

Clinical Application of 810nm Diode Laser and Low Level Laser Therapy for Treating an Endodontic Problem

A Case Presentation

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Abstract:

The standards of endodontics have constantly been raised in the last 25 years by practitioners' researches and their interest. Most of the scientists believe the recent developments and the use of lasers as the most exciting achievement in endodontic treatment. Nowadays, lasers are being used in endodontics to improve the prognosis of the root-filled teeth. The Implement of suitable wavelengths, together with conventional methods, can effectively sterilize the canal, dentin and periapical regions. This article describes a successful treatment of an endodontic case using 810nm diode laser and low Level Laser and sixteen months follow-up to improve healling of the edema.

Keywords: bacteriocidal effect, diode laser, low level laser therapy.

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Introduction

Endodontic treatment in modern dentistry has increasingly become important. Patients ask dentists to save their teeth and expect the results would be permanently satisfactory, with no further complications. Many teeth that are endodontically treated are subsequently crowned or engaged in expensive reconstruction procedures, thus it is imperative that endodontic techniques can be relied upon for a satisfactory long-term prognosis.

The conventional endodontic treatment is chemo-mechanical Disinfections. Classica root treatment includes cleaning the root canals using mechanical preparation and rinsing with antibacterial solutions and solvents. This should remove the bacteria from the canal system but endodontic treatment continually faces with several problems which lead to failure in the therapy. Conventional methods,

even if carried out with the utmost care, would not be always successful.

The therapeutic goal of each root treatment is creation of a sterile, bacteria-free environment both in the tooth and at the apex, including the periodontal tissue and the surrounding apical bone. Only then osteoblasts would be able to complete the healing process in the apical area. There are two factors that complicate achieving sterility in the tooth: The anatomical root configuration and the special characteristics of the resident bacterial flora (1).

Macro anatomy shows a very complex root canal system. We can find a lot of different structures such as lateral canals branching off the main canal and ending in accessory foramina. The greatest anatomical variety can be found in the area of the apical delta where the main canal might be connected to the apical area with one or many

foramina. Blind ending canals, called diverticels, pass through the root dentin, in irregular patterns. In addition, the entire dentin area of the tooth is composed of a system of fine small canals - the dentinal tubules - containing the processes of the odontoblasts. In an existing infection of the pulp, the bacteria not only settle on the entire root canal walls, branching canals, and apical delta canals, but they also penetrate the surrounding dentinal tubules (1). The dentin tubules system forms a bacteria reservoir, which offers ideal conditions for their growth (constant warmth, humidity and nutrients) and the microorganisms are able to survive against the body's own defenses and the conventional endodontic instrumentation and disinfection procedures (2,3). All these anatomical features predispose towards ideal conditions for bacteria to reside in and flourish. From all these protected macro and micro sites, bacteria and their byproducts along with infection, can easily spread to periapical and periodontal tissues. The criterion for success, therefore, is to completely eliminates all the bacteria within the complex canal system (1).

It is the presence of bacteria in the dentinal tubules that is considered by many authors to be one of the main causes of root canal failures (4,5). These findings are supported by the fact that certain bacteria are able to penetrate and colonize the small dentinal tubules very effectively in a short time. *Enterococcus faecalis* penetrates very easily and rapidly into the lateral dentinal tubules, and from this reservoir within the dentinal tubules, reinfection of the obturated canal could occurs (6).

The mechanical preparation with the flexible drills and files serves primarily to create an entrance to the apical third of the root canal by removal of the infected perilluminal dentin. The preparation of side canals and other branching is impossible. In addition, using this biochemical preparation technique always produces a smear layer. The smear layer is composed of organic components and consists of dentin chips, remnants of the pulp, predentin- and odontoblast appendices. The infected pulp remnants will contain bacteria and their by-products. To remove the smear layer and pathogens, various rinsing solutions are used. (NaOCl, H₂O₂, Chlorhexidine, EDTA)

The crucial disadvantage of the rinsing solutions is that their bactericidal effect is limited to the root

canal. Due to the narrow diameter of the dentinal tubules and the high surface tension of the liquid solutions, they are able to penetrate only a small distance down the tubules. The penetration depth of chemical disinfectants only reaches 100 µm into the adjacent dentinal tubules (7).

On the other hand, the bacteria can penetrate over 1000 µm from the canal lumen, as described by Kouchi et al., so they are therefore protected in the deeper layers of dentin. Gram-negative bacteria can penetrate to this protected area. The gram-negative bacteria are characterized by their unusual migration qualities and also their actual resistance to the chemical rinsing solutions. They maintain their virulence against conventional endodontic techniques, and from this bacterial reservoir, the bacteria will spread to the periapical areas of the tooth causing inflammation and infection (8).

The standards of endodontics have constantly been raised in the last 25 years by practitioners' researches and their interests. Most of the scientists believe the recent development and the use of lasers are the most exciting achievement in endodontic treatment. Different lasers are being used in root canal preparation, disinfection of canals and surrounding dentinal tubules, removal of the smear layer and debris, and the sealing of tubules. Thus, the laser is effective in eliminating bacterial infection and preventing its recurrence, and when used in conjunction with traditional techniques, would significantly enhance the long-term success of endodontic treatment (1).

Nowadays, lasers are being used in endodontics to improve the prognosis of the root-filled teeth. The implement of suitable wavelengths, together with conventional methods, can effectively sterilized canal, dentin and periapical regions. Many types of lasers have been used for this particular purpose, but only the wavelengths which can deliver their power through extremely fine flexible fiber optic systems and penetrate dentin to a depth that can eliminate bacteria are applicable. Laser light with wavelength in the near infrared range is absorbed by dentin only to a small extent. This characteristic is used for root canal sterilization as we do not want superficial absorption in the dentin - but a deep penetration into the intertubular tissue, in order to produce a sufficient bactericidal effect in the deep layers. Due to the physical conditions present in a tooth, the Nd:YAG and the diode laser

wavelengths are not absorbed in the hard dental substances and are thus able to be effective in the deep layers (1,9).

