Effect of low intensity laser supporting bone repair on a tooth with root perforation and periradicular lesion: case report and 12 years follow-up

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ABSTRACT

Introduction: Low intensity laser has properties that may be effective in endodontic treatment, such as restorative capacity, antimicrobial performance and cell proliferation. **Methods:** This report describes the action of low intensity laser as an adjunct to bone repair of a root perforation and peri-radicular lesion in a tooth submitted to endodontic treatment, in which endodontic retreatment was performed only in the mesiobuccal canal using calcium hydroxide as intracanal medication and low level laser. The other canals were not submitted to retreatment, in spite of having peri-radicular lesions. **Results:** The low-intensity laser was effective as an adjunct to the bone repair process, restoring ad-integrum, interradicular bone and the peri-radicular lesions of the mesial and distal roots, after 12 years of follow-up. **Conclusion:** The laser at low intensity can be used as a coadjuvant to the treatment of perforations, demonstrating long-term success.

Keywords: Endodontics. Low-Level Light Therapy. Root Canal Therapy

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Introduction

The use of low level laser has been studied since the 1960s, mainly by Prof. Endre Mester, who was one of the pioneers of the use of laser on biological tissues, with the aim of increasing the speed of tissue repair.

Low level lasers were found to promote various effects such as an increase in local microcirculation, lymphatic drainable, cell proliferation, increase in the number of fibroblasts, and consequently, an increase in collagen synthesis.

The action of these lasers on biological tissues begins with peripheral vasodilatation, degranulation of mastocytes, mitochondrial stimulation, increase in ATP production, increase in both fibroblast proliferation and the number of mitoses. The above-mentioned changes lead to an increase in the speed of epithelial regeneration and acceleration in the process of osteogenesis.[1-6]

The lasers were evaluated as coadjuvant therapy in post-extraction bone repair, with promising results such as an increase in the number of BMP (Bone morphogenetic proteins) in the irradiated site, and consequent increase in bone mineralization.[7-9]

In endodontics, low level laser has been used as coadjuvant to antibacterial therapy, as aid in the process of bone repair of peri-radicular lesions, and in direct pulp capping procedures, and has obtained promising results.[10]

Relative to root canal preparation, we emphasize that failure to pay attention to the degree of axial inclination of a tooth will result in failure to direct the burr parallel to the long axis of the tooth, and consequently this could result in a perforation.[11]

Adequate knowledge of the internal anatomy of the tooth and its variations are of fundamental importance during the procedures for preparing the intraradicular space for a prosthesis retention post, thus preventing accidents such as exaggerated or poorly directed dental wear procedures.[12]

Root perforations may result from various factors, among others, excessive removal of dentin during root canal preparation is emphasized; these are characterized by acute pain and continuous bleeding of the canal. Perforations may occur on the external side of the curve, or in a more coronal position of the internal curve.[13]

The undue use of large caliber instruments, as well as rotary instruments used in root canal preparations may lead to thinning of the walls, with eventual occurrence of perforations, particularly in the mesio-vestibular roots of maxillary molars and the mesial root of mandibular molars.[14]

The aim of this report was to demonstrate the effect of low level laser used as coadjuvant therapy in the process of bone repair and peri-radicular lesions of a tooth with a iatrogenic root perforation and peri-radicular lesions in the mesial and distal roots.

Case Report

The patient, M.L.N, 25 years of age, was referred to a private dental office for clinical exam and treatment of tooth 46.

At the beginning of 2003, the patient complained of pain and slight tumefaction in the vestibular regions of the right mandibular first molar. The clinical history reported that this tooth had been submitted to two endodontic retreatments, the latter being concluded in January 2002. The tooth remained with zinc oxide and eugenol-based interim sealing until October, and an interim metal-ceramic crown had been fixed. Furthermore, it was reported that the patient felt pain during preparation of the root canals for fixation of the intracanal posts. In the following session, during definitive fixation of the metal core, the patient again felt a great deal of pain. Nevertheless, the preparation, impression-taking and fixation of the metal-ceramic crown was carried out.

This was provisionally performed in the expectation that the pain would pass over time. This, however, did not occur, and led to the patient removing the work that had been done.

