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CASE REPORT

The Use of Nd:YAG Laser on Permanent Molar with Periapical Lesions, Two Year Follow Up

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Abstract

It is considered that Nd:YAG (1,064 nm) laser has a bactericidal effect against bacteria to a depth of 1.000 μm. The aim of the study was to assess the efficacy of Nd:YAG laser irradiation on permanent molar root canal disinfection and follow up of the healing process. The Nd:YAG laser system, emitting at a wavelength of 1064 nm, was applied for 46 and 36 numbered root canal for three times (1.5 W, 15 Hz, 5s) in working length of a 10-year-old girl patient with caries cavities extended to the pulp and extensive periapical radiolucency. At the third session of Nd:YAG laser application the patient was asymptomatic. After two years, the clinical and radiographic follow up revealed that the patient was asymptomatic and the periapical tissues and restored tooth were healthy. The Nd:YAG laser irradiation is not an alternative but a possible supplement to existing protocols for root canal disinfection.

Keywords: bacterial elimination, chronic periapical lesions, Nd:YAG laser, pediatric dentistry, permanent molars.

Introduction

Teeth with large apical lesions usually harbor more bacterial species and have a higher density of bacteria in their root canal when compared with small lesions, consequently heavier bacterial penetration occurs within the dentine depth. Some bacteria such as *Enterococcus faecalis* can penetrate to depths between 160 and 1,000m into the lateral dentinal tubules and hence it is difficult to disinfect the entire root canal system with currently used chemomechanical preparations.[1,2] The final goal of endodontic therapy is the disinfection of the root canal and its three-dimensional tubular network. In addition to the mechanical instrumentation of the root canal system, irrigation with sodium hypochlorite (NaOCl), and temporary intracanal dressing, such as calcium hydroxide for disinfection has been proposed to enhance the removal of vital and non-vital tissue remnants, tissue breakdown products, bacteria and bacterial products[1-7]. However, dentinal tubules are covered by the smear layer and debris created during mechanical instrumentation of root canal system, the irrigant is prevented from reaching microorganisms in the dentinal tubules.[2,7]

The elimination of those bacteria by traditional disinfection methods becomes more difficult on permanent molar root canals with chronic periapical lesions. Many irrigation solutions have been used for root canal treatment along with mechanical instrumentation to achieve better debriment. However these solutions act through direct contact with targets and have a limited penetration depth(100μm) into irregularities of root canal walls, they are unable to eliminate microorganisms from deeper layers of the dentin.[6] Some investigators advocate the use of calcium hydroxide as an intracanal medicament in a multiple-visit approach. Despite the use of $Ca(OH)_2$, certain microbial species in a limited group of cases do survive and can be held responsible for persistent infections.[6]

Recently, lasers have been used for dental treatment, such as canal enlargement, treatment of root fracture, pulpotomy and endodontic surgery with advances in laser technology and suitable delivery systems.[2,4] Furthermore, debris and smear layer in root canals can be removed by laser irridation and it can all decrease microorganisms in the deep dentin layers and complicated lateral branches. The sterilization of root canals has been examined by using various lasers, such as the Nd:YAG laser, the Er:YAG laser, the Er,Cr:YSGG laser, the diode laser, and the CO2 laser, and most studies have shown favorable results with regard bacterial reduction.[2] Among lasers, the Nd:YAG laser has been reported to be useful for the removal of the smear layer and debris and for disinfection[8-10] and the Nd:YAG laser represents the longest researched device in this field.[11] It has a bactericidal effect against Gram positive and Gram negative bacteria to a depth of 1.000 μm.[1,2,4,8 ,9 ,10]

Thus, it is considered that using laser irradiation in teeth with large apical lesions reduces treatment time, the number of dressings and has more effective bacteria elimination. The aim of the study was

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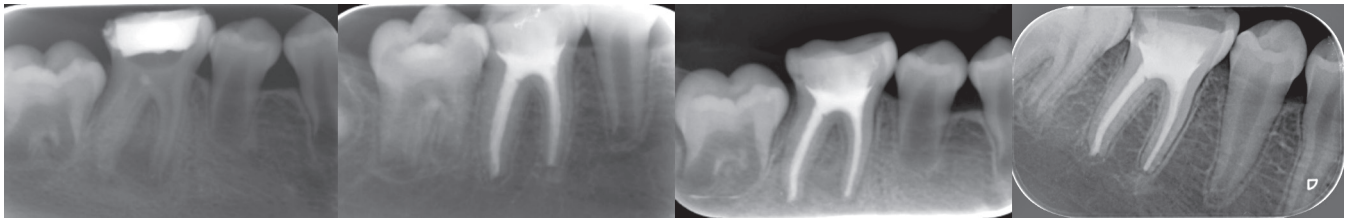

