



EARLY RESULTS AFTER DIRECT PULP CAPPING WITH TRICALCIUM-SILICATE BASED MATERIAL AND MINERAL TRIOXIDE AGGREGATE AND ER: YAG CAVITY PREPARATION IN DOGS

V. Stefanova^{1*}, Sn. Tsanova¹, P. Atanasova¹, Iv. Borisov², Ts. Chaprazov², M. Tsanova¹

¹Department of Operative Dentistry and Endodontics, Faculty of Dental Medicine, Medical University, Plovdiv, Bulgaria

²Trakia University, Stara Zagora, Bulgaria

ABSTRACT

PURPOSE: To study and compare the histological response of dog's pulp on the fourteenth and thirtieth day after Er:YAG laser preparation and direct pulp capping with tricalcium-silicate-based material and mineral-trioxide-aggregate.

METHODS: The experiment was carried out in two dogs. Eight cavity preparations and a communication with the dental pulp were made by Er:YAG dental laser. Four of the cavities were filled entirely with tricalcium-silicate-based material and in four of the preparations mineral-trioxide-aggregate was put as a liner and glass-ionomer obturations were made. The fourteenth and thirtieth days histological samples were observed by microscope with a built in photo camera.

RESULTS: There is an average degree of pulp inflammation in the samples of both investigated groups on the fourteenth day. On the thirteenth day in the specimens with tricalcium-silicate-based material there is a stripe of pre-dentin and normalization of the beneath pulp tissue. The samples with MTA show a slighter level of pulp healing stimulation compared to the other pulp capping material. No dentin bridge formation is observed. **CONCLUSIONS:** Direct pulp capping with tricalcium-silicate-based material and mineral-trioxide-aggregate after Er:YAG preparation in dogs provides optimal conditions for a pulp regeneration.

Key words: MTA, Biodentine, histology, pulp regeneration

INTRODUCTION

Direct Pulp Capping is an alternative procedure to extraction or endodontic therapy, in which a medicament is placed directly over the exposed pulp.

The management of direct exposures of the pulp to the oral environment by caries or other forms of injury has intrigued the dental profession for hundreds of years. While for a long time it was considered a hopeless task to save it from breakdown by a conservative pulp-capping or pulpotomy procedure, it became apparent, some 80–90 years ago, that pulpal healing is indeed possible. Although many products have been

suggested the most appropriate pulp capping material is yet not found. (1, 2, 3)

Mineral Trioxide Aggregate (MTA) has generated considerable interest as a direct pulp capping agent in recent years. Unset MTA is primarily calcium oxide in the form of tricalcium silicate, dicalcium silicate and tricalcium aluminate. Bismuth oxide is added for radiopacity. MTA is considered a silicate cement rather than an oxide mixture, and so its biocompatibility is due to its reaction products. Interestingly, the primary reaction product of MTA with water is *calcium hydroxide*, and it provides MTA's biocompatibility.

Many of the advantages and potential mechanisms of action for MTA are similar to calcium hydroxide, including its antibacterial and biocompatibility properties, high pH, radiopacity and its ability to aid in the release of

*Correspondence to: Vesela Stefanova, Department of Operative Dentistry and Endodontics, Faculty of Dental Medicine, Medical University-Plovdiv, Bulgaria, 3 Hristo Botev blv, vesela_st@yahoo.com, +359888656232

bioactive dentin matrix proteins. There is a significant difference between MTA and calcium hydroxide in the fact that MTA provides some **seal** to tooth structure. (4)

A new **tricalcium-silicate based formulation** (Biodentine™, Septodont, France), which is a dentine replacement material where the original dentine is damaged was developed. This dental material conciliates high mechanical properties with excellent biocompatibility and a bioactive behavior. In addition to the chemical composition based on the Ca_3SiO_5 – water chemistry which brings the high biocompatibility of already known endodontic repair cements (MTA based), this **calcium-silicate cement** shows higher physico-chemical properties (short setting time, high mechanical strength...) which make it clinically easy to handle and compatible, not only with classical endodontic procedures, but also for restorative clinical cases of dentine replacement. Sealing ability of this biomaterial is equivalent to glass-ionomers, without requiring any specific conditioning of the dentine surface. Leakage resistance and mechanical strength improve over the first weeks after placement. In addition, various factors are believed to influence the success of direct pulp capping. Burs may cause an additional mechanical trauma of the pulp. (5)

As an alternative to the rotary instruments dental lasers for cavity preparation are used. The Er:YAG (2940 nm) and the Er,Cr:YSGG (2780 nm) are currently two of the most commonly used lasers in dentistry. They exhibit the highest absorption of all infrared lasers in water and hydroxyapatite and are thus ideally suited for ‘optical drilling’ in enamel, dentin and composite fillings. The Er:YAG laser was reported to be 60% more efficient in enamel and 30% in dentine in terms of ablation speed per average laser power (in mm^3/Ws). (6)

AIM: To study and compare the histological response of dog’s pulp on the fourteenth and thirtieth day after Er:YAG laser hard dental tissue preparation and direct pulp capping with tricalcium-silicate based material and mineral trioxide aggregate.