After removing the crown, and during the clinical exam, the patient still felt pain, had tumefaction in the vestibular region of tooth 47 with a cast metal core. In the radiographic exam, the tooth was shown to have filled root canals, periapical radiolucent areas and thickening of the periodontium in the region of the furca (Figs 1 A and B).

Urgent treatment was performed, during which the metal core was removed with Enac ultrasound, using a special ST 09 tip. After removal of the core, the root canals were explored with a type K file No.10, thus allowing confirmation of the suspected perforation that was eventually localized close to the region of the furca, in the mesio-vestibular root, as shown in Figure 2.

Figure 1. Initial Radiographs taken at different radiographic angles, demonstrating periapical radiolucence and in furca region. 2/13/2003.

Figure 2. Radiographic image of file introduced into perforation 3/4/2003.

Once perforation of this root was confirmed, the option taken was to perform retreatment of this (mesio vestibular) canal only; seeing that it showed an adequate radiographic aspect after the previous retreatment, perpetuation of the lesion could be related to the perforation. Therefore, retreatment of the other canals would not be justified. With the aid of Hedströem files and xylol used as gutta percha solvent, the filling material was removed from the canal; it was prepared mechanically using the oscillatory movement technique, with the aid of copious irrigation with 2.5% sodium hypochlorite. Afterwards, the canal was filled with calcium hydroxide paste Pa/distilled water and temporarily sealed with Cotosol and IRM (Figs 3A and B).

Therefore, with the tooth temporarily sealed and the canals filled with calcium hydroxide-based intracanal medication, the patient was submitted to therapy with low level laser. A total of 15 laser sessions were performed with 2 weekly applications, punctually, in contact mode, perpendicular to the tooth, with fluence of 9 J/cm². The laser used was the Twin-Flex (MMOpitcs - São Carlos - São Paulo/Brazil), emitting in the infrared spectral region, with 785nm and power of 70 mw.

The patient returned one month after the first intervention with the aim of evaluating the procedures performed up to then. However, the patient presented no symptoms in the treated tooth. The procedure of changing the intracanal medication was performed approximately every three months, and the teeth was temporarily sealed as previously described (Figs 4A, B and C).

On 28.12.2003, the decision was taken to perform definitive filling of this canal with gutta percha cones and zinc oxide and eugenol-base filling paste according to the Lateral Condensation technique. The perforation was filled with the same filling cement as that used for the canal. Sealing of the canal entrances was concluded with light polymerizing resin. Figure 5A, dated 15.04.2004, illustrates satisfactory repair of the lesioned areas (periapical and furca regions), and filling of the mesio-vestibular canal.

Clinical and radiographic control was performed periodically. The control radiograph dated 29/12/2005 demonstrated complete restitution of the lamina dura of the periodontium in the region of the furca, and reduction of the periapical radiolucent areas of the mesial and distal roots that were not retreated (Fig 5B).

The tooth was restored with a complete crown, supported and retained by means of a cast metal core fixed in the distal and mesio-lingual canals (Figs 6A and B).

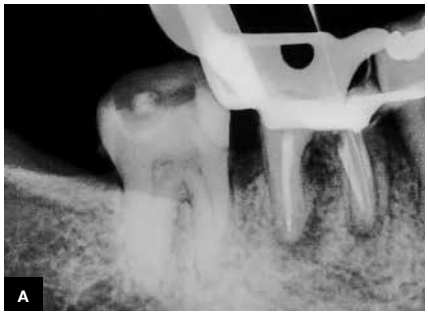

Figure 3. Removal of filling and odontometry, canal filled with calcium hydroxide and interim sealing of root canals.

Figure 4. Periapical radiographs showing evidence of reduction in radiolucent areas at time intervals of 3 months (06.06.2003, 26.09.2003 and 09.12.2003).