Fig 1a Fig 1b Fig 1c Fig 1d

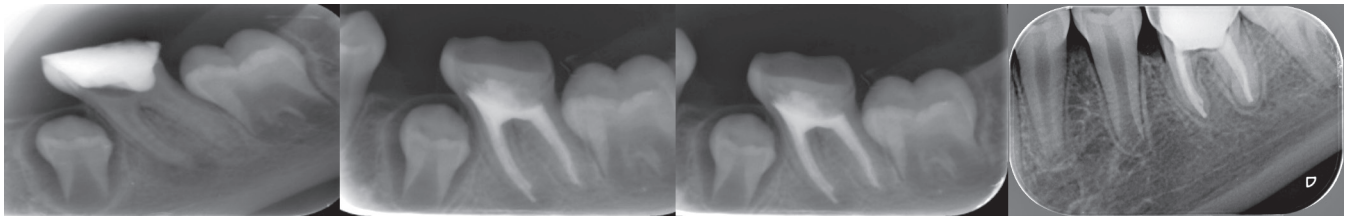

Fig 2a Fig 2b Fig 2c Fig 2d

Fig 1a radiograph of 46 numbered teeth before teratment
Fig 1b radiograph of 46 numbered teeth end of endodontic treatment
Fig 1c radiograph of 46 numbered teeth follow-up(1 year)
Fig 1d radiograph of 46 numbered teeth follow-up (2 years)

Fig 2a radiograph of 36 numbered teeth before treatment
Fig 2b radiograph of 36 numbered teeth after endodontic treatment
Fİg 2c radiograph of 36 numbered teeth follow-up(6 months)
Fig 2d radiograph of 36 numbered teeth follow-up (2 years)

to assess the efficacy of Nd:YAG laser irradiation on permanent molar root canal disinfection and follow up of the healing process.

Case description

A 10-year-old girl patient was referred to the department of Pediatric Dentistry because of severe pain in her right and left mandibular first molars. Clinical examination revealed that both teeth had deep occlusal caries, tenderness to percussion and the preoperative radiographic examination of 36 and 46 showed cavities extended to the pulp and extensive periapical radiolucency(fig 1a-2a). The patient's medical history was unremarkable. For booth teeth at the first treatment session, After isolation with a rubber dam the decay was removed from the tooth surface using a cylindrical diamond bur (Mani Inc., Japan). After a thorough inspection of the pulp chamber floor had confirmed the location of three root canal orifices, these root canals were examined with no.10 K-type files (Mani Inc.) The internal diameter was standardized to Gates Glidden drill number 4 (Mani Inc., Japan) with a slow speed handpiece (NSK, Tokyo, Japan). In the first session working length was determined radiologically by #15K files and canals were instrumented with a #15 K file for 1 min to allow a # 20 file to easily reach the working length. Root canals were instrumented with endodontic files up to #40 and NaOCl irrigation was used during instrumentations. Following 5.25% NaOCl irrigation; all canals were dried with sterile paper points and $Ca(OH)_2$ (Sultan; Sultan chemists, Englewood, NJ, USA) was placed using size 30 paste carier (Mani Inc.,Tochigi-Ken, Japan) and the access cavity was filled with quick-setting zinc phosphate cement. All materials were used according to manufacturers' instructions.

Fifteen days later, zinc-phosphate cement was removed using a cylindrical diamond bur (Mani Inc., Japan). Under saline irrigation, intra-canal dressing was removed with #30 K-file to the length of the tooth. The canals were dried with sterile paper points. The Nd:YAG laser system, emitting at a wavelength of 1064 nm, was applied for each root canal for three times(1.5 W, 15 Hz, 5s) in working length during the irradiation procedure. Between sessions $CaOH_2$ placed into root canals. Sterile cotton pledget was placed in the pulp chamber, and the access cavity was filled with quick-setting zinc phosphate cement. Fifteen day interval, the laser irradiation was applied for three times. After laser irridation session, rapid healing process in clinical signs (tenderness to percussion, spontaneous pain, anaerobic root canal smell, presence of exudate) due to infection of the teeth 36 and 46 was observed at the root canals irradiated by Nd:YAG laser. At the third session of Nd:YAG laser application the patient was asymptomatic and root canal treatment was completed; the canals were rinsed, dried and obturated, laterally condensed with gutta-percha and Endomethasone N(septodont)(fig 1b-2b). Cavities were restored with low shrinkage hybrid composite AELITE LS Posterior (BİSCO). The patient was recalled after 6, 12, 24 months for clinical and radiographic follow up. On clinical examinations 36 and 46 were functional without sensitivity to percussion. Follow up radiographic examinations 6 months postoperatively revealed resolution of the periapical radiolucent area (fig 2c). The teeth were asymptomatic with intact surrounding soft tissues. In 12 months recall, clinical and radiographic findings indicated a healing process of the periapical lesions(fig 1c). After two years, the clinical and radiographic follow up revealed that the patient was asymptomatic and the periapical tissues and restored tooth were healthy (fig 1d-2d).