MATERIALS AND METHODS

The experiment was carried out in two dogs at the age 1.5 years old and 25 kg of weight with permanent dentition. Eight cavity preparations

and a communication with the dental pulp ($D < 1\text{mm}$) of maxilla and mandible premolars and molars were made by Er:YAG dental laser (Lite Touch) with sapphire tips ($D - 0.8\text{mm}$, $L - 17\text{mm}$) using the software of the device. Four of the cavities were filled entirely with tricalcium-silicate based material (Biodentine) and in four of the preparations mineral trioxide aggregate (MTA) was put as a liner and glass ionomer obturations were made. The materials were mixed and applied according to the instructions of the producers. Fourteen and thirty days after the beginning of the experiment the investigated teeth were fixed in 10% formalin solution, dematerialized, cut in $5\ \mu\text{m}$ slices and stained. The histological samples were observed by microscope (Olympus BX 51) with a built in photo camera. The odontoblast and pre-dentin zones, blood vessels near by the cavity preparation and dentin bridge forming were examined.

RESULTS

In this study we found histological evidences of a average degree of pulp inflammation in the samples of both investigated groups on the fourteenth day. Wide blood vessels in the peripheral pulp zone are observed. (**Figures 1, 2**)

On the thirteenth day of the experiment in the specimens with tricalcium-silicate based material there is a well seen stripe of pre-dentin near the preparation and normalization of the beneath pulp tissue. (**Figure 3**) The samples with MTA show a slighter level of pulp healing stimulation compared to the other pulp capping material. (**Figure 4**)

On this early stage of the experiment no dentin bridge formation is observed.

DISCUSSION

For the first time in our research the pulp response after Er:YAG dental hard tissue preparation and tricalcium-silicate based material as a pulp cap was studied and a comparison to MTA was made. Only histological investigation can give objective data for the real status of the pulp. There are obvious difficulties for such experiments in humans. There are several papers for direct pulp capping in rats and cats which study the histological results after pulp capping with MTA and calcium-hydroxide (7) and the healing process after the combination between MTA and Er:YAG laser ablation of the pulp exposure (8).

They report for a pulp inflammation with invasion of inflammatory cells (neutrophil granulocytes) and dilated blood capillaries near by the preparation in the first/second week of the experiment, and no evidences for reparative dentin bridge formation on this early period

which are similar to our own results. The use of MTA together with Er:YAG dental laser compared to pulp capping only with calcium-hydroxide or MTA show better histological results in cats (7).

