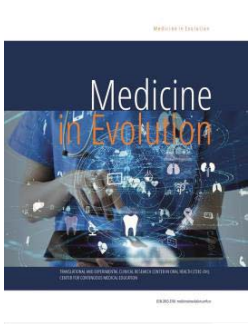
Conservative treatment of the dental pulp in the young permanent dentition



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Abstract

Aim and objectives: The purpose of this clinical trial was to evaluate the effectiveness of calcium hydroxide [Ca(OH)2] and mineral trioxide aggregate (MTA) in treating deep carious lesions using the direct total caries removal approach. The objective of treatment planning for young permanent teeth is to ensure the well-being of the pulp, while also facilitating ongoing root growth and the natural formation of dentin.

Material and methods: The study was carried out on 81 teeth with advanced caries treated by indirect pulp capping using calcium hydroxide and MTA.

Results: Following therapy, the recall rates were 92% at six and twelve months. Endodontic emergency treatment was provided for four teeth that were capped with Ca(OH)2 (2 at 6 months and 2 at 12 months posttreatment), and two capped with MTA (2 at 12 months posttreatment), due to signs of irreversible pulpitis that were confirmed clinically and/or radiographically. Between the two pulp-capping agents at six and twelve, there were not significant differences in pulp vitality.

Conclusions: When it comes to indirect pulp-capping success can be achieved with both materials: calcium hydroxide and MTA.

Keywords: pulp-capping, dentin repair, pulp protection, tooth decay, permanent immature teeth

INTRODUCTION

Conservative treatment of young (immature) permanent teeth is very important because they are characterized by an incompletely formed root and an open apex. When teeth with profound caries lesions or unintentional pulp exposure are treated, pulp capping is a minimally invasive essential therapy that keeps the pulp functioning. [1,2] The absence of the apical periodontium in the terminal area of the root, forces us to apply other endodontic techniques in the situation of pulpal or pulpo-periodontal damage of these teeth, different from those applied to mature permanent teeth. These techniques aim to maintain pulpal vitality at least in part to allow for further root formation and apex maturation when possible. In the case of immature permanent teeth, untreated dental caries are the main factor of pulpopathies due to the possibility of faster action and evolution, due to the reduced thickness and increased permeability of the dentin. [3] In the first phase, in the dentin and in the pulp there are defense phenomena characterized by: the formation of sclerotic dentin (by intra and peritubular calcifications at the level of the dentin) and the deposition of tertiary dentin at the pulpal level. By advancing the decay process, in the odontoblastic and subodontoblastic area, signs of chronic inflammation appear (mild vasodilatation and the appearance of some defense cells). This stage is asymptomatic and reversible. [4]

Capping is a complex therapeutic method, addressed exclusively to deep cavities prepared during the treatment of dental decays, having the role of protecting the dental pulp and preventing pulpal inflammation or other diseases. Another role is to stimulate the mechanisms of neodentinogenesis (formation of new dentin) which ensures the partial recovery of hard dental substances. In addition to these objectives, indirect capping also aims to ensure pulpal healing conditions, block the activity of existing bacteria, and reduce wound permeability by blocking the dentinal tubes, thus ensuring the protection of the pulp from external physical and chemical agents. It was found that vital dentin had a higher resistance against decay than non-vital dentin. Therefore, under certain conditions, an attempt to keep the exposed pulp vital can be successful. [5-7]

For the treatment of infected pulp, it is recommended to remove the decays, prevent the trauma, and apply a substance that induces healing. The idea that a vital pulp is important for the long-term preservation of a tooth and that the exposed pulp is capable of forming hard tissue has been widely accepted. [8] Calcium hydroxide was used globally as a protective paste layer and has been the standard for the past 50 years. Its use is well documented and its degree of safety for pulpal capping is clinically acceptable. [9, 10] Historically, calcium hydroxide (Ca(OH)2) has been considered the gold standard. Despite to the positive experience with calcium hydroxide, contemporary literature accepts many newer materials for the pulp, such as dentin adhesives, mineral trioxide aggregate, collagen, chondroitin sulfate, hyaluronic acid, calcitonin, ammonium hydroxide, barium, magnesium, aluminum, strontium hydroxide, albumin, cyanoacrylate manufacture. [11, 12] At this time, due to its bioinductive properties, pulpal capping is indicated to be made with materials derived from Mineral trioxide aggregate (MTA), the future of capping paste as a predictable and viable way of treatment seems to be correct. [13-15] The recommended therapeutic methods in the endodontic therapy of immature permanent teeth are indirect or direct capping that fully preserves the vitality of the pulp, based on the stimulatory effect of calcium hydroxide or derivatives resulting from MTA. [16]

Preservation of the vitality of the pulp of immature permanent teeth is possible due to the numerous embryonic cellular elements with high biological value and the rich vascularization that offers a high degree of reversibility to inflammatory processes and even healing. [17, 18]

Aim and objectives

The ultimate goal in the treatment of pulpal diseases of immature permanent teeth is the integral preservation of the vitality of the pulpal organ necessary for the complete development of the root.

