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Success of Direct Pulp Capping and Partial Pulpotomy of Primary Teeth using MTA

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Abstract: ***The purpose of this study was to compare the clinical and radiographic success rate of direct pulp capping (DPC) and partial pulpotomy (PP) treatment using MTA as pulp capping agent in treatment of primary teeth with pulp exposure after direct complete excavation. Methods: In the research were included 88 primary teeth with deep carious lesions without signs and symptoms of irreversible pulpitis and where pulp exposure occur. All teeth were treated under local anaesthesia and direct complete excavation DPC was conducted when the pulp is exposed up to 1 mm. PP is a procedure in which the inflamed tissue is removed to a depth of 1 mm or deeper. The pulp wound was dressed with grey MTA, GIC. Forty-nine teeth were treated with direct pulp capping and MTA; 53 teeth were treated with partial pulpotomy and MTA. The patients were scheduled for follow-up in 6 and 12 months. Results: The difference in the level of success was not statistically significant (p>0.05) for the groups of teeth treated with partial pulpotomy (93.48%-91.30%) versus those treated with direct pulp capping (92.86%-88.09%). Conclusions: Primary teeth with reversible pulpitis can be treated successfully by DPC and PP using MTA.***

Keywords: dental pulp exposure, reversible pulpitis, pulp dressing agent, calcified tissue barrier, MTA

1. Introduction

Despite the large progress in the prevention of dental caries [1, 2, 3] clinicians often diagnose deep caries and exposed dental pulp in both dentitions. Specialized literature discusses different treatment options for vital pulp exposed in primary teeth [2, 4, 5, 6]

The purpose of pulp therapy is to maintain the vitality of the pulp. The most preferable method of treatment of reversible pulpitis in primary teeth is direct pulp capping [7, 8, 9] and pulpotomy [10, 11, 12]. Partial pulpotomy, which is widely used for the treatment of exposed pulp in permanent teeth [13, 14, 15] has been already taught [5] and tested as treatment method in primary teeth [16].

Another aspect of pulp treatment is the issue of selecting biological pulp capping material that affects the remaining vital pulp. Current clinical practice abounds with studies demonstrating high success rates of Mineral trioxide aggregate (MTA) administered as pulp capping agent in primary teeth [17, 18, 19, 20]. MTA has been shown to induce less pulp inflammation and more dentine bridge formation when compared with CaOH cement [7, 21, 22, 23, 24].

The aim of this study was to compare the clinical and radiographic success rate of direct pulp therapy (DPC) and partial pulpotomy (PP) treatment in primary teeth with reversible pulpitis using mineral trioxide aggregate as pulp dressing agent.

2. Materials and Methods

Ethical approval was obtained from the Human Ethics Research Committee at the Medical University - Sofia, Bulgaria. Financial support was obtained from the Medical Science Council (Medical University-Sofia) through Grant No. 19/2011.

Criteria for selection of children were healthy children aged 4-8, without history of allergies and with positive attitude towards dental treatment. Written consent was obtained from the parents of all the participating children.

Criteria for selection of primary teeth were teeth with large cavitated carious lesion, visually without pulp exposure, without mobility, no swelling, tenderness to percussion or palpation, no evidence of draining sinus or previously conducted treatment, and they were suitable for adhesive restoration. *Symptoms* were tooth without pain - no night and spontaneous pain, pain to cold, sweet and pressure while chewing. *Bitewing Radiography* were used to select teeth with deep dentin carious lesions and a risk of pulp exposure -the demineralized dentin penetrated three fourths or more of the entire dentin thickness, with physiological root resorption up to ½ of the length of the root/s, teeth without internal or external resorption, with no furcation radiolucency or widened periodontal ligament space. These pre-operative clinical and radiographical criteria are typical for reversible pulpitis.

Intraoperative Findings. In addition a mechanical pulp exposure did not exceed 1-2 mm in diameter, and a haemorrhage control of pulp exposure site was achieved within one minute.

Treatment procedures

All teeth were treated under local anaesthesia (Scandonest 2%, Septodont, France; Ubistesin forte , 3M ESPE AG, Germany) isolated with cotton rolls. All cavities were opened with a carbide bur in a high-speed handpiece under constant water spray. A large round bur in a low speed handpiece and spoon excavators were used during caries

excavation. Following caries removal it is possible to expose superficial pulp tissue (after completely excavation of the infected dentin). DPC for teeth with diagnosis of reversible pulpitis is a procedure in which the pulp in the communication area is exposed up to 1 mm. PP is a procedure in which the inflamed tissue beneath an exposure is removed to a depth of 1 mm or deeper to reach healthy pulp tissue (5). In all cases bleeding was controlled with gentle pressure applied with a cotton pellet soaked in saline. If haemorrhage control was unsuccessful, after a period of 60 sec, the tooth was excluded. The pulp wound was dressed with grey MTA (Angelus, Solucoes Odontologicas, Londrina, Brazil). The MTA was mixed according to manufacturer's instructions and the mixture was gently placed using an amalgam carrier. A sterile cotton pellet moistened with distilled water was placed over the MTA and was then covered with a layer of GIC (GC Fujii–Tokyo, Japan). The teeth were restored with compomer (Compoglas, Ivoclar, Vivadent), lightcured for 40 seconds, using self-etching adhesive system (AdheSE, Ivoclar Vivadent).

