Endodontic treatment of periapical chronic periodontitis

A Laser Assisted Technique

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_Abstract

Nowadays, the bactericidal effect of laser irradiation is well known in endodontic therapy. Many studies showed that, in combination with an appropriate shaping and cleaning of root canal system, laser irradiation, inside the root canal, could increase the percentage of bactericidal effect in endodontic treatment. Three clinical cases of teeth with periapical chronic periodontitis are presented. In two cases, teeth were treated by one-visit laser-assisted therapy, using Nd:YAG 1,064 nm, the other case was treated following a standardized protocol for diode laser 808 nm. In all the cases a complete long term clinical and radiographic healing was observed. We suggest that "single visit treatment Laser assisted" could be useful in the endodontic treatment of periapical lesions, because it's safe and could be indicated for patient's time constraints.

_Introduction

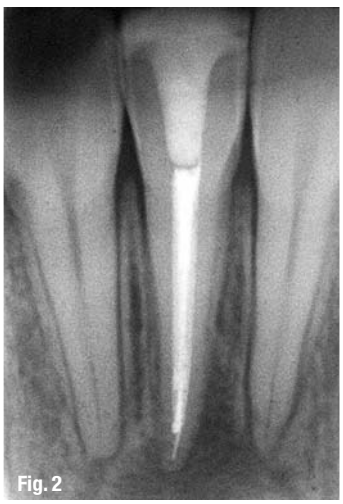
Root canal disinfection of necrotic teeth may be achieved through proper shaping and cleaning techniques, with the aid of instruments that, combined with irrigant solutions, remove the pulp and infected dentine. Specifically, it is possible to remove necrotic pulp tissues and one layer of 1–2 µm of organic and inorganic materials, adhering to the root canal wall, formed during the mechanical instrumentation, which is the so-called "smear layer".

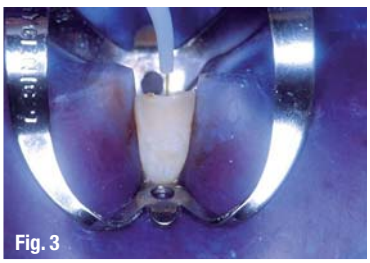
Cleaning is usually performed by chemical irrigant solutions. The most used irrigant solution is sodium hypochlorite (NaOCl), that is able to dissolve organic substances, especially on necrotic tissue fragments that have lost their blood supply, while it is powerless on live tissues.[1,2]

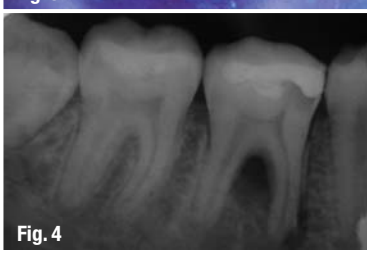
No solutions alone are effective against organic and inorganic components, so chelating agents

Fig. 1_Periapical X-ray of the 4.1. Note the large periapical radiolucency compatible with apical periodontitis and the presence of two canals.
Fig. 2_Periapical X-ray control at 6 months, note an important reduction of the radiolucency.
Fig. 3_Insertion of a Nd:YAG laser's fiber after the cleaning and shaping of the two canals.
Fig. 4_Periapical X-ray of the 4.6 with a large periapical lesion.


Fig. 1


Fig. 2


Fig. 3


Fig. 4

have been proposed as root canal irrigants too. These substances can chemically bind to calcium ions, removing the salts of calcium from the internal walls of root canals and going, therefore, to soften the dentin during preparation. The most used chelating agents are ethylene diamine tetracetic acid (EDTA) and citric acid.

To obtain a good disinfection, endodontic solutions, acting through direct contact with target bacteria, must penetrate the entire root canal system, including various side canals and dentinal tubules, that would otherwise constitute an important source for potential bacterial re-infection.

Experimental studies showed that different bacterial species can invade and traverse the dentinal tubules even up to significant extensions. Perez et al.[3] reported an average depth of penetration of S. sanguis to 458.8 µm along the dentinal tubules, with a maximum of 792 µm. Berkiten et al.[4] showed that the S. sanguis could penetrate up to 382.3 µm. According to Gutierrez et al.[5], however, the depth of penetration of bacteria is about 250 µm. So, if bacterial colonization occurs at these depths, these portions of canal would be inaccessible to conventional irrigation procedures, especially in the apical third.

