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Comparison of the Diode Laser Wavelengths 445 nm and 810 nm in Gingival Depigmentation – A Clinical Evaluation

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Abstract

Introduction: Nowadays, esthetic appearance plays an important role in the field of dentistry. Discolorations and pigmentations of the gingiva reduce the appearance of a healthy-looking smile. On this occasion, the use of lasers shows a promising approach for a fast and non-aggressive treatment in this field. Different laser wavelengths are being used for gingival depigmentation this clinical study aimed to investigate the effect of the novel laser wavelength (445 nm) in this field and compare it with an 810 nm diode laser.

Methods: Two diode laser wavelengths (445 nm and 810 nm) were used for depigmentation. The laser output power chosen was 1 W. An optical fiber with a diameter of 400 µm was used. 21 patients with pigmented gingiva were selected. Depigmentation was carried out in a split-mouth design for a direct comparison of the clinical effect. Outcomes were documented by photograph after one month and six months of follow-up.

Results: For each wavelength, 21 volunteers evaluated 21 clinical cases of depigmentation, which means that 441 comparisons were carried out in total regarding the color change from brownish to pinkish. A 100% clarification was achieved for 445 nm. In the 810 nm group, the color change in 44 of 441 cases (10%) could not be clearly identified. No statistically significant difference in pain experience was reported for both laser treatments.

Conclusion: The clinical evaluation showed that within the limitations of this study, most of the clinical outcome parameters were highly acceptable by the patients due to mild pain and discomfort for both laser systems.

Keywords: Gingival depigmentation; Optical fiber; Diode laser; Split-mouth design.

Introduction

Combination of several factors can lead to a perfect healthy-looking pink smile framing teeth natural beauty. A complaint of gingival hyperpigmentation is a reason why many patients demand perioesthetic procedures.[1,2] The most common cause of dark gums is the physiological factor that occurs due to the excessive production of melanin from melanocytes.[3]

In the past decades, various treatment techniques such as bur abrasion, scraping, partial thickness flap, cryotherapy, electrosurgery, and laser therapy have been used for this purpose, and most of them have resulted in side effects such as pain, scarring, bleeding, gingival recession, and bone damage. It is mandatory to consider that depigmentation should be done with caution because improper treatment may lead to gingival erosion, damage to the alveolar bone and periosteum tissues, delay in gingival tissue repair, and loss of tooth enamel.[1,4,5]

In recent years, lasers have been widely used as an effective, suitable, and reliable treatment option. Different techniques, settings, and wavelengths of lasers have been used in this field, but an approved protocol that is widely accepted in this field is not available.[1,6,7]

The diodes are non-ionizing and non-mutagenic types of lasers. These kinds of lasers are absorbed by tissue chromophores including melanin and oxyhemoglobin.[6]

Lasers have been considered as an effective, compatible and valid method and treatment of choice among many

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clinicians for gingival depigmentation.[8,9]

Several advantages such as easy handling, short treatment time, optimal hemostasis, decontamination, and no need for periodontal dressing have been reported for laser depigmentation. However, it is costly since it requires expensive equipment.[10,11]

Diode lasers are absorbed mainly in the chromophores of tissues (e.g. hemoglobin and melanin), so the diode laser can properly affect darker pigmented tissues.[11] Photothermal effects occur after the absorption of diode laser photons and cause an increase in the temperature of soft tissues which in turn leads to excision and coagulation.[12]

Developing application standards for gingival laser depigmentation has been necessitated due to the diversity of used wavelengths, application methods, and settings. The target of this clinical trial was to evaluate the effect of the novel diode laser wavelength of 445 nm compared to the classical 810 nm in gingival melanin depigmentation. Clinical outcome parameters by photo documentation after the treatment were evaluated by blind volunteers and the patient's pain feeling was reported according to the VAS chart.

Material and Methods

Ethical Issues

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved and registered in the Ethics Committee in Biomedical Research of Shahid Beheshti University of Medical Sciences (code number: IR.SBMU.RIDS.REC.1394.177). Also, the study protocol was recorded in the Iranian Registry of Clinical Trials (www.irct.ir) with code: IRCT2015121925610N1.

The patients were aware of the procedure and the objective of the study and signed a written informed consent form.

