EFFICIENCY OF THE 445NM-WAVELENGTH DIODE LASER AND SUBGINGIVAL CURETTAGE IN THE TREATMENT OF CHRONIC PERIODONTITIS - A CLINICAL EVALUATION

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ABSTRACT

The aim of this research is to examine the effectiveness of the Sirolaser Blue laser (445nm) in combination with subgingival curettage in the treatment of periodontal pockets by using clinical parameters: plaque index (PI) and periodontal pocket probing depth (PPD).

Materials and methods: The patients with chronic periodontitis were included in this study, and about 230 periodontal pockets were sampled. Patients were divided into two groups: the first group of respondents was treated with a combination of subgingival curettage and irradiation with a SirolaserBlue (445nm) and the second group of respondents was treated only with subgingival curettage. We measured the values before treatment, and evaluation of treatment results was conducted one month after by determining clinical parameters PI and PPD.

Results: The PI value before the treatment in group 1 was 1.74±0.05, whereas after the treatment this value has dropped considerably to 0.52±0.06 ($p<0.001$). The PI value before the treatment in group 2 was 1.29±0.08, whereas after the treatment, it has dropped considerably to 0.84±0.07 ($p<0.001$). Also, the PPD value before the treatment in group 1 was 4.62±0.09, whereas after the treatment this value has dropped considerably to 3.21±0.08 ($p <0.001$). The value of PI before the treatment in group 2 was 4.10±0.08, and after the treatment it has dropped considerably to 3.45±0.07 ($p<0.001$).

Conclusion: The results of the study support the improvement of clinical parameters (PI, PPD) after one month, where both clinical parameters showed a greater reduction in the group where, in addition to subgingival curettage, irradiation with Sirolaser Blue (445nm) was performed. Taking into account all of the above considerations, we can conclude that the blue beam (445nm) has proved to be effective in the treatment of chronic periodontitis challenging us to future task of examining its effectiveness in the treatment of other periodontal diseases.

Keywords: Chronic Periodontitis, Diode laser 445nm, Subgingival Curettage

Introduction

Periodontal disease is an inflammatory condition caused by dental plaque's microorganisms. The most important role in the development and progression of periodontal diseases is presence of anaerobic microorganisms and their by-products [1, 2] being associated more with the progression than with the onset of the disease [3].

Periodontal disease affects up to 90% of the world population and, due to its prevalence, it is characterized as a social problem thus being very important to find a proper and appropriate therapeutic approach (modality). Chronic periodontitis is the most common form of periodontal disease and it occurs as a result of the spread of inflammation from the gingiva to the deeper tissues of the periodontium [4, 5].

It affects nearly 40% of adult population [4]. It begins as a gingivitis, and if not timely treated, it can progress to periodontal disease.

The disease has its main clinical features, such as, for example:

I) it is more common in adults (above 40 years);

II) periodontal destruction is inversely proportional to the level of oral hygiene and the body's vital defense factors;

III) the disease can be localized and generalized [4].

Since the microorganisms are the main cause of periodontal disease, golden standard in periodontal therapy is successful removal of the microorganisms from tooth surfaces (scaling and root planning/SRP). However, some microorganisms remain after SRP can prevent reparation and regeneration of periodontal tissue and can endanger tooth survival. Due to this fact, dentistry is in a continuing search for new techniques and protocols that could contribute to the more efficient removal of microorganisms from periodontal pockets.

Causal (basic) therapy of periodontal disease is the first stage in the therapy and is part of the overall and highly complex treatment of this disease. It is used in all patients suffering from periodontal disease, regardless of the type and severity of the disease. The ultimate goals of causal therapy are:

I) to reduce or eliminate inflammation of the gingiva and other periodontal tissues;

II) to stop the development of the pathological process, and;

III) to raise the biological potential of the tissue in order to create conditions for continued therapy with appropriate surgical procedures [6].

Subgingival curettage is part of causal therapy and as a method it stands distinctively at the borderline between conservative and surgical treatments in periodontology. The aim of subgingival curettage is to remove residual concernments, necrotic cementum, and granulations found on the soft wall of the pocket, without performing gingivectomy or gingiva removal [4].

In addition to a number of standard methods that are widely used to treat this disease, the use of dental laser treatment also occupies an important place. In the therapy of periodontal diseases, due to a high level of complexity associated with the pathology of such diseases, the role of low-level laser or the so-called *soft laser therapy* is particularly interesting, as it should contribute to an accelerated rate of healing of the periodontal tissue by creating a wide range of anti-inflammatory, analgesic and antiedematous effects [7].

According to some authors, low-level or *soft laser therapy* is regarded only as a supporting method in the therapy of periodontal diseases [7, 8].

Results of some studies show the advantages of non-surgical diode laser treatment (with a low-level laser) in patients with chronic periodontitis [9].