Moreover, it is difficult to get a complete disinfection at the apical third because of several factors: the thin diameter of this portion of the root canal, the high surface tension of solutions irrigants (sodium hypochlorite, hydrogen peroxide, EDTA, Chlorhexidine, cetrimide), the small diameters of the dentinal tubules and, finally, the distance from the point of introduction of the solution. These factors impede the solution flowing and reduce the wet ability of root canal walls, thus resulting an insufficient depth of penetration of bactericidal solutions, which cannot reach the microorganisms in the deeper layers of dentin.

In recent years, numerous experimental studies have been conducted to demonstrate the effective penetration of endodontic irrigants. For example, Berutti et al.[6] have shown that NaOCl can penetrate along the dentinal tubules up to a maximum depth of 130 µm, which could not be enough to attack the bacteria that penetrated through the tubules in the deeper layers of dentin. This difference between the depth of penetration of microorganisms and irrigants is often responsible for cases of failure of conventional endodontic treatments.

Furthermore, Nair[7] in 2005 concluded his microbiological experience saying that "it is very unlikely that an absolutely micro organism-free canal system can be achieved by any of the contemporary root canal preparation, cleaning, and root-filling procedures".

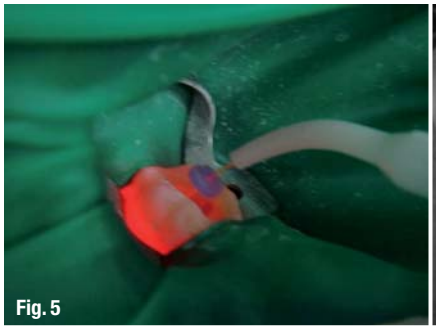

Fig. 5


Fig. 6


Fig. 7

Fig. 5_Diode laser irradiation of the canals after mechanical strumentation and irrigation with NaOCl.
Fig. 6_X-Ray after 6 months shows the healing of the periapical lesion.
Fig. 7_Periapical lesion involving the 4.6.

Nowadays, the potential bactericidal effect of laser irradiation[8–10] is well known. Used in combination with shaping and cleaning of root canal system, it can significantly increase the percentage of long-term success of endodontic treatment. The basic concept of endodontic laser therapy is that no technique can effectively disinfect the apical third since the impossibility, by solution of achieving this area. Nd: YAG and diode laser, with the optical fibre of 200 µm (as a K-file 20 diameter), may help to solve this problem.

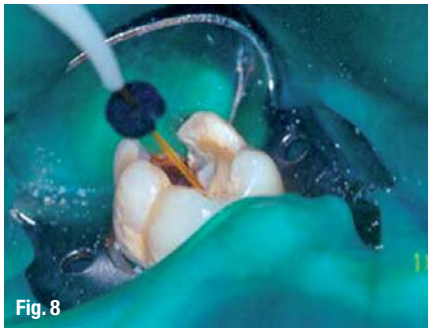
Klinke et al.[11] showed a significant bacterial reduction produced by an Nd:YAG laser within the first 300 µm of dentin tubules and bactericidal action, although weaker, to depths of 1,000 µm. Other studies[12, 13] showed the bactericidal effect of diode laser. Also our group[10, 14], in the past through in vitro experiences, showed the antimicrobial activity of Nd:YAG and diode laser, confirming literature data.

Considering the activity of Nd:YAG and diode laser against bacteries, the treatment of necrotic teeth with apical chronic periodontitis through a one visit laser-assisted treatment is evaluated in this study.

_Clinical Cases

Three clinical cases with periapical chronic periodontitis of endodontic origin, were treated in the Department of Odontostomatological Science in Sapienza University of Rome. The teeth showed no symptoms and signs of clinical acute process (absence of swelling) and radiographically a variously extended lucency .

For the treatment of these clinical cases a standardized protocol was used. After the application of a rubber dam, a conventional endodontic therapy was performed, with the use of mechanical Ni-Ti instrumentation (Profile, Maillefer, USA) and irrigant


Fig. 8

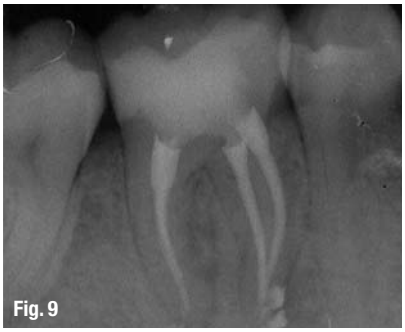

Fig. 9

Fig. 8_Nd:YAG laser irradiation.
Fig. 9_X-ray after 6 months shows the healing of the periapical lesion.

solutions (NaOCl 5 % and EDTA 17 %). At the end of this phase, in a wet canal with NaOCl, laser irradiations were applied.

