Evaluation of combined Nd:YAG laser treatment of moderate periodontitis

A randomised controlled clinical study

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_Introduction

One of the main goals of dentistry is the prevention of disease. Minimally invasive methods of treatment are preferred. For this reason, the concept of treatment in periodontology has radically changed over the past decades. While in the early days, extensive surgical interventions used to be the centre of attention, today more conservative treatment is the focus.

Treatment procedures recently transitioned from surgical to non-surgical, after the potential of scaling and root planning (SRP) to eliminate inflammation and arrest progression of periodontal disease was successfully demonstrated in a number of clinical trials (Axelsson & Lindhe 1978; Badersten et al. 1984; Hirschfeld & Wasserman 1978; Lovdal et al. 1961). Researchers debate whether there is a significant reduction in the depth of the periodontal pocket when the Nd:YAG laser is applied as an adjuvant therapy.

The balance of evidence seems to favour the improvement of the pocket depth with the use of Nd:YAG as an additional tool for the periodontal treatment, but more research still is needed in this area in order to evaluate the effectiveness of laser treatment with different settings.

_Aims of the present study

The objective of this study is to examine whether the use of Nd:YAG laser as an adjunct to traditional SRP improves the results of traditional therapy, especially concerning the bleeding index and the depth of the periodontal pocket. Furthermore, the present study is aimed at providing insight into the existing debate in scientific literature regarding the bleeding index and the depth of the periodontal pocket.

The hypothesis of this study is that the application of the Nd:YAG laser as an adjunct tool to local, non-surgical SRP therapy will result in a significantly greater reduction of the bleeding index and the periodontal pocket depth than the traditional mechanical treatment of periodontitis alone. Consequently, the null hypothesis states that there will be no significant differences between the two test groups on the two clinical parameters of bleeding index and pocket depth.

_Materials and methods

A total of 20 healthy patients (twelve women, eight men), aged between 35 and 55, with mild periodontitis (pockets of a depth of 4 to 6 mm) participated in this study. Patients were excluded from this study according to the following criteria: smokers, pregnant women or nursing mothers, type I and type II diabetics, patients currently under antibiotic treatment and patients who had taken antibiotics within three months prior to their selection for the study, patients suffering from cardiovascular disease (high-risk heart disorder) and patients with contagious diseases (El Yazami et al. 2004).

The patients were randomly selected to be divided into two groups of ten persons each. Group 1 was chosen to be the test group. Patients were treated according to the protocol of AALZ (Aachen Dental Laser Center) with SRP, using manual instruments combined with the Nd:YAG laser. Group 2 was assigned to be the

control group and the patients were treated with SRP using manual instruments. Additionally, all of the patients were given instructions for oral hygiene routines and methods.

Clinical assessments of the BOP (bleeding on probing) index and mean PD (periodontal pocket depth) were recorded prior to phase 1, immediately after phase 2 and three months after phase 3.

_Pre-treatment examination

Every patient was initially assessed by taking his or her medical history (Armitage 2004; Raffetto 2004). The patients underwent a clinical and radiographical examination prior to the treatment. Their X-rays were taken with the bitewing technique with the Planmeca dixi 3 digital intra-oral digital imaging system. Two periodontal parameters were registered and charted: BOP and PD. Measurements were taken for six aspects of each tooth: mesiobuccal (mb), buccal (b), distobuccal (db), mesiolingual (ml), lingual (l), and distolingual (dl) using calibrated periodontal probes.

_Initial therapy

Initial therapy entailed removing plaque and polishing the teeth, as well as giving instructions and encouraging the patients.

_Closed curettage

Closed curettage was carried out with mechanical root planning using hand instruments—Gracey curettes # 1/2, 3/4, 7/8, 11/12, and 13/14 for both of the groups (Schwarz et al. 2003). The average amount of instrumentation in each group was nine minutes for single-rooted teeth and ten minutes for multi-rooted teeth.

