

Effect of diode laser irradiation on the apical sealing of MTA retrofillings

Efeito da irradiação de laser de diodo no selamento apical em retrobturações com MTA

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ABSTRACT: Apical sealing is essential for the success of paraendodontic surgery, so any procedure that may favor an adequate sealing of the apical remainder should be performed. The purpose of this study was to evaluate the influence of diode laser irradiation on the apical sealing of root-end cavities with MTA retrofillings. Root canals in twenty extracted human teeth were shaped with K-files and filled with gutta-percha. The apices were cut off and root-end preparations were performed. The roots were divided randomly in 2 groups. Group 1 (ten specimens) was retrofilled with MTA. Group 2 was irradiated with diode laser, with 1 W for 20 seconds, on the apical surface and root end cavity before retrofilling with MTA. The specimens had their external surfaces impermeabilized with cyanoacrylate, except for the apical surface, and were then immersed in 1% rhodamine B dye for 72 h and placed in plaster stone. After that, the specimens were submitted to longitudinal abrasion until half of the root remained. The linear dye leakage was observed in these mid-roots between the root canal wall and retrofilling. The linear dye leakage was measured with Image Lab software, and the results were statistically analyzed with Student's *t* test. There were no statistically significant differences between the two groups ($p > 0.05$). The diode laser irradiation did not improve the apical sealing of MTA retrofillings under the conditions of this *in vitro* study.

DESCRIPTORS: Lasers; Endodontics; Retrograde obturation.

RESUMO: O selamento apical é fundamental para o sucesso da cirurgia paraendodôntica. Assim, procedimentos que melhorem o selamento do remanescente apical devem ser utilizados. O objetivo deste estudo foi verificar se a irradiação de laser de diodo poderia aumentar o selamento apical em cavidades retrógradas obturadas com MTA. Foram utilizadas 20 raízes de dentes humanos extraídos que, após preparo com lima tipo K, tiveram seus canais obturados com guta-percha. Os ápices foram cortados e sofreram preparo de cavidades retrógradas. As raízes foram divididas aleatoriamente em 2 grupos. O grupo 1 (dez espécimes) foi retrobturado com MTA, e o grupo 2 sofreu irradiação de laser de diodo na potência de 1 W por 20 s na superfície apical e na cavidade retrógrada antes da obturação com MTA. Os espécimes foram impermeabilizados externamente com cianoacrilato, com exceção da superfície apical, imersos em corante rodamina B a 1% por 72 h, incluídos em gesso e posteriormente desgastados no sentido longitudinal até obter-se metade da raiz. Foi feita a leitura da infiltração linear do corante nessas hemi-raízes, entre a parede do canal radicular e a retroobturação, com auxílio do programa de computação Image Lab. Os resultados foram analisados estatisticamente pelo Teste *t* de Student. Não houve diferença estatística significativa entre os dois grupos ($p > 0,05$). A irradiação com laser de diodo não proporcionou aumento do selamento apical em retrobturações com MTA sob as condições do presente estudo *in vitro*.

DESCRIPTORES: Lasers; Endodontia; Obturação retrógrada.

INTRODUCTION

Apical surgery is a useful procedure when endodontic therapy has failed, and apical sealing plays an essential part in its success^{2,15}. This hermetic seal is intended to prevent the remaining dentinal tubules contamination from reaching the periapical tissues, or to prevent root canal re-infection by the periodontium⁵.

The apical sealing obtained with an MTA (mineral trioxide aggregate) retrofilling produces better results than amalgam, Super EBA¹⁴, IRM, glass ionomer and cyanoacrylate¹, according to dye leakage studies. MTA presents high biocompatibility, equal to that of amalgam¹⁶, and induces tissue repair with bone regeneration^{7,11}.

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Among the present resources in Dentistry, laser irradiation has several applications, and its properties are very interesting in endodontic therapy. It has an effect on dentin permeability^{3,8}, and is used for cutting hard and soft tissues, and in coagulation, vaporization and disinfection procedures¹⁰. It seems clear that laser has a large amount of study possibilities. Because of its optical properties, laser irradiation has been also used in apical surgery.

The diode laser – GaAlAs – has a wavelength of approximately 809 nm and, like Nd:YAG, has its light in the infrared spectrum. It has been used in the detection of cavities by transillumination, and in dentinal disinfection¹². Because its cost is lower than that of other lasers, diode laser appears as a viable alternative that needs further experimental testing for its use^{4,9}.

The purpose of this study is to evaluate the influence of the diode laser on the apical sealing in root end preparations filled with MTA.

MATERIAL AND METHODS

Twenty single roots were cleansed and kept in saline solution storage. The cervical third was resected to produce specimens with a total length of 15 mm. The specimens had their root canals cleaned and shaped with K-files up to #40 with 0.5% sodium hypochlorite and 10% urea peroxide – Endo PTC cream (Oficinalis Pharmacy, São Paulo, SP, Brazil), and final irrigation with 17%

EDTA-T (Oficinalis Pharmacy, São Paulo, SP, Brazil). After these procedures the specimens were filled with gutta-percha (Dentsply®, Petrópolis, RJ, Brazil) and N-Rickert cement (Oficinalis Pharmacy, São Paulo, SP, Brazil). The apicectomy was done perpendicular to the long axis of the teeth, 3 mm short of the apexes with a diamond bur mounted on a handpiece with water cooling. Three millimeter-deep, intracanal cavities were made on the root ends with a #2 carbide bur.

