especially in teeth treated before full apical closure.<sup>[1]</sup> Researchers have suggested that increased pH alters the strength of the bond between hydroxyapatite and collagen fibrils, induces conformational change in proteoglycan molecules, and exerts a proteolytic effect through increased matrix metalloproteinase activity.<sup>[7,9]</sup> The success rate of the vital pulp therapy increases provided the following: Dental pulp is not inflamed, proper control of bleeding, applying a non-toxic material, and capping material plus restoration provide perfect sealing against ingress of bacteria.<sup>[10]</sup> Indirect pulp capping is defined as the application of therapeutic materials to an area of infected dentin over the pulp. In a deep cavity, where the pulp is not actually exposed, it is indicated only in symptomless vital teeth.<sup>[11]</sup> Direct pulp capping is a vital pulp therapy technique which aims at treating reversible pulpal injury and maintaining pulpal tissues viability by protecting the pulpal system from bacterial ingress and,

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hence, enhancing its reparative capacity.<sup>[11,12]</sup> Calcium hydroxide is an ideal lining material for the very deep cavity preparation and also continues to represent an option for both the indirect and direct pulp capping.<sup>[13,14]</sup>

This study was carried out to evaluate the clinical efficacy of calcium hydroxide on arresting deep carious lesions in permanent teeth.

## MATERIALS AND METHODS

This clinical was conducted between 2012 and 2014 in Tamar University, Yemen. The study included 190 patients aged 15–55 years old. A written informed consent was obtained from all patients. This study was approved by the ethical committee in the Faculty of Dentistry, Tamar University.

The inclusion criteria were any permanent anterior or posterior teeth with radiographic image of caries lesion in the inner half of dentine, positive response to the cold test with  $-20^{\circ}\text{C}$  refrigerated spray, and negative sensitivity to percussion test. Exclusion criteria were lingering spontaneous pain and/or pain disturbs sleep, apical radiolucency, non-teeth, any systemic diseases, and pregnancy.

Pre-operative radiographic examination was taken in parallel technique with the aid of X-ray film positioning device rim for standardization. All radiographs of all included teeth showed deep caries in close relation to the pulpal chamber with no evidence of widening periodontal ligament, furcation radiolucency, internal resorption, or periapical radiolucencies.

All included teeth had deep caries, some of which had mild or moderate pain that needed application of the anesthesia. The operator carefully removed the deep caries using a round bur followed by final excavation with hand instruments leaving a small amount of carious dentin to prevent pulp exposure, good isolation of cotton role and saliva ejector to prevent saliva leakage where necessary. A calcium hydroxide base material was applied over the dentin to encourage the formation of tertiary dentine and protect the pulp. Glass ionomer was applied in the cavity followed by the final restoration in at the same appointment. In some cases, the procedures were taken in two separate appointments, in which temporary filling is placed the first visit, and after 4 weeks, the temporary restoration was replaced by permanent restoration.

The efficacy of each material as a therapeutic modality for preserving pulpal vitality was assessed by a recall program. Patients were recalled for clinical evaluation (no pain, no sensitivity to percussion, and palpation test) and radiographic examination after 2 weeks, 3–4 weeks, 3 months, and 6 months, and 1 year.

The case was regarded as a failure when one or more of the following signs were present: Negative vitality response, periapical radiolucency, and widening of the lamina dura, pain, or swelling.

### Statistical analysis

The data were analyzed using IBM SPSS program for Windows, Version 21.0 (Armonk, NY: IBM Corp). Chi-square test was used at a statistical significance level of  $P < 0.05$ .

## RESULTS

A total of 190 patients (95 males and 95 females) participated in the study. Calcium hydroxide was applied in 190 teeth, of which 90 were in the maxilla and 100 were in the mandible. Posterior teeth comprised majority of the treated teeth (170 vs. 20) [Table 1].