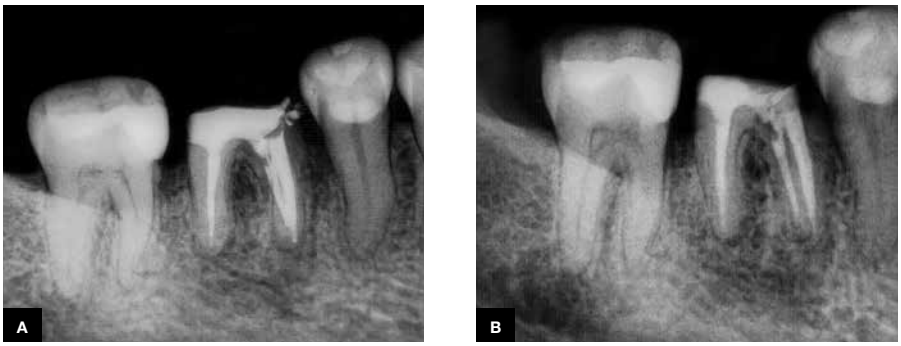

Figure 5. A) Control radiograph, filling of canal MV and repair of lesioned areas. 4/15/2004. **B**) Control Radiograph 12/29/2005.

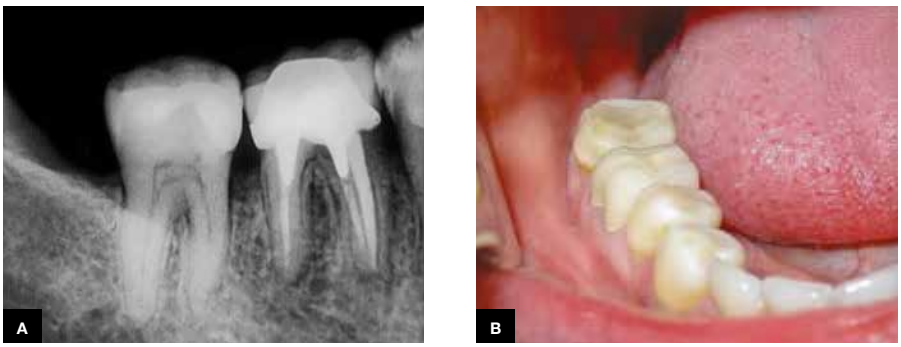

Figure 6. Radiographic and Clinical aspect after 12 years of follow-up (11.12.2015).

Discussion

The procedures of cleaning, impression-taking and disinfection of root canal systems must be performed promptly, completed with high-quality three-dimensional filling, with the purpose of reestablishing function of the tooth. We emphasize that recontamination of root canals may occur if there is delay in performing the final restoration of the tooth after endodontic treatment, because conclusion of root canal treatment consists of immediate definitive restoration of the tooth.

Treatment of these perforations may be performed with the aid of calcium hydroxide, which has properties - among others - of inactivating bacterial enzymes (antibacterial effect) and tissue enzymatic activation, particularly alkaline phosphatase (mineralizing effect). When associated with aqueous or viscous vehicles, it forms a paste that it introduced into the canal, and vertically compacted against the perforation, creating favorable conditions for the occurrence of repair.[14,15]

A root perforation may also be sealed with MTA (Mineral Trioxide Aggregate), a powder that consists of a combination of trioxides with other hydrophilic mineral particles that crystallize in the presence of humidity. This material was originally indicated as filling in cases of intra-radicular and furca perforations, and comparative studies have been conducted relative to its sealing capacity in comparison with materials previously used for this purpose, such as silver amalgam and IRM. In the contemporary context, the

use of MTA in sealing the perforation would be the most adequate procedure, however, at the time of performing the proposed treatment, the absence of longitudinal studies analyzing the efficacy of this material in the long term, made it inadvisable to use it.[11,16]

Treatments by means of reparative surgeries with a view to sealing perforations were described by Gonn and Ludergam, 1966, who proposed a multidisciplinary treatment to repair a perforation of the furca in a tooth. Endodontic retreatment of the tooth was performed, and afterwards periodontal surgery was carried out, using guided tissue regeneration techniques and sealing of the perforation with Ketac-endo cement and follow-up for up to 24 months, with evidence of repair shown in radiographs.[17]

Whereas, through the approach of Lubart, et al., 1995 and Abergel, et al., 1996, the clinical use of low level lasers for accelerating the bone repair process has been recommended, because the mentioned lasers had effects on biological tissues by intermediation of photophysical reactions and/or photochemical processes and by primary and secondary mechanisms.[18,19]