Most of the available diode lasers are infrared/red diode lasers. Recently, the blue diode laser (Sirolaser Blue,445nm) was introduced, demonstrating three wavelengths: 970nm, 660 nm and a blue beam wavelength of 445nm. Very few studies have been published so far to show what

results have been achieved with blue beams in any field of dentistry, and thus in periodontology too. The emergence of new techniques and devices on the market requires us to explore various therapeutic possibilities and compare their therapeutic effect with the currently applicable treatment protocols.

The **aim** of this research is to examine the effectiveness of the Sirolaser Blue laser (445nm) in combination with subgingival curettage in the treatment of periodontal pockets in patients with chronic periodontitis, by using clinical parameters of plaque index (PI) and measurement of periodontal pocket probing depth (PPD).

Materials and methods

The research included respondents of both genders who expressed their interest to participate in the research trial at the Department/Clinic for Oral Medicine and Periodontology of the Faculty of Dentistry in Sarajevo in the period between November 2020 and January 2021.

The research was conducted in the form of a clinical prospective study.

All respondents signed the Informed Consent Form confirming their willingness to participate in the trial on a voluntary basis. The study included 15 patients aged between 35 and 65 years, and 59% of them were women and 41% were men. Respondents were divided into two groups. The first group of respondents included the patients suffering from chronic periodontitis who were treated with a combination of subgingival curettage and irradiation with a Sirolaser Blue laser (445nm) (photothermal effect) in the treatment of periodontal pockets, whereas the second group of respondents included the patients suffering from chronic periodontitis who were treated only with subgingival curettage in the treatment of periodontal pockets.

During the of the study, we sampled about 230 periodontal pockets distributed evenly in two groups.

Inclusion criteria:

Respondents who have been clinically and radiologically diagnosed with chronic periodontitis, they have not undergone any periodontal intervention over the past year. There are both smokers and nonsmokers among the respondents and patients without history of systemic diseases and taking any medications in the last three months were included.

All respondents were subjected to a periodontal anamnestic diagnostic protocol and clinical radiological evaluation (OPG image analysis).

The periodontal anamnestic-diagnostic protocol includes general anamnesis, clinical examination, identification of plaque index (PI) and measurement of periodontal pocket probing depth (PPD- Pocket Probing Depth). Evaluation of treatment results was conducted after one month, by determining PI and PPD.

All clinically examined parameters and obtained results were recorded in a number of patient record sheets designed specifically for the purposes of this research.

Patients were divided into two groups, wherein the first group of the patients received SRP and

Sirolaser Blue laser (445nm), while in the second group periodontal therapy consisted of SRP only. The procedure was performed in such a way that, after the classic mechanical treatment of the periodontal pocket, the pocket was subject to debridement with a 320 μm optical fiber. For the purpose of this research, the parameters were set individually at: 445 nm, 2 W, 20-50 Hz, duty cycle 50%, Ø - power=1-1.5 W, for a 320-micron tip which was used to irradiate the periodontal pocket.

In accordance to the recommended precautions, the course of work with the dental laser, the patient, the therapist and the dental nurse wore goggles.

Statistical method:

The results have been processed by using standard statistical methods, through application of the SPSS computer-generated statistics analysis

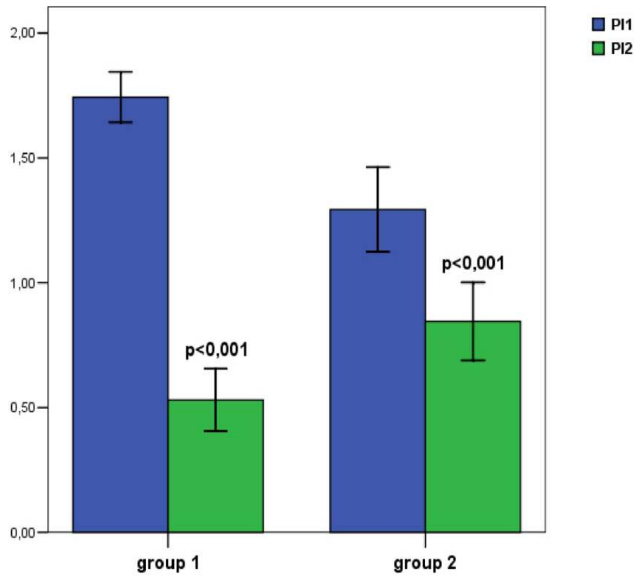

Diagram 1. PI values before and one month after the treatment in the respondent groups

Results are presented as mean± SEM; PI1- value of plaque index before treatment; PI2- value of plaque index one month after treatment; p-relative to the value before treatment of the same group

The PI value before the treatment in group 1 was 1.74±0.05, whereas after the treatment this value has dropped considerably to 0.52±0.06 (p<0.001). The PI value before the treatment in group 2 was 1.29±0.08, whereas after the treatment it has dropped considerably to 0.84±0.07 (p<0.001) (Diagram 1).

