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Laser Reduction of Periodontal Pathogens in the Periodontal Pocket using a Nd:YAG Laser - A Literature Review

Mariya Miteva

Department of Periodontology and Dental Implantology, FDM, Medical University of Varna

Abstract: ***The standard management of periodontal diseases focuses on infection control, detoxification of dental surfaces, regeneration of lost tissues, and plaque-control regimens via mechanical debridement, but other therapeutic modalities, such as laser therapy have also been proposed. The objective of this study was to evaluate the microbiological outcomes following Nd: YAG laser irradiation in periodontal pockets during nonsurgical periodontal treatment.***

Keywords: periodontitis, Nd:YAG laser, periodontal pathogens

1. Introduction

Treatment of periodontal diseases includes various anti-infection regimens. The primary goal is to remove hard and soft bacterial deposits, leading to a smooth and biocompatible surface, in order to minimize further bacterial adhesion and to facilitate host cell re-attachment. In the treatment of periodontal disease, scaling and root planing (SRP), which includes mechanical removal of biofilms, is an effective causative method for infection control. On the other hand lasers can also be used in treatment of periodontal pockets.

Effect of Nd:YAG laser on periodontal pathogens

The use of Nd: YAG laser in soft tissue encourages researchers to use it in the pre-treatment of root surfaces. At energy values of 150 to 87.5 mJ / pulse Nd: YAG lasers show a bactericidal effect by suppressing and destroying suspected periodontal pathogens from both periodontal pocket and hard dental tissues [1].

Ben Hatit et al. concluded that laser treatment reduce the amount of microorganisms in the periodontal pocket [2]. Yamaguchi et al. also prove that laser treatment removes lipopolysaccharides from the root surfaces [3]. These studies support the hypothesis that lasers are useful in the treatment of periodontal diseases. The findings of this review show that laser application is also possible during implant surgery [4] and treatment of peri-implantitis.

In addition, Moritz et al. [5] suggest that mechanical instrumentation related to laser treatment of periodontally affected root surfaces can suppress periodontal pathogens such as Aggregatibacter actinomycetemcomitants (AA), Porphyromonas gingivallis (Pg) and Prevotella intermedia (Pi). This is confirmed by other authors [1].

Wang Z et al. on the other hand, indicate that Nd: YAG irradiation after SRP has a stronger bactericidal effect, especially with regard to dark pigmented Gram (-) rods. [6]

Kranendonk A. et al. examined in vitro the bactericidal effect of a Nd: YAG laser on six periodontal pathogens. Suspensions of six different periodontopathogens (Aa, Pg, Prevotella intermedia (Pi), Tannerella forsythia, Fusobacterium nucleatum, and Parvimonas micra) were prepared in small Eppendorff tubes and subjected to five different time intervals. The laser parameters used are 6 W (from a scale of 1-12 W), 50 Hz and a pulse duration of 250 ms. After laser exposure, blood agar was seeded for bacterial counting. After 5 seconds of laser radiation, there was a decrease in the total number for all six periodontal pathogens studied. After 15, 30 and 45 seconds. no viable microorganisms were detected. In this in vitro study, it was found that 15 sec. application of the Nd: YAG laser is effective for the total destruction of the six periodontal pathogens studied. [7]

De Andrade A et al. investigate bacterial reduction following the use of Nd: YAG laser and SRP in class II furcation lesions in patients with chronic periodontitis. Thirty-four furcation lesions were examined in 17 patients. The control group received conventional treatment and the test group conventional treatment, followed by laser radiation with a Nd: YAG laser (100 mJ / pulse; 15 Hz; 1.5 W, 60 s, 141.5 J / cm^2). Both treatments led to improvement in most clinical parameters. There was also a significant decrease in the colony forming units of the total number of bacteria in both groups. The largest decrease was observed in the experimental group immediately after treatment. The number of dark pigmented bacteria and the proportion of patients with Pg, Pi and Aa decreased immediately after treatment and returned to values close to the original 6 weeks after baseline in both groups. Nd: YAG laser, along with conventional treatment, significantly increases bacterial reduction in class II furcation involvements immediately after irradiation, although it was not observed 6 weeks after baseline. [8]

Javed Al et al. investigated the effectiveness of the additional use of Nd: YAG laser in the treatment of periodontal inflammation in patients with and without type 2 diabetes mellitus. A total of 44 patients were divided into two groups – 1st group (test) - 22 patients (SRP + Nd: YAG) and 2 group (control) treated with SRP alone. At the 3rd month of the study no significant differences in the studied

parameters were found in the two groups (PI, BoP and PPD). [9]

Nd: YAG lasers have also been shown to be effective in treating periodontal pockets with Epstein-Bar virus. 78.2% of EBV-positive patients turned negative after treatment. [10]

Giannelli M et al. discovered that Nd: YAG lasers were able to remove periodontal pathogens located in epithelial cells outside of the periodontal pocket without causing connective tissue damage and microvascular ruptures. They also reported a reduction of the ICAM-1 molecule from the vascular endothelium [11]

Yang MB and colleagues [12] found out that laser irradiation with Nd: YAG can damage periodontal fibroblasts. The extent of damage depends more on the duration of the laser radiation than on the average energy. Fibroblast damage was also confirmed by Chen YJ et al. [13, 14].

In a study by Chen et al. [13], in which cell cultures from human periodontal fibroblasts were irradiated at low energy values with a Nd: YAG laser, a significant decrease in cell viability and collagen synthesis was reported on the 5th postoperative day. There is also evidence of mineralization of necrotic cells on the 28th postoperative day. The laser parameters are 50 mJ power and 10 Hz, a defocused laser beam, a 400-µm optical fiber, and an exposure duration ranging from 60 to 240 seconds.

One of the first in vivo studies to detect the reduction of pathogenic bacteria after irradiation with an Nd: YAG laser showed a decrease in Pg, Pi and Aa. However, the teeth extracted 7 days after root surface debridement showed recolonization with different bacterial morphotypes. [1]

A later study compared Nd: YAG laser treatment with SRP and showed a reduction in Tannerella forsythia, Pg, and Treponema denticola levels in both clinical protocols, but incomplete AA elimination. Laser treatment resulted in a greater reduction in microbial counts than SRP, although both treatments led to baseline values at the 10th week after treatment. [2]

Another in vivo study compared SRP with SRP, followed by irradiation with Nd: YAG at a relatively high energy density of 124 J / cm2. The pockets were treated once a week for 3 weeks. Pg, Pi and Aa levels were examined 6 months after treatment and only Pg levels were significantly reduced compared to the SRP alone group. [15]

In vitro studies using a Nd: YAG laser at low parameter values reported ablation of calculus without the detrimental effects on the underlying cement and dentin [16]; a linear relationship between the energy used, the microbial count, the hemoglobin concentration and the minimum energy required to achieve a bactericidal effect [17]; different sensitivity of different microorganisms to laser irradiation [17]; and varying sensitivity to changes in calculus, cementum and dentin, even in the same individual [16].

2. Conclusion

The strong bactericidal effect makes the laser treatment an indispensable part of periodontal treatment. The clinical and microbiological improvements may be a combination of a beneficial conditioning of the root surface, mechanical disorganization of the biofilm, and reduction in viable bacteria as well as inactivating bacterial endotoxins, but the evidences are contradictory to support its effectiveness and further researches are needed

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