Discussion

Successful endodontic therapy mainly depends on the elimination of microorganisms from the root canal system. Conventional root

canal treatment aims the removal of the infected pulp and dentin layers by using mechanical techniques and bactericidal irrigants and medicaments.

Many irrigant solutions and medicaments have been used for canal treatment along with mechanical instrumentation to achieve better debridement. We used NaOCl as a irrigant to remove smear layer, debriments, infected pulp remnants, bacteri and bacterial products. We also used $Ca(OH)_2$ as intracanal medicaments between treatment sessions. Their bactericidal effect has been proved in many studies [1,5]. But they are unable to eliminate microorganisms from deeper layers of dentin because these solutions act through direct contact with targets and have a limited penetration depth into irregularities of root canal walls[1,6]. Kouchi et al[12] could demonstrate that bacteria are capable of invading the dentinal tubules up to a depth of 1,100mm. On the other hand, it has been demonstrated that NaOCl [13] and $Ca(OH)_2$ [6,14] have a limited ability (about 130mm) to penetrate and disinfect.

The cleaning effectiveness of different instrumentation techniques and irrigation solution on the smear layer produced after the preparation of the root canal walls has been investigated by several researchers. They found that none of the techniques and irrigant solutions used totally debrided the entire root canal system.[15-17]

In recent years numerous authors described different laser systems in endodontic treatment as feasible and effective tools for root canal cleansing, disinfection and removal of debris and smear layer from prepared root canal walls.[1-10] Among lasers, the Nd:YAG laser has been reported to be useful for the removal of the smear layer and debris and for disinfection.[8-10] The indications on the germ-reducing effect of Nd:YAG laser vary from study to study. The differences in the bactericidal efficacy were probably due to the infected microorganisms, infection conditions, output conditions and evaluation methods. In 1994, Rooney et al. and Hardee et al. described in different experimental designs and bacterial combinations germ reductions of 99% when using a Nd:YAG laser.[5] Byström and Sundqvist[18] were only able to discern a bacterial reduction of 80% after five treatment sessions, only be achieved with root canals up to ISO 30, but not with curved roots. The results reached by Gutknecht et al.[19,20] of 99,92% on average for the bacterial reduction by means of the NdYAG laser in the root canal were achieved with a standart adjustment 1.5W, four times 8s[21] of the application which were similar adjustment that we used in treatment of the permanent molar root canals with chronic periapical lesions. In the study of Bergmans et al, the bactericidal efficacy of the Nd:YAG laser has been reported to range from 77 to 99%. [22] Yasuda et al[2] reported the bactericidal efficacy of Nd:YAG laser was 86%. In the present case both teeth 36 and 46 showed succesfull healing process. After two years, the clinical and radiographic follow up examinations there were any symptoms about post-treatment dental infectious and the periapical tissues and restored tooth were healthy. We suppose that the success of this present case is relevant with the high bactericidal efficacy of Nd:YAG laser irridation at deep dentinal tubules.

Some studies were to examine the depth effect of the laser in the root canal dentine. Klinke et al.[23] demonstrate that Nd:YAG laser irridation although weakened by penetrating dentin layers has bactericidal effects in depths of 1,000mm and above, this laser also effective in removal of debris. This is very close to the depth of bacteria which are capable of invading the dentinal tubules up to 1,100mm[1,12]. The discrepancy of the penetration depth of micro-organisms and bactericidal rinsing solutions often holds responsible for therapy resistant cases and long-term failures which can be observed in conventional endodontics.

An in vitro study with Nd:YAG laser root canal irridation before the obturation procedure showed higher sealing ability of the root filling materials when compared with non-laser treated canals[24]. Another similar study evaluating the methylene blue dye penetration between the filling materials and the root canal showed that the Nd:YAG laser root canal irridation after conventional canal preperation led to a higher sealing ability when compared with the samples not irradiated with laser and even with the samples irradiated with the Er:YAG laser[4].

In laser systems such ad Nd:YAG, Argon and Diode the energy can be transmitted into the root canal by thin and flexible endodontic optic fiber tips with the diameter of 200 mm diameter that provide easy access to tooth structure. This quality in addition to the bactericidal effect of laser irradiation can be effectively utilized in endodontic therapy to achieve complete cleansing of the root canal system following the instrumentation phase of the treatment and prior to the obturation of the root canal[3]. The precise handling and the reliable bactericidal effect at settings which do not endanger adjacent structures, make Nd:YAG laser of our choice.

Conclusions

The use of laser irridation for endodontic applications has increased in recent times due to the development of different wavelengths together with advances in laser technology and suitable delivery system. On the basis of this laser knowledge it can be concluded that combination therapy consisting of irrigation and Nd:YAG laser irradiation, especially with chonic apical lesions is an effective treatment option. Such cases are still considered a challenge to the specialist and this may be the reason that researchers and clinicians continue to explore and search for more effective material, methods and techniques offering the patient minimal postoperative discomfort as well as an higher success rate outcome.

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