3. Follow-Up Examination

The teeth were reviewed in 6 and 12 months following the operative procedure by one of the investigators. At each review appointment, the presence or absence of the following was assessed clinically - pain, tenderness to percussion, gingival inflammation, exudate/ discharge, draining sinus, mobility, and integrity of restoration. Control radiographs were taken in 6 months and in 12 months. These were compared in order to assess whether internal root resorption, widening of the periodontal ligament space or furcation radiolucencies had developed following treatment. Development of calcified barrier was also evaluated.

Every tooth was classified in any of three categories:

- Treatment is "successful" when the tooth is with no evidence of abnormal clinical and radiographic changes. It is possible to see formed calcified tissue barrier.
- The case is registered as "disturbances without complications" when one or more of the following were present - short term pain, mild tenderness to percussion, violation of integrity of restoration. Retreatment of the tooth is not required.
- Treatment is "unsuccessful" when one or more of the following were present - history of persistent pain, swelling, sinus tract, radiographic evidence of furcal pathosis, internal root resorption, widened periodontal ligament space, which requires another treatment method.

Case selection and treatment were performed by two calibrated investigators who are pediatric dentists in their private practice (Sofia, Bulgaria).

Statistical Analysis

For statistical analysis of the results we applied Two Sided Two proportions test (with 95% significance level, 5% risk of type I error) . The zero hypothesis is that the success rate in both treatment protocols are the same, i.e. the results of the treatment carried out in each of the two methods with MTA are equally good.

4. Results

Out of 77 healthy patients with 102 pulp exposures and restorable primary teeth that met the inclusion criteria, only 69 patients finished the treatment and the total number of treated teeth was 88 (m_1-22, m_2-18, m^1 – 24, m^2- 24). Eight patients with 14 treated teeth were later excluded from the study. Four failed to return for recalls at any time and four failed to return after the first recall. Forty-two teeth were treated by DPC and 46 were treated by PP. The success rate after clinical and radiographic analysis in 6 and 12 months are presented in Table 1.

Table 1: Distribution of successful and failed cases in 6 and 12 months in groups of primary teeth treated by DPC or PP using MTA

Treatment method	N treated/ N observed children	N treated/ N observed teeth	Review in 6 months	Review in 12 months	Two way test of statistical significance (p)	
			Observed teeth % of success	Observed teeth % of success	6 m	12 m
Direct pulp capping	37/33	49/42	36* 3** 39–92.86% 3***	35* 2** 37 – 88.09 % 2***	1-2 (0.908)	1-2 (0.620)
Partial pulpotomy	40/36	53/46	40* 3** 43 – 93.48% 3***	40* 2** 42–91.30% 1***		
Total	77/69	102/88				

*- successful treatment, **- disorders without complications
***- treatment failure/ unsuccessful treatment

Direct pulp capping

During the clinical evaluation three of 42 teeth were evaluated as a case of "disturbances without complication". Two of them showed initially, slight tenderness to palpation and mild gingival inflammation. These patients were given Ibuprofen, and after a few days the complaints ceased. In the third case radiographs showed furcation radiolucencies without complaints. These teeth were monitored over the next six months. Other 3 teeth were classified as "treatment failure". One of them had increased mobility with gingival inflammation, and the other two developed a draining sinus. Radiographs showed internal root resorption, furcation radiolucencies and were extracted. There were no clinical and radiographic changes in the remaining 36 teeth. None of them developed a calcified tissue barrier. During the first six months of observation teeth showed a "successful treatment" of 92.86%.

After 12 months 39 teeth were reviewed. One of them showed "disturbances without complications" in terms of defect in the restoration. Another one showed furcation radiolucencies without complains. Two teeth had "treatment failure". The first tooth showed gingival inflammation with increased mobility. Radiograph didn't show root complications. The case was set for retreatment by pulpotomy. The second tooth developed a draining sinus and was extracted. The remaining 35 teeth in the group showed

no clinical and radiographic changes (fig.1). None of them developed a calcified tissue barrier. After 12 months treatment results showed level of clinical and radiographic success of 88.09%.