MATERIAL AND METHODS

A longitudinal interventional randomized control trial was conducted on 70 people (81 teeth), of which 40 boys and 30 girls aged between 8-16-year-old children. A single operator, trained in the standardization of the procedures, performed all of the restorative treatments. A maximum of two teeth per patient were included in this study. (In cases where two teeth were restored in the same patient, one of the teeth was capped with MTA, while the other was capped with $Ca(OH)_{2)}$. A simple randomization method was used for selection— the first tooth selected was assigned to be treated with $Ca(OH)_2$ and the second with MTA.

The clinical criteria of inclusion were:

- active carious lesion deep into dentin, involving oclusal and/or proximal surfaces of primary molars, without clinical observation of pulp exposure;
- absence of clinical symptoms of irreversible pulpitis, such as spontaneous pain or sensitivity to pressure;
- absence of clinical diagnosis of pulp exposure, fistula, swelling of soft and periodontal tissues, and abnormal tooth mobility;
- possibility of restoration.

All teeth exhibited initial deep caries and no prior restorations.

One operator completed all indirect pulp caps. After patients obtained profound local anesthesia, the operator placed a dental dam and used an oral sealant to prevent saliva leakage where necessary.

Group I, calcium hydroxide. Calcium hydroxide was applied using the steps: anesthesia, isolation and cavity preparation. A thin layer of about 1 mm was applied on the opening, the material used was Kerr Life, then a base layer composed of a phosphate cement was applied and then a final composite restoration.

Group II, MTA. The MTA was applied as follows: the cavity was cleaned under anesthesia, isolation and cavity preparation. The MTA was mixed with sterile water in the proportions recommended by the manufacturer, the resulting paste being applied, the thickness of the applied paste was 1.5-2.5 mm.

Figure 1. Tooth anesthesia

Figure 2. Removal of decayed dentin

Figure 3. Application of calcium hydroxide

Figure 4. The final appearance of the filling

Figure 5. Cavity preparation for the MTA

Figure 6. The MTA layer applied

A base of glass ionomer cement was applied after the pulp-capping materials were applied. After that, the teeth were etched for 30 seconds with 37% phosphoric acid, and Prime and Bond NT, a single-bottle adhesive system, was applied. The restoration procedure was then finished by gradually inserting a microfilled hybrid composite resin material into the cavities and using the LED device to light cure it for 20 seconds. Rubber cones, discs, and diamond-composite finishing burs were then used to polish the teeth.

The patients were informed of the recall appointments at baseline (one week) and 6, 12 months posttreatment. Two skilled and calibrated dentists evaluated all subjective symptoms, such as pain or tooth sensitivity to different stimuli, during the observation periods. When pulp vitality was seen, along with a normal response to thermal, electrical, and tactile tests and no indications of spontaneous pain, the treatment was deemed clinically successful. When radiolucency and periodontal ligament space widening were absent, it was deemed radiographically successful.

RESULTS

The study included 70 people, of which 40 boys and 30 girls aged between 8 and 16 years, (Table 1) patients selection. A total of 81 permanent teeth of 70 patients were capped randomly with either $Ca(OH)_2$ (n=42) or MTA (n=39) and restored using composite resin.

The patients included 30 girls and 40 boys, with a mean age of 12 years.

Table 1. Distribution by sex and the number of cappings

Total number of the consulted subjects		Total number of cappings	
Boys	**Girls**	**Boys**	**Girls**
40	30	48	33
70		81	

According to table 1 we notice the distribution by sex of the studied group, so we notice that the female sex is represented in a proportion of 43% while the male sex is represented in a proportion of 57%.

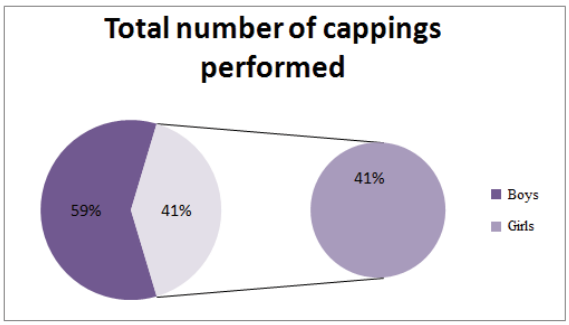

Figure 7. Capping performed on both boys and girls

Out of a total of 70 children examinated, 40 were boys (57%) and 30 girls (43%). In this group, 81 pulp cappings were performed, of which 48 are for boys (59%) and 33 for girls (41%), the difference between the two sexes being insignificant.