The primary and secondary mechanisms of action of direct irradiation with red and infrared lasers on cells have shown that cytochrome c oxidase, which is a terminal enzyme of the respiratory chain of eukaryotic cells, may be a possible photoacceptor when cells are submitted to irradiations. The primary mechanisms are: changes in the redox property of the respiratory chain components after photoexcitation of its electronic states, generation of singlet oxygen, transitory localized heating of the absorber chromophores and increased production of superoxide anions, with subsequent increase in the concentration of H2O2, product of its dismutation

(Chemical process in which an element with a certain oxidation number transforms itself, originating

Compounds that have two or more oxidative numbers. The secondary mechanisms are related to a cascade of reactions connected with changes in the cell homeostasis parameters (pH, concentration of Ca, AMPc and ATP concentration).[19,20]

The irradiations are differentiated by their photochemical and photophysical properties; visible light is believed to trigger a cascade of metabolic events through the formation of photosensitive reactive oxygen species (ROS) that stimulate the redox activity of the respiratory chain, while the infrared (light?) reactivates the ATPase ion pumps in the cell membrane.[18]

In an in vitro study comparing the antibacterial action of disinfection photoactivated with agents widely used for this purpose, such as 2% chlorhexidine and 2.5% sodium hypochlorite, it was demonstrated that the disinfection photoactivated with the aid of low level laser obtained statistically similar results to those of chlorhexidine. This demonstrated the possibility of using this method in endodontic treatment.[21]

It should be pointed out that variations in lasers described in the literature and the different protocols used made it difficult to perform a meta-analysis and systematic review of the laser therapy alone, and as coadjuvant to endodontic anti-infection therapy. However, by means of clinical and in vitro studies, as in the case described in the present article, laser therapy has been demonstrated to be a promising method.[22]

The increase in the speed of bone repair was demonstrated radiographically in a study analyzing the repair obtained in teeth with peri-radicular changes, treated with endodontic therapy; a significant increase in the speed of bone neoformation was found in the group of teeth irradiated with low level laser when compared with the control (non irradiated) group.[23]

In the clinical case reported, the patient was submitted to low level laser therapy with the purpose of obtaining an increase in the speed of repair, in spite of the patient being asymptomatic. The fluence (9J/cm^2) and quantity of sessions applied were based on the studies of Benedicenti (1982); Kert and Rose (1989).[24,25]

Different reports of cases in which low level laser therapy was associated with bone repair have been reported in the literature, [26,27], however, the present report presented clinical and radiographic follow-up for a long period (12 years), demonstrating the successful treatment of the case and possibility of using other roots as control. This was possible considering that endodontic treatment was performed only in the mesio-vestibular root and the tooth had a peri-radicular lesion in the distal root as well as in the perforation in the region of the furca. It was possible to analyze the action of the laser in different clinical situations, without there being bias related to different hosts. Radiographically, the tooth showed satisfactory sealing after the last retreatment. Therefore, the option taken was to perform retreatment of the mesio-vestibular canal only, and the use of low level laser acted as coadjuvant to the healing process, accelerating bone repair of the peri-radicular lesions in the other canals. This therapy

favored the maintenance of tooth 46 in function, with the absence of inflammatory signs and symptoms, and use of less invasive methods.

Acceleration of repair possibly occurred due to the changes in chemical mediators, increase in activity of undifferentiated mesenchymal cells arising from the periodontal ligament and their differentiation into fibroblasts, with consequent fibroblast proliferation.[7]

Conclusion

Endodontic treatment or retreatment of teeth with peri-radicular lesions must be carried out in the best possible manner by means of adequate cleaning and shaping of the root canal system, preferably by using calcium hydroxide-based intracanal medication which, due to its antibacterial and mineralization inducing potential greatly contributed to the repair of the peri-radicular lesions.

Low level laser may be used as coadjuvant in the bone repair process for the treatment of peri-radicular lesions. The operator must, however, have extensive knowledge about the characteristics of the tissue to be irradiated, laser to be used, fluencies, number of sessions and power of the appliances, in order for treatment to be really effective.

Considering the results obtained in the present clinical case, it would appear to be reasonable for us to conclude that the absence of symptomatology in this tooth and the evident reduction in radiolucent areas - as shown in the radiographic sequences dated 29.12.2005 and 11.12.2008 - allowed us to consider the therapeutic approach here instituted to be most successful.

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