_Laser treatment

De-epithelisation of the sulcus was performed in one session, one week after the cleaning of the last quadrant with a 2,940 nm Er:YAG laser. The following settings were applied: frequency 20 Hz, energy 100 mJ, average output 2 W, with the aid of an RO7 handpiece, without water, only with the use of air, and pulse duration 750–950 µs. The laser was used for the de-epithelisation of the sulcus, effectively removing the epithelium of the sulcus. This treatment was executed by continuously moving the tip of the RO7 handpiece back and forth from the gingival crest.

During this procedure, the surface of the sulcus appeared to be a whitish colour and the tip of the RO7 handpiece became covered in the removable epithelium cells. These cells on the handpiece and the surface of the sulcus were frequently wiped off with a cotton roll or wet gauze (Harris et al. 2002). Scientific literature shows that the concept of de-epithelisation encompasses the promotion of reattachment and the formation of new connective tissue.

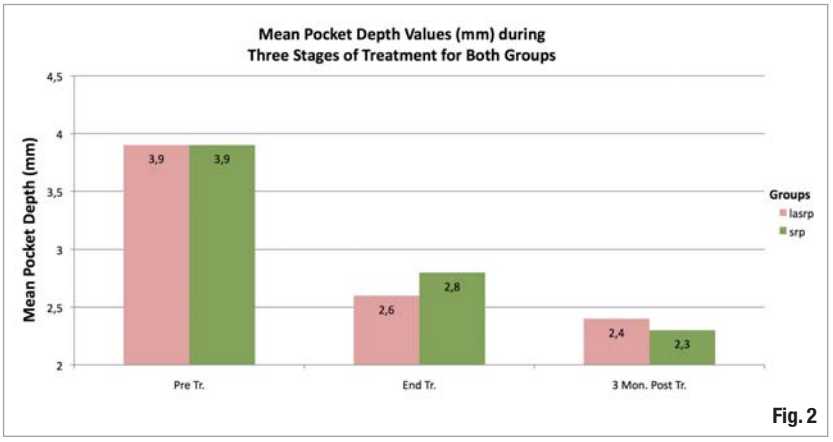

Fig. 2

Fig. 1_Mean PD values (mm) during the three phases of treatment for both groups.

One week after the de-epithelisation of the sulcus, pocket sterilisation (Fig. 1) was performed with a 1,064 nm Nd:YAG (output power 2 W, frequency 20 Hz, with the aid of a 300 µm fibre, pulse duration 75 to 100 µs). Before the use of the Nd:YAG laser in the pockets, the area was dried with air. With the aid of a 300 µm thick quartz fibre placed on the bottom of the pocket, the pocket was irradiated circularly for 30 to 40 seconds parallel to the surface of the root, maintaining contact with the tissue. This procedure was performed in the entire mouth without anaesthesia, only with the application of topical anaesthetic gel. When signs of bleeding occurred, the fibre was applied to the next pocket. The procedure was repeated three times in intervals of four to seven days.

It is important to note that this interval time between the treatments must be strictly kept. If the patients are treated earlier than four days, more tissue will be removed, the wound will be larger and shrinking will occur. A treatment later than seven days can result in recolonisation of the periodontal bacteria.

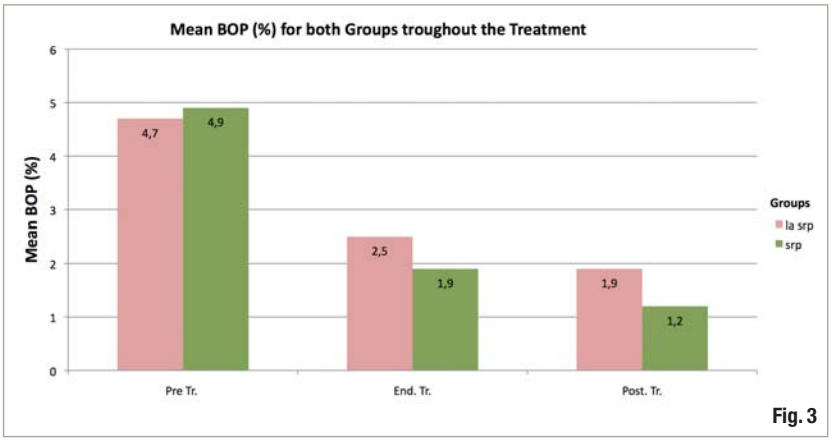

Fig. 3

Fig. 2_Mean BOP (%) for both groups throughout the treatment.