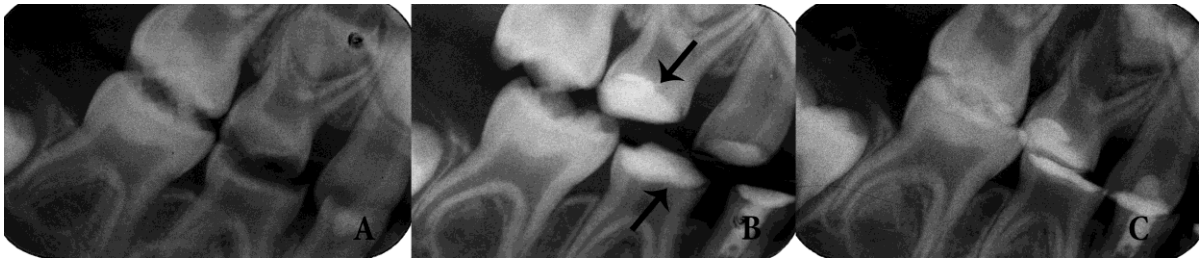

Figure 1: G.St. 4 year old boy. A. Radiograph taken before treatment showing deep carious lesion (teeth 54) and normal periapical conditions. B: Six months after direct pulp treatment using MTA.No visible calcified tissue formation (arrow). C. 12 months after DPC. Review showing normal furcation radiolucencies. No calcified tissue formation

Partial Pulpotomy

Three of clinical monitored teeth were evaluated as cases of "disturbances without complication". In two of them clinical characteristics showed short-term pain and slight tenderness to percussion initially. The patients were prescribed Paracetamol for 3 days and the pain ceased. The third tooth had a defective filling and it was redone. Three teeth were identified as "treatment failure". One of the cases developed a draining sinus, and other 2 had increased mobility with gingival inflammation. Radiographs showed internal root resorption (fig.3) and the teeth were extracted. The remaining 40 teeth showed no clinical and radiographic changes. None of them developed a calcified tissue barrier. During the first six months of observation teeth showed a success rate of 93.48%.

In 12 months 43 teeth were reviewed. Two of them showed "disturbances without complications" in form of defective restorations. One case was classified as "treatment failure" - clinical findings revealed gingival inflammation with increased mobility. Radiograph showed no root resorption or furcation radiolucencies. The tooth was retreated by pulpotomy. Among the remaining 40 teeth clinical and radiographic changes were not found. None of them developed a calcified tissue barrier with the exception of one (fig.2). After 12 months treatment results showed level of clinical and radiographic success of 91.30 %.

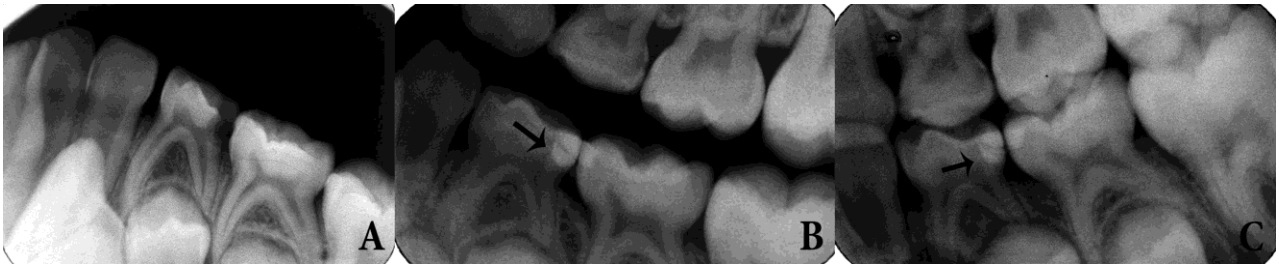

Figure 2: K.K. 7,5 year old boy. A. Radiograph taken before treatment showing deep distal carious lesion (tooth 74) and normal periapical conditions. B: Six months after PP treatment using MTA. No visible hard bridge formation (arrow). C. 12 months after PP review showed normal furcation radiolucencies. Hard tissue formation is visible (arrow).

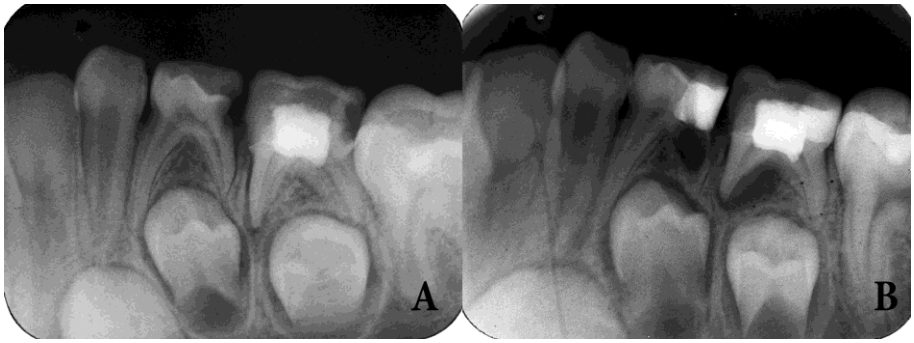

Figure 3: B.Y.6 year old girl. **A**. Radiograph taken before treatment showing deep distal carious lesion (tooth 74) and normal periapical conditions. **B.** Three months after PP treatment using MTA. Review showed internal root resorption. No hard bridge formation.The tooth had to be extracted.