The specimens were randomly separated in 2 experimental groups:

- Group 1 (without irradiation) – retrofilled with MTA® (Angelus, Londrina, PR, Brazil).
- Group 2 (with irradiation) – irradiation with diode laser (L 808 - Lasering™, Modena, Italy) (Figure 1) with 1 W for 20 seconds, by contact. The apical surface and cavity were scanned in all directions, and were then filled with MTA.

The specimens had their external surfaces impermeabilized with cyanoacrylate (Super Bonder® - Loctite Henkel, Itapevi, SP, Brazil), except for the apical surfaces, before storing in 1% Rhodamine B dye for 72 h.

The specimens were dried in an incubator at 37°C for 2 h and placed in plaster stone. After that, the samples were submitted to longitudinal wear until half of the root remained. Each specimen provided two linear dye leakage results (one measurement in each inner wall).

RESULTS

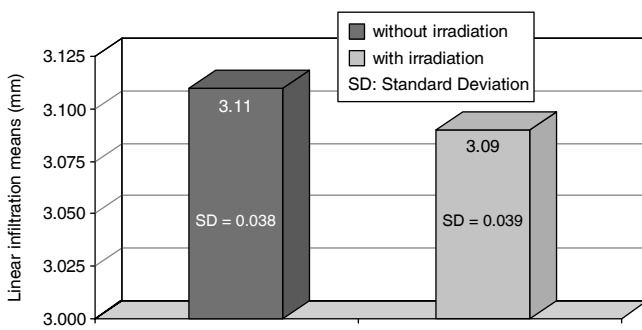
Linear dye leakage was considered from the apex up to the end of the stained area of the inner wall of the canal. The measurements were made with ImageLab® software (Diracom Bio Informática, Vargem Grande do Sul, SP, Brazil). The results were statistically analyzed with Student's *t* test. No differences between the two groups were found (Graph 1 and Table 1).

DISCUSSION

Periradicular surgery is a last attempt to save a tooth where re-intervention is not possible or endodontic treatment was not able to produce resolution of the disease. The main cause for it is a persisting contamination of the dentinal tubules, despite conventional endodontic treatment. Such microbial permanence in the root canal system is due to iatrogenic procedures, inaccessible infected niches or resistant microorganisms, leading to fail-



FIGURE 1 - Diode laser L 808 - Lasering™.



GRAPH 1 - Linear infiltration means (mm).

ure of the endodontic treatment and retreatment. Surgical intervention aims primarily at obtaining apical sealing in order to stop endodontic-periodontal communication^{2,15}.

Among root end filling materials are Super EBA, IRM, silver amalgam, glass ionomer and MTA. Mineral trioxide aggregate (MTA) is the material which presents the best results in terms of apical sealing when compared to the other materials in dye leakage or endotoxin studies⁶. It has high biocompatibility¹³ and, similarly to amalgam, causes a favorable inflammatory reaction at 7, 15, 30, 60 and 90 day periods in rats¹⁶. In that study the authors observed dystrophic calcification in the connective tissue adjacent to the MTA filling, which they credited to a reaction of calcium oxide (present in MTA) with tissue fluids, forming calcium hydroxide. Those findings are corroborated by total resolution results in root perforations observed in another long term study⁷.

The diode is a semiconductor chip, which consists of two semiconducting materials, one carrying a positive charge, and the other a negative one. They are separated by a non-conductive bandgap layer. Applying positive and negative voltages to conductors leads to a combination that releases energy as a light when the materials are gallium arsenide and aluminium - GaAlAs⁸. The diode laser has been studied in photoactivated disinfection of the root canal and external root surface treatment and disinfection¹⁰. When applied on external root surfaces with 1 W of power *in vitro* without previous scaling or root planning procedures, the diode laser caused dentinal permeability decrease⁹. SEM analysis shows few cementum and smear layer changes with diode laser at 1 W of power in extracted teeth with previous scaling and planning procedures. No melting, fusion or carbonization were found¹².

In the present study, the diode laser was applied with 1 W on the apical and cavity surfaces

TABLE 1 - Linear dye leakage in millimeters.

| Group 1: without irradiation | Group 2: with irradiation |
|---------------------------------|------------------------------|
| 3.156 | 3.073 |
| 3.189 | 3.179 |
| 3.122 | 3.096 |
| 3.093 | 3.065 |
| 3.059 | 3.136 |
| 3.091 | 3.118 |
| 3.177 | 3.048 |
| 3.096 | 3.078 |
| 3.089 | 3.091 |
| 3.145 | 3.065 |
| 3.155 | 3.073 |
| 3.171 | 3.097 |
| 3.094 | 3.129 |
| 3.067 | 3.111 |
| 3.126 | 3.084 |
| 3.116 | 3.059 |
| 3.051 | 3.109 |
| 3.158 | 3.119 |
| 3.109 | 3.088 |
| 3.091 | 3.090 |

before retrofilling with MTA to avoid interaction between the diode laser and MTA, because this type of laser greatly interacts with dark pigmented surfaces. Using the diode laser after retrofilling with MTA would increase the temperature, which might crack the retrofilling.

The power setting used was based on a previous thermal analysis study¹², in which it was found to be safe. Dye leakage decrease was not observed in this study. This suggests that the laser irradiation caused little or no effect on the apical surface and on the MTA retrofilling interface. Further studies using a higher power setting or a different scanning dynamics with more intervals should be carried out in order to evaluate a possible improvement of the apical sealing.

CONCLUSION

Following the parameters used here and under the conditions of the present study, the specimens submitted to diode laser irradiation did not present any difference in apical sealing when compared with the specimens of the non-irradiated group.

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