The researcher chose the setting parameters above because it was reported that Nd:YAG laser irradiation with a setting of 100 mJ, 20 Hz, 2 W for 30 seconds only inhibits the DNA metabolism and the cell division rate (Gutknecht et al. 1998). In this case, a safe soft-tissue laser treatment can be performed. White et al. (1994) examined in vitro the changes of intra-pulpal temperatures during Nd:YAG laser irradiation of root surfaces at 0.3 to 3.0 W (30 to 150 mJ/pulse, 10 or 20 Hz). They reported that within the parameters outlined in their study, pulsed Nd:YAG laser energy should not cause any devitalising rise in the intra-pulpal temperature when it is applied to root surfaces with adequate remaining dentine thickness (Aoki et al. 2004).

_Statistical analysis

The data collected was tested for normality by Q-Q plots and Kolmogorov–Smirnov tests. The data was found to be normally distributed and parametric tests were conducted to examine significant differences between the mean values. Dependent t-tests were used to check for significant differences between the same subjects before, during and at the end of the treatment, and three months post-treatment. This procedure was carried out in both groups. In addition, independent t-tests were used to check for significant differences between the two groups at each phase, that is, pre-treatment, at the end of the treatment and three months post-treatment.

_Results

According to the statistical analysis, there were significant differences ($p < 0.05$) for each group between phases 1 to 2 and phases 2 to 3 for BOP and PD. More specifically, the mean PD value decreased in the laser-combined SRP therapy group from 1.28 ± 0.54 mm ($p < 0.05$) at the end of the therapy, to 0.25 ± 0.32 mm ($p < 0.05$) after three months and in the SRP group from 1.03 ± 0.81 mm ($p < 0.05$) at the end of the treatment, to 0.54 ± 0.38 mm ($p < 0.05$) three months post-treatment (Fig. 2).

Furthermore, the BOP mean value decreased in the group under laser-combined SRP therapy from $21.6 \pm 9.5\%$ ($p < 0.05$) at the end of the therapy to $7.3 \pm 6.03\%$ ($p < 0.05$) three months post-treatment and in the SRP group from $30.07 \pm 20.65\%$ ($p < 0.05$) at the end of the treatment to $7.06 \pm 8.66\%$ ($p < 0.05$) three months post-treatment, showing a statistically significant decrease ($p < 0.05$) between phases 1 and 2 and phases 2 and 3 (Fig. 3).

No significant difference ($p > 0.05$) in the PD mean values occurred in the comparisons of the two groups (pre-treatment: $t = 0.2$, $p = 0.845$; end of treatment: $t = -0.6$, $p = 0.56$; three months post-treatment: $t = 0.4$, $p = 0.72$). When the two treatment groups were compared for mean differences in BOP values (%), no statistically significant differences emerged ($p > 0.05$) at any phase of the treatment.

_Discussion

Two parameters of periodontal disease were investigated in this randomised controlled study, the probing depth and the sulcus haemorrhage. The aim of the present study was to compare the clinical results of these parameters after non-surgical periodontal treatment to those of SRP via hand instruments or Nd:YAG laser as an adjunct tool to the conventional mechanical instrumentation. The results have demonstrated that non-surgical periodontal treatment with both of the two treatment modalities leads to a significant reduction in PD and BOP. However, when the two treatment groups—test and control—were compared for mean differences in BOP values and in PD values at each phase of the treatment, there were no significant differences.

_Conclusion

At this stage and within the framework of the present study, it appears that the use of Nd:YAG combined with non-surgical periodontal treatment improves the clinical outcome of an initial periodontal therapy. The findings should be confirmed by a study of a larger number of patients, a longer follow-up period, different treatment-planning protocols and different energy settings. Furthermore, basic and clinical studies are required in order to clarify the application of the Nd:YAG laser as a complementary therapy in periodontal therapy.

A bright future lies ahead for laser applications in periodontal procedures. Laser-assisted therapy is a successful treatment option that can effectively help the patient to maintain optimal periodontal health._

Editorial note: A complete list of references is available from the publisher.

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