The applied Two Sided Two-Proportion Test showed (table 1) that the difference in the level of success was not statistically significant ($p>0.05$) for the groups of teeth treated with PP versus those treated with DPC with a slight predominance of PP (93.48% - 91.30%) compared to that of DPC (92.86% - 88.09%) during the observation period of six months and 1year. Nine teeth were considered to be failed during the follow up period of the study.

5. Discussion

The research interest in this study is to verify whether after detection of mechanical pulp exposure of deciduous teeth in the process of complete removal of carious dentin in treatment of asymptomatic pulpitis, minimally invasive endodontic treatment techniques - DPC or PP could be successfully applied. Clinical protocol for the performance of PP in primary teeth is described from Schröder [5]. The main purpose was to observe the clinical and radiographic level of success of the DPC and PP in treatment of reversible pulpitis of primary teeth using MTA as pulp dressing agent**.** The criteria "favorable and successful" of the treatment procedures and MTA were the lack of clinical and radiographic signs of failure during the one year follow-up period.

In our study, MTA was a favorable pulp capping agent in 88.09% of the cases with DPC and in 91.30 % of the cases which were treated with PP. Respectively the presence of unfavorable clinical or radiographic symptoms were only in 5 teeth treated with DPC (11.90%) and 4 teeth treated with PP (8.69%). The results showed that PP cases had a higher proportion of teeth with a favorable outcome compared with the DPC cases, but the differences in the cases for both methods are statistically insignificant ($p<0.05$). The different outcome could be explained with the PP procedure, which consists of removal of part of the inflamed pulp tissue and therefore removal of some of the bacteria, which was not done during the DPC. Qudeimat *et al*. [5] also believe that it is likely to be a result of more removal of bacteria from the tooth, but many factors may have contributed. The sealing effect of MTA and the low toxicity [25], appear to encourage dentine bridge formation in exposed pulps and this may be due to a combination of its biocompatibility and alkalinity [20]. According to Okiji and Yoshiba [26] MTA acts not only as a “calcium hydroxide-releasing” material, but also interacts with phosphate-containing fluids to form apatite precipitates. Caicedo *et al*. [7] state that the formation of a dentine bridge is the sign required to signify a favorable response to pulp therapy. Very often with the help of radiographs, it is not possible to determine whether a bridge has formed. In our study we could not observe (except in one tooth) the radiographic image of hard tissue barrier in place of pulp communication. The teeth in which after one year there were no clinical and radiographic signs and symptoms of pulpitis were determined as teeth with successful treatment. Our study shows that "clinical success” can be achieved despite the lack of hard tissue barrier.

In our study only 9 teeth showed postoperative problems. Four teeth (3 with DPC and 1 with PP) developed draining sinuses, 5 teeth (2-DPC, 3-PP) had increased mobility with gingival inflammation. The pulps in these teeth probably were inflamed prior to treatment without clinical signs. The postoperative pain is a sign of an exacerbation of this inflammation following treatment. Internal root resorption occurred in 2 teeth with clinical symptoms of draining sinus – 1 was a PP case and other was a case with DPC. Internal resorption, can be generally a result of a swollen, inflamed pulp. Two DPC cases and 1 PP case had furcation radiolucencies. It can be expected that necrosis of the remaining pulp would manifest radiographically in this manner. In the DPC cases a furcation radiolucency is likely to develop as a result of bacteria and their toxins diffusing through accessory canals to the furcation area. In the case of a PP, a furcation radiolucency is likely to occur as a result of the same factors, but reducing the bacteria count by PP improves the chances of recovering of the pulp and preserving its vitality. All this makes endodontic therapy in primary teeth a very delicate procedure.

An often commented disadvantage of MTA, that the setting time (about four hours) and the need for the material to be in contact with water during the setting reaction we overcame by covering MTA with GIC and completed the restoration of the tooth with compomer. We have to say that the whole procedure can be completed in one appointment.

6. Conclusion

This study demonstrates that primary teeth with exposed pulp and reversible pulpitis can be treated successfully by DPC (**88.09 %**) and PP (**91.30%**) using MTA as pulp dressing agent. The whole procedure can be completed in one appointment.We suggest direct pulp capping and partial pulpotomy of primary teeth using MTA should not be rejected as treatment options, but should be investigated further, since they are a potentially success treatment.

7. Acknowledgements

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