Patient Selection

Twenty-one patients with physiological gingival hyperpigmentation were included in this study. The patients were referred to Dental Laser Department by oral medicine specialists for laser-assisted gingival depigmentation. The inclusion and exclusion criteria were as follows:

- age between 25 and 30 years
- bilateral pigmented gingiva on both jaws
- no gingivitis or periodontitis
- non-smokers
- no signs and symptoms of systematic diseases
- no medical complication
- no intake of anticoagulants and antidepressants

Photographs were taken before and after laser treatment, and all photos were taken under the same condition whereby the camera was fixed on an articulated arm with the same angle and direction with the same light to have the same optical conditions of photographs.

Laser Sources

Laser parameters were as follows: 1 Watt power and 400 µm fiber diameter. The lasers used in this research were diode lasers from ARC Company (Laser GmbH, Nuremberg, Germany); one of them was 445 nm wavelength Fox® type IV as the blue laser and the other one was an 810 nm laser (Fox® type III).

The fiber motion was backward and forward on the pigmented area. A distance of 1 mm from the gingival margin was considered to minimize the risk of gingival recession.

All laser treatments were performed under local anesthesia. The upper and lower left sides of the jaw were irradiated with the blue diode laser (445 nm), and the upper and lower right sides were irradiated with the near-infrared diode laser (810 nm) (split-mouth design). Photographs were taken before the treatment (baseline), one month after the treatment, and 6 months after the treatment at follow-up appointments (Figure 1). After the irradiation procedure all patients were recommended to take painkillers (Ibuprofen 400 mg) if the pain level was unbearable.

Regions of interest (ROI) were selected before laser treatment (Figure 2).

Twenty-one independent volunteers visually evaluated the ROI of the photographs concerning the color changes from brownish to pinkish (Figure 3) of the pigmented areas as a blind test, which means that they had no

Figure 1. Photo Documentation of Depigmentation Effects Before, After 1 Month and After 6 Months

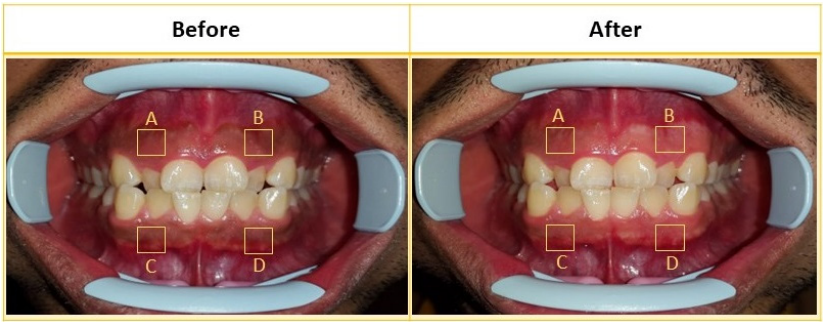

Figure 2. Selected ROI (A and C for the Blue Laser 445 nm, B and D for the Near Infrared Laser 810 nm) for Discoloration Evaluation Before Laser Treatment (Left) and After a 6-Month Follow-Up (Right)

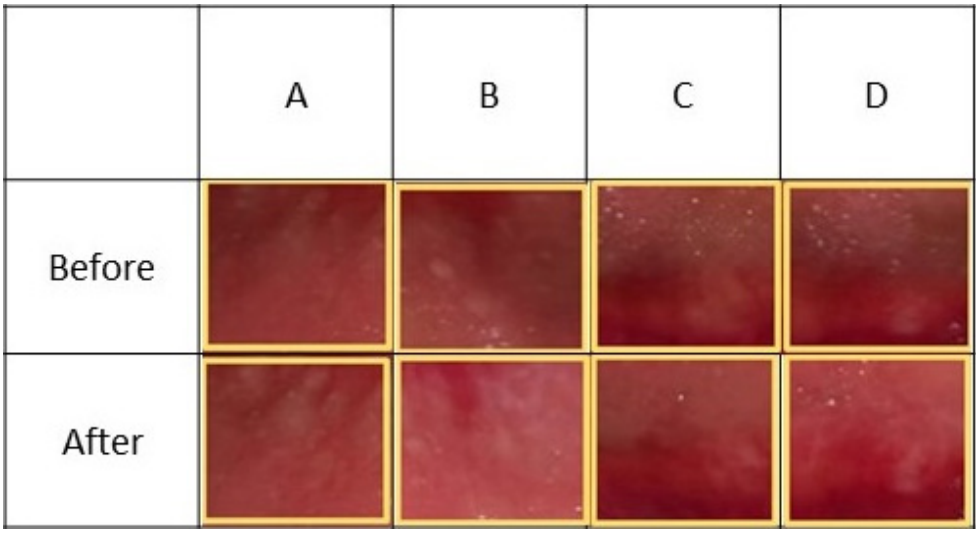

Figure 3. Magnified Images of the ROI From Figure 2

dental background knowledge and experience about the treatment procedure and the treatment technique.