The findings of this study exhibited that calcium hydroxide showed overall survival rate of 89.6%, with significant differences between anterior (100% success rate) and posterior teeth (71.2%) ( $P < 0.05$ ). The number of failures was 14 teeth in the first 6 months which increased up to 20 at the end of the year [Table 2].

## DISCUSSION

In this study, evaluation of calcium hydroxide application after incomplete caries dentine removal in deep cavity among different aged patients was indicated as one step of the excavation procedure. Cavity sealing after partial removal of carious tissue may modify bacterial growth and drastically reduce the presence of cariogenic bacteria.<sup>[15]</sup> The

**Table 1:** Distribution of treated teeth

Variable	n (%)
Male	95 (50)
Female	95 (50)
Maxilla	90 (47.3)
Mandible	100 (52.6)
Anterior	20 (10.5)
Posterior	170 (89.4)
Total	190 (100)

**Table 2:** The success and failure rate among anterior and posterior teeth

Teeth	Number	Success n (%)	Failure n (%)	P value
Anterior	20	20 (100%)	00	<0.05
Posterior	170	150 (88.2)	20 (18.8%)	
Total	190	170 (89.4)	20 (10.5)	

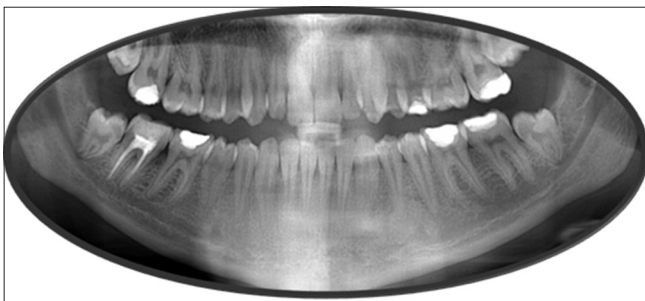
benefit to the patient would be a more conservative, and simultaneously, a less invasive approach to caries treatment reducing widespread anxiety among dental patients.<sup>[16]</sup> During the vitality tests, one tooth presented painful symptoms after 1 year of the treatment, but the painful sensation ceased immediately after the stimulus was removed.<sup>[15]</sup> This diagnosis implied that the pulp was vital but had some areas of inflamed tissue that would heal after conservative vital pulp therapy<sup>[17]</sup> [Figure 1].

The significant calcium release provides reparative ions, creates a sustaining alkaline environment required to promote wound healing, provides immediate bond and sealing properties, and stimulates hydroxylapatite and secondary dentin formation within affected tissues.<sup>[17,18]</sup>

Anterior teeth in deep caries lesions presented a higher success rate than the posterior after 1 year. The stepwise (SW) excavation is the therapy presenting a longer maintenance of pulp vitality and tooth structure compared to complete caries removal. The complete caries removal leads to a higher rate of pulp exposure, which has worse pulp prognosis.<sup>[19]</sup> The present study shows that the partial caries removal and restoration in one appointment in one session present a higher success rate. In SW treatment, the failure of the temporary restoration may lead to caries progression and endodontic complications after a certain period of time.<sup>[20-22]</sup>

The dependence of patients' returns to conclude SW excavation, coupled with the lack of evidence of the need of cavity reopening for final excavation suggest that the treatment in a single appointment may be preferable. Based on our findings, it is possible to state that the partial caries removal is a more successful therapy after 1 year. This result consistent with previous studies suggesting that it is unnecessary to completely remove carious dentine before a restoration to maintain pulp sensibility.<sup>[23-27]</sup>

This study has some limitations that should be taken into consideration, the main limitation is that no comparison groups. Another limitation of this study is the fact that other confounding factors such as age and gender were not investigated.



**Figure 1:** The treated cases depending on the severity of the lesion according to criteria of (ICDAS)

## CONCLUSION

Application of calcium hydroxide was effective for the protection of pulp in deep carious lesions of permanent teeth.

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