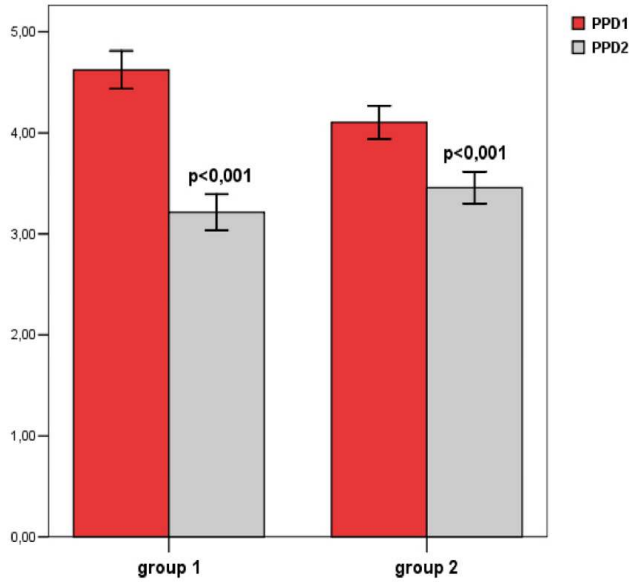

Diagram 2. PPD values before and one month after the treatment in the respondent groups

Results are presented as mean± SEM; PPD1- value of pocket probing depth before treatment; PI2- value of pocket probing depth one month after treatment; p-relative to the value before treatment of the same group.

The PPD value before the treatment in group 1 was 4.62±0.09, whereas after the treatment this value has dropped considerably to 3.21±0.08 (p <0.001). The value of PI before the treatment in group 2 was 4.10±0.08, and after the treatment it has dropped considerably to 3.45±0.07 (p<0.001).

Table 1. Comparative analysis of PI and PPD values between respondent groups before and one month after the treatment

Variable	Group 1 (n=117)	Group 2 (n=116)	p
PI before treatment	1.74±0.05	1.29±0.05	<0.001
PI one month after treatment	0.52±0.06	0.84±0.07	0.002
PPD before treatment	4.62±0.09	4.10±0.08	<0.001
PPD one month after treatment	3.21±0.08	3.45±0.07	0.043

Results are presented as mean ± SEM

The PI value before the treatment in group 1 was 1.74±0.05 and was considerably higher compared with the PI value before the treatment in group 2; 1.29±0.05 (p<0.001). The PI value after the treatment in group 1 was 0.52±0.06 and was considerably lower compared with the PI value after the treatment in group 2; 0.84±0.07 (p=0.002). The PPD value before the treatment in group 1 was 4.62 ± 0.09 and was considerably higher compared with the PPD value before the treatment in group 2; 4.10±0.08(p<0.001). The PPD value after the treatment in group 1 was 3.21±0.08 and was considerably lower compared with the PPD value after the treatment in group 2; 3.45±0.07 (p=0.043).

program called SPSS Statistical Package for Social Sciences version 21.0. The results are presented as a mean value (mean ±) and a standard error of the arithmetic mean (SEM). The Kolmogorov-Smirnov test was used to test the significance of the difference in deviation from the normal distribution. The results have been analyzed by using the Student t-test for independent, or the paired t-test for dependent numerical variables. The value of $p < 0.05$ is considered statistically significant.

Results

The results of our study show that there is a statistically significant difference in terms of plaque reduction observed before and one month after therapy, in both groups, with a larger reduction in group 1. The same results were achieved of a clinical evaluation of periodontal pocket probing depth (diagram 1, 2).

The comparison has been made on the basis of a clinical evaluation of plaque index (PI) and measurement of periodontal pocket probing depth (PPD) that was performed before and one month after the treatment (table 1).

Discussion

During the course of the study, the clinical parameters of plaque index (PI) and periodontal pocket probing depth (PPD) were only monitored. These parameters were established before the treatment and one month after the treatment.

The results of our study show that there is a statistically significant difference in terms of plaque reduction observed before and one month after therapy, in both groups, with a larger reduction in group 1, where respondents were treated with a combination of subgingival curettage and irradiation with a 445nm Sirolaser Blue laser.

Similar results have been achieved in other studies as well.

Caruso et al, in their study conducted in 2015 with the aim of comparing the effectiveness of laser treatment (980nm) as a support to subgingival curettage in the treatment of chronic periodontitis, have compared the clinical PPD parameters (Pocket Probing Depth), CAL (Clinical Attachment Level), GI, and PI. Their plaque index results show a PI value of 1.263 p (0.45) in the group undergoing a combined subgingival curettage and dental laser treatment and a PI value of 1.263 (0.45) in the group undergoing subgingival curettage only. After one month, PI values for the first group were 0.421 (0.50), while for the second group these values were 0.894 (0.56) 10]. As we can see, the PI results recorded for the first group are significantly lower compared to those recorded in the non-laser group, which also corresponds to the results of our study.