Laser light, however, penetrates up to $>1000\ \mu\text{m}$ into the dentin. This provides a distinct advantage, since bacteria can immigrate up to $1000\ \mu\text{m}$ into the tubules. Laser radiation in the near-IR range has a bactericidal effect by causing changes in the bacterial cell wall. Microbiologists talk about a permanent destruction of the cell membrane, which is commonly in connection with direct heat having an impact on the bacteria. This damage is enough to stop the growth of the cells and can be reached with very small doses of heat (1).

Low Level laser therapy for treatment

The anti-oedematous effect of laser energy is based on a dilation of lymphatic vessels and a reduction in the permeability of blood vessels. Laser energy has a regenerative effect on lymphatic vessels, as it has on veins.

Laser therapy has two different effects on the oedema. The laser stimulated the synthesis of PGI_2 (prostacycline), which has a strong vasodilating effect, and counteracted the aggregation of platelets. The accumulation of the PGI_2 in the tissue reduced the oedema tendency. Laser light was also shown to counteract the occurrence of fibrin networks, which were studied with radioactive iodine.

One of the most thoroughly studied areas in laser therapy is the wound healing. In fact, this was one of the first indications which has been studied by Mester and by Carney as early as 1967 (10).

Case Features

The patient was a 22 years old female and her chief complain was a fistula on her chin with a large swelling around it (figure 1). She has no previous history of systemic disorders or long term medications, but she mentioned a history of trauma to her face few years ago.

The first diagnosis was the skin infection and the physician drained the fistula, but the lesion keeps growing so the patient was referred for dental examination.

Clinical examination shows that there is no evidence of dental caries or gingival inflammation around anterior lower teeth, but the labial vestibule



Figure 1. Chief complain: a fistula on the chin skin with a large swelling around it.

was very shallow (figure 2). In addition the patient feels some pain with the percussion on right and left lower incisors. Radiography examination shows periapical radiolucency around lower incisors (figure 3).



Figure 2. Shallow labial vestibule.



Figure 3. Radiographic examination.

Fistula

Considering the vitality test, our diagnosis was pulp necrosis due to the previous trauma which resulted in chronic apical periodontitis (chronic apical abscess) and because of the shallow depth of vestibule and high attachments of muscles the fistula was occurred on the skin of chin (figure 4). On the basis of this diagnosis, we chose root canal treatment on teeth lower incisors along with root canal sterilization with 810nm diode laser and Low Level Laser Therapy (LLLТ) to improve the healing of the fistula and the oedema around, for treatment plan.



Figure 4. During RCT, the rinsing liquid came out from the fistula which confirms the endodontic origin of the problem.

The settings for canal sterilization were 1W, 2mm laser per second in 4 times. The settings for LLLТ were 4 J/cm², 30mW, Red Spectrum (685nm) for the fistula and 4 J/cm², 200 mW, Infrared Spectrum (810nm). The total sessions of LLLТ was 15 sessions (2 sessions per week).

As it shown in figure no.5 the outcome of the treatment was impressive. The regeneration of the trabecular pattern of the periapical bone after just 2 months follow up shows the good healing process of the periapical region. Also the reduction of oedema around the fistula after 2 months was obvious (figure 6).



Figure 6. Treatment outcome after 2 month.



Figure 5. Treatment outcome after 2 month follow up.



Figure 7. Follow up after 16 month



Figure 8. Follow up after 16 month

Conclusion

Laser-supported endodontics can be used in the following cases:

Chronic apical parodontitis - Acute apical parodontitis - pulp necrosis - Periapical abscess - Apical resorption (inflammatory) - Therapy resistant long-term failure, i.e., root canal treatment for more than 4 months without any improvement of the subjective or objective symptoms - Combined periodontal (1). The clinical application of the diode laser irradiation in deep dentinal tubules is also recommended where anatomical difficulties (apical delta, accessory canals and curved canals) do not permit the instrument to be used within the dentin walls. Laser-supported endodontics is only limited by inaccessible root canals. It is therefore contraindicated in case of non-removable foreign bodies and where there is a complete obliteration of the root canals. Deep root fractures, as in conventional endodontics, will still require surgery (1).

LLLT can improve the healing of wounds and oedema. Honmura has studied the effects of a GaAlAs laser on experimentally produced inflammation in rats. In all cases in the laser group, the degree of inflammation was reduced by 20-30%. Laser therapy also reduced the extent of the oedema in the acute inflammation phase. In comparison using the inflammation-reducing substance Indomethacin, laser therapy was better in one experimental model, no so good in another, but effective in both cases. Laser therapy also impeded the vessels' permeability in cases of acute inflammation and thereby reduced the acute oedema. permeability in cases of acute inflammation and thereby reduced the acute oedema (11).

Finally, we may say that modern laser technology has brought crucial advantages to successful techniques, beyond those of conventional

endodontics. Since laser-supported endodontics provides an excellent prognosis with substantial bacterial reduction, in many cases, the patient may be saved from an invasive, surgical intervention.

The effect of laser therapy in wound healing in healthy individuals is limited and the first indication for laser therapy in wound healing is for individuals or tissues with a compromised state. But it is not a good idea to wait and see whether or not a wound would heal and then treat it with laser if it fails to heal. On the contrary, an evaluation of the actual state of the individual/tissue should be made in the first place and then the laser therapy applied if it is deemed necessary.

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