All 21 cases were evaluated by 21 volunteers. Therefore 21×21 cases (a total of 441 comparisons for 445 nm and 810 nm) were compared.

The pain level was recorded as no pain, mild pain, moderate pain, and severe pain. This method of measurement was based on patients' answers to the question about the amount of pain felt and discomfort during the first 24 hours after the first session.

Statistical Evaluation

To test the differences in the volunteer's visual assessment of the ROI between the two lasers, McNemar's chi-square test that is applied for the paired data structure from the split-mouth design (count data) was used. To assess the differences between the patients' reported pain (ordinal data), a Wilcoxon signed rank test was used. The statistical significance level was set at 0.05; statistical analysis was performed using the statistical programming environment R- 3.5.1.

Results

For the 445 nm diode, the results obtained from the comparison of before and after the treatment were evaluated. The color changes from brownish to pinkish were established in all 21 clinical cases. Therefore, a 100% esthetic improvement could be realized.

In contrast, the results of the 810 nm diode did not show such a successful result. Only 90% differed clearly from brownish to pinkish, according to the evaluation made by the volunteers. This means that in 44 of 441 cases, the color change could not be clearly identified (Figure 4).

Therefore, from the statistical point of view, the results showed a statistically significant difference ($P < 0.001$) between the rates of success of two wavelengths (441 of 441 for 445 nm vs. 397 of 441 for 810 nm).

The second item which had been taken under consideration was pain experienced during the treatment depending on the wavelength. All 21 patients could not differentiate which side had more pain during the treatment. Most of the cases showed mild or no pain for both laser wavelengths after the treatment. As Figure 5 shows, there was no statistical difference in pain experience for both laser treatments.

Discussion

This clinical evaluation was carried out to compare the

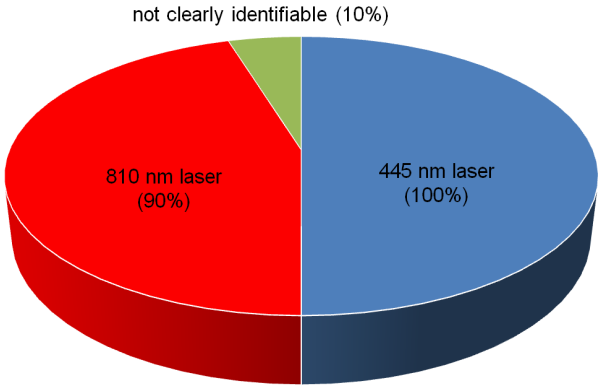

Figure 4. Comparison Between the Results of 445 nm and 810 nm Diode Lasers

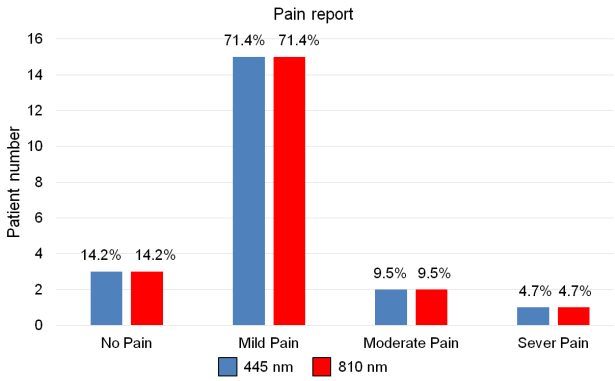

Figure 5. Comparison of Pain Between the Groups

effect of depigmentation on gingival tissue by means of two laser wavelengths 445 and 810 nm. According to the absorption spectra for the wavelengths of 810 and 445 nm in melanin, it seems to be a good choice to use these lasers for gingival pigmentation removal with minimal side effects.[4-6]