The identical results were achieved by Alzoman et al. in 2015 in their study of 32 patients with chronic periodontitis, during which they examined the effectiveness of GaAlAs (685nm) and subgingival curettage [11].

In their study conducted in 2017, Matarese et al. have examined the effectiveness of a diode laser (810nm) as a replacement for subgingival curettage, during which they have examined the plaque index as FMPS (Full-Mouth Plaque Score) in aggressive periodontitis, where they have also observed a statistically significant degree of plaque reduction after an evaluation period of one month [12], which also corresponds to the results of our study.

Similar results were also recorded by other authors [13, 14], while some other authors did not find in their studies any statistically significant differences in PI values between the groups of patients treated with and without laser [15, 18].

Regardless of the results of our own study and the similar results recorded in a number of other studies, there is still insufficient information found in most scientific sources of dentistry literature to confirm the thesis that the use of a laser device can prevent the formation of plaque on the laser irradiated tooth surface [15, 16, 17].

More studies speak in favor of mechanical plaque control and good motivation and education of patients to maintain their oral hygiene.

The most important indicator of periodontal disease is the loss of epithelial attachment which is expressed by the values of pocket probing depth (PPD).

The results of our study show the existence of a statistically significant difference in the average values of pocket probing depth (PPD).

According to that, the average pocket probing depth values have been reduced statistically significantly after laser therapy.

Similar results have been confirmed in a great number of other studies.

A study conducted by Schwarz et al. (2001) a laser (980nm) was used for a "closed" subgingival treatment and root planning, while laser treatment (980nm) was compared to conventional curettage instrumentation (subgingival curettage). The results showed a statistically significant difference in terms of PPD reduction in the group treated with laser 18], which also corresponds to our results.

In their clinical study conducted in 2019 on 51 patients with periodontitis, by dividing patients into three groups, Fotios Katsikanis et al. have compared the levels of efficiency between three therapy groups: i) subgingival curettage as a standalone therapy group, ii) subgingival curettage in combination with laser therapy as the second therapy group (Biolase Ezlase 940 nm), and, iii) subgingival curettage in combination with photodynamic therapy as the third therapy group (GaAlAs 670 nm). A follow-up evaluation conducted after three months shows that there was a certain level of PPD reduction in all three groups, but no statistically significant difference was observed between these three groups. After a 6-month evaluation period, the laser-treated group showed a slightly greater reduction in PPD in the deeper periodontal pockets [15].

Meseli et al. (2017) have evaluated the effects of the diode laser (810 nm), which was used as a support to mechanical periodontal treatment, by examining various clinical parameters and the depth of periodontal pockets, and they found that PPD was statistically significantly lower in the group treated by mechanical cleaning with diode laser irradiation after 8 weeks [14], which also corresponds to the results of our research.

Many authors have published results of their research that speak in favor of the use of diode lasers in the treatment of periodontitis, finding that lasers can be used as a powerful tool in the treatment of periodontal disease, but only in combination with the more extensive therapist education and experience [19, 20, 21].

Marisa Roncati et al. (2017) suggest that laser should be incorporated as an integral and mainstream part of periodontal therapy [20].

The limiting factor of the present study is a relatively short period of time available for evaluation of periodontal pockets. On the other hand, very few studies in dentistry in general have ever been published about the use of a blue-beam diode laser (445nm), which is why it is so difficult to compare the effect of the blue beam with the effect of lasers of other wavelengths.

Some of the studies about the use of the blue beam (445nm) were conducted *in vitro*. Consequently, Sarah Böcher et al. (2019) have compared the laser Sirolaser Blue (445 nm) and its photothermal and photodynamic effects with other therapeutic procedures performed on some specifically designed models of periodontal pockets. The study examined 7 different treatment modalities. The results of this study show that the groups treated with lasers demonstrate the presence of greater effects in eliminating periodontopathogenic microorganisms. The photothermal effect of the blue beam proved to be better compared with its photodynamic effect [22].

In order to provide the best care to patients, we are obliged to constantly search for new treatment modalities and compare them with already known therapeutic protocols.

Conclusion

Regardless of limitations, the results of the present study support the fact that the clinical parameters (such as e.g. PI, PPD) were improved after only one month, while both clinical

parameters showed a greater degree of reduction in the group where – in addition to subgingival curettage – irradiation with Sirolaser Blue laser (445nm) was also performed. Taking into account all above mentioned considerations, we can conclude that the blue beam (445nm) has proved to be effective in the treatment of chronic periodontitis challenging us to the future task of examining its effectiveness in the treatment of other periodontal diseases, as well as the task of comparing it with other treatment modalities.

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