Table 2. Materials used for cappings

Materials used for cappings	
$Ca(OH)_2$	MTA
42	**39**

Table 2 illustrates the material used for the cappings, calcium hydroxide and MTA. We can notice that 51.85% of the cappings were made with calcium hydroxide and 48.14% cappings was done with MTA. (Fig. 8)

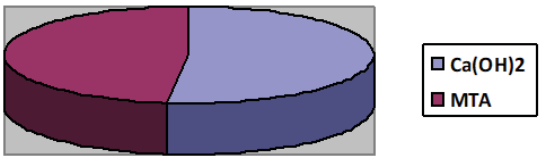

Figure 8. Material used for the cappings

Table 3. Distribution of cappings chosen on the arches

Teeth chosen for the acpping technique							
Maxillary				**Mandible**			
Lateral group		Front group		Lateral group		Front group	
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
23	12	3	2	25	16	0	0
35		5		41		0	
40				41			

As can be seen in the table above, molars were the most susceptible to this operation, work was done almost equally on both arches. There were also 6 cases in which patients had

extensive caries in the front teeth, due to the fact that the patients were young, it was decided to capping the pulp chamber to the detriment of endodontic treatment.

Table 4. Clinical Assessment of Tooth Vitality Distribution

Material	Condition of Pulp Tissue			
	Normal (vital)		Irreversible Pulpitis	
	n	%	n	%
Calcium Hydroxide (n=42)				
baseline	42	100	-	-
6 months	40	95.24	2	4.76
12 months	38	90.48	2	4.76
Total			4	9.52
Mineral Trioxide Aggregate (n=39)				
baseline	39	100	-	-
6 months	39	100	-	-
12 months	37	94.78	2	5.13
Total			2	5.13

DISCUSSIONS

Using the full caries removal technique, we evaluated the effectiveness of MTA and Ca(OH)2 as pulp-capping materials for treating teeth with deep dentin carious lesions. The present study's results demonstrated the high success rate of indirect pulp capping, which was found to be as high as 92.59% regardless of the material used, and the high efficacy of complete caries removal using a one-visit approach. This high success rate could be explained by a precise diagnosis, total removal of the carious tissue, which stops the carious process from progressing, and a well-sealed restoration that stops microleakage. Because of the tight restoration, any remaining cariogenic bacteria in the cavities would have perished upon the removal of their food source, causing the arrest. [28, 29]

To minimize the pulpal response, restorative materials must seal the edges of the cavity, prevent micro-infiltration and block the arrival of bacterial substances to the pulp by penetrating the dentinal tubules. However, if micro-infiltration from several restorations could be measured in vivo, it is very likely that all restorations will show some form of infiltration. If these teeth remain asymptomatic, it is probably because the rate at which exogenous materials pass through the dentin to the pulp is balanced by the rate at which these materials are removed through the pulp circulation, thus ensuring its vitality. Consequently, it is desirable that the dentinal barrier effect be maximized to provide the best pulpal protection. Each situation must be evaluated to determine which method is more favorable in achieving the best barrier effect. [30-34]

The role of indirect capping is also to ensure that the pulp healing process has the necessary conditions, namely, blocking the activity of existing bacteria and reducing the permeability of the lesion by blocking the dentinal tubules. Pulpal protection against external factors, both physical and chemical, is ensured in this way. In order to be able to apply this procedure, it is necessary to understand the cariogenic activity, how the carious processes work and who influences the progression of caries. In addition, the dentist must have knowledge of the biofilm of a carious lesion, how neodentinogenesis works but also alternative methods of excavation, all of which are necessary in order to treat a deep carious lesion and most likely extended by a successful indirect capping, the opening of the pulp

chamber being considered a failure in this chapter. [35]Thus the metabolic activity of the dental wound together with the biofilm from the tooth surface are the forces responsible for any mineral loss at the level of a tooth or the cavitary surface.

Contrary to the generally used procedures in filling a cavity, there is little evidence that the affected dentin should be completely removed and that this procedure should be more important than sealing the cavity. Affected dentin release does not appear to be involved in the progression of caries, pulpal inflammation, or pulpal necrosis. In this process some bacteria survive, many doctors have wondered what will happen to them and if they do not cause further damage and why they do not.

The pathology of dental caries is a dynamic process that takes place in the dental plaque, this being the microbial deposit or biofilm on the dental surface that results in an alteration of the balance between the dental substance and the overlying biofilm. Over time there may be a loss of minerals leading to the destruction of hard dental tissues and a visible dental lesion may occur.

Mechanical exposures are more likely to succeed in straight capping than carious-based openings. If the operator selectively selects the case, obtains hemostasis, in the case of direct capping, disinfects the exposure and the prepared cavity, uses the dam and properly seals both the pulp opening and the cavity preparation, success can be achieved with both calcium hydroxide and MTA. Although both techniques can successfully achieve pulp capping, the calcium hydroxide technique has proven successful over a longer period of time.

The gold standard of indirect pulp-capping materials, calcium hydroxide, is still widely used due to its ease of handling, paste form, and cheaper price when compared to MTA. However, studies found that professionals working in university settings tended to use MTA due to their up-to-date knowledge of contemporary literature, suggesting that MTA may become more popular in the future. [26]

CONCLUSIONS

For the treatment of deeply embedded carious lesions, indirect pulp capping in conjunction with total caries removal demonstrated a good success rate. At 12 months after treatment, Ca(OH)2 and MTA were both found to be clinically effective.

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