Two cases were lased with Nd:YAG 1,064 nm (Pulse Master 600 IQ, ADT, USA) and one case with diode laser 808 nm (Laser Innovation, Italy). The parameters varied according to the wavelengths (1,5 Watt, 15 Hz, 100 mJ, 318 J/cm^2 for Nd:YAG; 2,5 Watt, Ton 35 ms, Toff 35 ms, 278 J/cm^2 for diode).

The following steps were used for all cases: placing the 200 µm fibre up to 1 mm to the working length and making a movement from apical to crown touching the canal walls.

According to the literature[15,16], four irradiations of 5" each were performed with Nd:YAG laser and five irradiation of 5" each with the diode laser. Every irradiation had a rest period of 5" to avoid the temperature increase above the threshold of 7 °C .

After the irradiation, root canal obturation using vertical condensation technique with gutta-percha was performed. Then, a radiographic and clinical follow up at 3 and 6 months was made.

_Case 1

The Patient I.P., 36 years old female, was referred to our Department. During assessment, the patient reported recurrent mandibular abscesses. Clinical examination revealed a fracture of the incisal edge of the first right mandibular incisor consequent to a trauma that she had six months before. The periapical radiographic examination revealed the presence of two root canals and a large periapical radiolucency compatible with apical periodontitis (Fig. 1). The final diagnosis of periapical chronic periodontitis was made; so a conventional endodontic treatment and a final Nd:YAG laser irradiation into the root canal (Fig. 2) were performed before root canal obturation. The control at six months showed an important reduction of the radiolucency of the periapical area of the tooth (Fig. 3).

_Case 2

The patient B.G., female, 20 years old, came to our observation. The clinical examination revealed an extensive composite resin restoration of the right first mandibular molar; the pulp test was negative and the radiography revealed, in the same tooth, a periapical radiolucency area involving the furcation too (Fig. 4). A final diagnosis of periapical chronic periodontitis was made. In this case, a diode laser 808 nm was used to complete the conventional endodontic therapy (Fig. 5). The X-ray control at six months showed the new bone apposition and the complete recovery of the lesion (Fig. 6).

_Case 3

The patient M.G., male, 39 years old, was referred to our Department one week after an endodontic emergency in another Dental Hospital. Clinically, a cutaneous sinus tract was evident; intraoraly a big hole was revealed in the lower right first molar. The X-ray revealeed an extensive region of demineralization of the enamel and dentin crown and a periapical radiolucency compatible with apical periodontitis especially on mesial root (Fig. 7). After cleaning and shaping the canals, four Nd:YAG laser irradiations were performed (Fig. 8), then the canal obturation was carried out. In the control at seven days the extraoral fistula disappeared and a radiographic recovery was obtained after six months (Fig. 9).

_Discussion and Conclusions

Since the ruby laser was developed by Maiman in 1960, researchers investigated laser applications in dentistry. In particular, in Endodontics many studies demonstrated the antimicrobial activity of various wavelength towards Gram positive and negative pathogens, both *in vitro* and *in vivo*.[8–13, 15, 16] Clinically, this unmistakable property can be helpful in the treatment of serious endodontic infections caused by bacteria resistant to conventional therapies. Moritz et al.[17] showed that there is a strong correlation between antibacterial effect of Nd:YAG and structure of target bacterial cells. In fact, if few radiations can kill Gram negative bacteria, Gram positive bacteria appear to be more resistant and require repeated exposures.

The bactericidal action of the laser irradiation is due to the heat transmitted from fibre in the root canal system and is directly correlated to the amount of radiation and its energy level and power output. At the same time Levy et al.[18] demonstrated that Nd:YAG laser irradiation induced pressure waves, with different characteristics from waves induced by freely vibrating sonic and ultrasonic endodontic instruments when applied to water-filled root canals.

This concept can explain the reason of bactericidal laser activity when used in a wet canal.

However, it is reasonable to say that laser disinfection must be preceded by conventional endodontic techniques (cleaning and shaping of root canal).

The resolution of apical chronic periodontitis occurred in all three cases presented, confirms that laser disinfection, using controlled parameters, can be considered a safe therapy, without adverse effect on both periodontal and dental tissues. Moreover, the opportunity to improve the antibacterial result of the endodontic treatment through the laser decontamination is an advantage that might lead clinicians to prefer single-visit treatment to the multiple visits (approached by repeated intracanal medications i.e. calcium hydroxide) for the treatment of apical chronic periodontitis. In conclusion, since three cases are not sufficient to confirm the hypothesis that all cases of apical chronic periodontitis could be resolved with one visit treatment laser assisted, our next goal is to reach a statistically significant number of cases, to report the real efficacy of the single-visit endodontic laser treatment versus conventional treatment for the resolution of chronic apical periodontitis of endodontic origin._

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