Other non-photonic technologies like surgical tissue removal or bur abrasion as well as other laser wavelengths have been used to reduce discolorations and pigmentations of the gingiva to improve the esthetic appearance. According to the results of a systematic review regarding the most effective method for the management of gingival hyperpigmentation, it was concluded that new techniques, especially laser treatments, are equally effective or even better than conventional methods such as surgical stripping. The diode laser was the most frequently used technique and was accompanied by better clinical outcomes such as esthetic, lower pain, faster healing, and patients' preference and satisfaction.[8]

To determine the best choice regarding laser parameters for patients according to laser tissue interactions, several studies are being conducted. The 445 nm blue wavelength was introduced in the dental market in 2015. Most of the studies regarding the use of blue lasers in dentistry have been related to composite photo polymerization, tissue decontamination, oral surgery, photobiomodulation, and orthodontics. Up to now, studies related to the use of 445 nm diode laser for gingival depigmentation are very limited.[13,14]

The clinical outcomes of current research demonstrated that both 445 nm and 810 nm laser techniques can be successfully applied for the treatment of gingival hyperpigmentation. However, the application of the 445 nm diode laser for gingival depigmentation was associated with more satisfactory results.

In the comparison of the Nd:YAG laser and the Diode laser in the management of physiologic gingival melanin pigmentation, it was concluded that Both Nd:YAG and diode lasers were effective in the management of physiologic gingival pigmentations.[15]

Regarding using lasers for gingival depigmentation, Murthy et al reported that in general lasers are an effective and safe method for gingival depigmentation. Healing was uneventful and no repigmentation occurred.[16] Mahajan et al in their comparison between the scalpel and the diode laser reported that both laser and scalpel techniques were equally effective for depigmentation, yielding acceptable aesthetic results.[17]

In a study, Kaya et al compared the Er:YAG (2.94 µm) and the diode laser (808 nm) in the treatment of gingival melanin depigmentation. They concluded that both Diode and Er: YAG lasers administered at 1 W could result in satisfactory depigmentation, and the total chair time of treatment was significantly shorter with the diode laser than with the Er: YAG laser treatment. No adverse effects were reported for both lasers.[18]

In a split-mouth clinical trial study by Bakhshi et al, comparing the Er,Cr:YSGG laser at 2.78 nm and the 808nm diode laser, they found that the diode laser had more efficiency for the reduction of DOPI and Hedin melanin index scores.[10]

Therefore, the literature shows that the diode laser wavelength of 810 nm can be used as a kind of benchmark to compare it with other diode laser wavelengths. Moreover, according to our results, the 445 nm diode laser could also have successful clinical outcomes.

Conclusion

The results of this clinical evaluation revealed that both wavelengths could be used for gingival depigmentation. However, clear and comprehensible depigmentation effects could be observed at 445 nm in contrast to 810 nm. Regarding pain perception, no statistically significant difference could be observed between the two wavelengths.

Authors' Contribution

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Funding acquisition: Seyed Masoud Mojahedi Nasab, Andreas Mayr.

Investigation: Seyed Masoud Mojahedi Nasab, Matthias Frentzen, Somayeh Rahmani, Fahimeh Anbari, Saranaz Azari-Marhabi.
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Project administration: Seyed Masoud Mojahedi Nasab, Somayeh Rahmani, Fahimeh Anbari.
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Software: Matthias Frentzen, Andreas Mayr.
Supervision: Seyed Masoud Mojahedi Nasab, Jörg Meister.
Visualization: Somayeh Rahmani, Fahimeh Anbari.
Writing–original draft: Somayeh Rahmani, Fahimeh Anbari, Saranaz Azari-Marhabi, Deniz Mojahedi Na sab.
Writing–review & editing: Fahimeh Anbari, Saranaz Azari-Marhabi.

Competing Interests

The authors state no conflicts of interest regarding this study.

Ethical Approval

This study was approved by Ethical Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RIDS.REC.1394.177). It also should be stated that this study was a part of a serial research all with one ethical code and trial registry. Three continuous studies were as follows:

1. Gingival depigmentation by Er, Cr:YSGG laser and diode laser: a split mouth, clinical trial study
2. A Comparative Histological Study of Gingival Depigmentation by 808 and 445 nm Diode Lasers and current paper
3. Comparison of the Diode Laser Wavelengths 445 nm and 810 nm in Gingival Depigmentation – A Clinical Evaluation

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