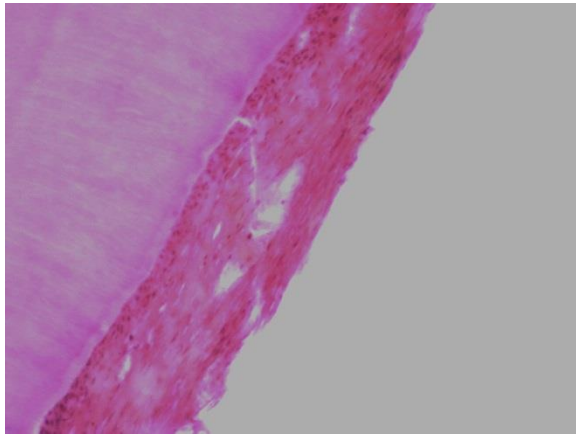


Figure 1. MTA-14th day x20

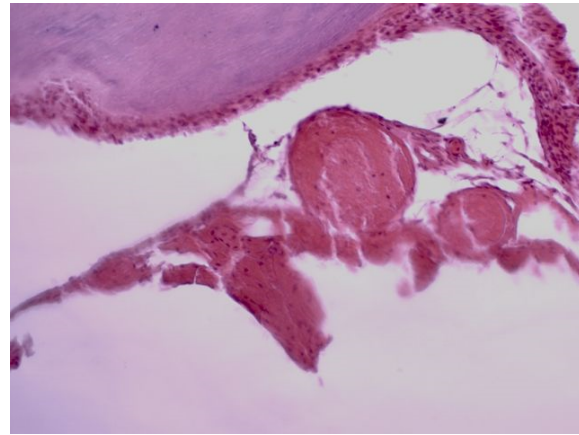


Figure 2. Biodentine-14th day x20

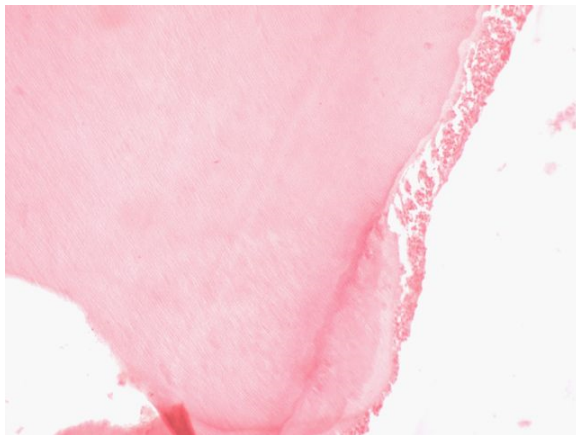


Figure 3. Biodentine-30th day x10

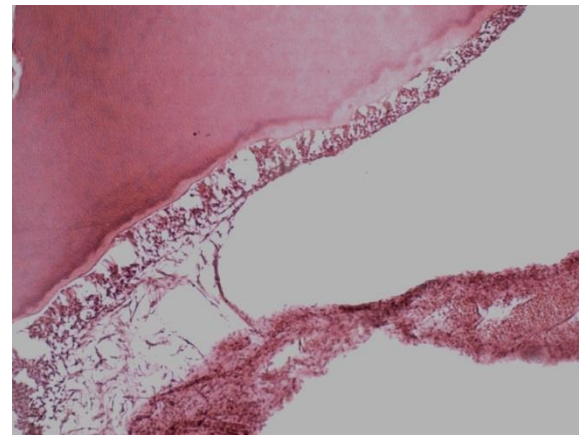


Figure 4. MTA-30th day x 10

We have chosen dogs as experimental animals because of the dental similarities with human teeth bigger than those with rats and cats.

In a SEM research Tsanova and Tomov (9) study the morphological changes of dentin after rotary instruments and Er:YAG dental laser preparation and they found clear dentin walls without smear layer with widely opened tubules after laser application compared to the thick smear layer and filled dentin canals after bur preparation. The absence of smear layer is a good condition for better sealing of MTA and tricalcium-silicate based material and their bioactive action and together with the bactericidal effect of Er:YAG

laser ablation can be key factors for the success of the direct pulp capping.

CONCLUSIONS

On the fourteenth and thirtieth day after direct pulp capping with tricalcium-silicate based material and mineral trioxide aggregate after Er:YAG dental laser hard tissue preparation in dogs histologically proved optimal conditions for a pulp regeneration process are available.

ACKNOWLEDGMENTS: The study is a part of a scientific research project 23/2012 funded by Medical University-Plovdiv, Bulgaria

REFERENCES

1. Hilton TJ. Keys to clinical success with pulp capping: A review of the literature. *Oper Dent* 2009; 34-5, 615-625
2. Ward J. Vital pulp therapy in cariously exposed permanent teeth and its limitations. *Aust Endod J.* 2002;28(1):29-37
3. Bergenholtz G, Spangberg L. Controversies in Endodontics. *Crit Rev Oral Biol Med* 2004; 15(2):99-114
4. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review--Part III: Clinical applications, drawbacks, and mechanism of action. *J Endod.* 2010 Mar;36(3):400-13
5. www.septodont.fr, Biodentine-Septodont, Active Biosilicate Technology, Scientific File, March 2014
6. Perhavec T, Diaci J. Comparison of Heat Deposition of Er:YAG and Er,Cr:YSGG Lasers in Hard Dental Tissues. *J. Laser Health Academy*, 2009, 2-1
7. Dammaschke T, Wolff P, Sagheri D, Stratmann U, Schäfer E. Mineral trioxide aggregate for direct pulp capping: a histologic comparison with calcium hydroxide in rat molars. *Quintessence Int.* 2010 Feb;41(2):20-30
8. Hasheminia SM, Feizi G, Razavi SM, Feizianfard M, Gutknecht N, Mir M. A comparative study of three treatment methods of direct pulp capping in canine teeth of cats: a histologic evaluation. *Lasers Med Sci.* 2010 Jan;25(1):9-15
9. Tsanova Sn., Tomov G. Morphological changes in hard dental tissues prepared by Er: YAG laser (LiteToch, Syneron), Carisolv and rotary instruments. A scanning electron microscopy evaluation. *Folia Medica* 2010; 52(3); 46-55