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A Comparative Histological Study of Gingival Depigmentation by 808 and 445 nm Diode Lasers

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Abstract

Introduction: Using lasers in melanin depigmentation is one of the main fields of interest for dental practitioners and patients. However, it is important to know what would happen inside the tissue and how the cells would interact inside the tissue with a laser.

Methods: In this study, we used both wavelengths of 445 nm and 808 nm on sheep gingiva to find out the effects and side effects of these diode lasers while using them for gingival depigmentation.

Results: After microscopic evaluation, we concluded that 808 nm and 445 nm lasers with a power of 1 W are safe enough to use in the depigmentation of gingiva, and both lasers are highly effective in melanin pigments which are located in basal membrane.

Conclusion: The 445 nm blue laser produced a less thermal effect, which means it is safer to be used in gingival hyperpigmentation than a diode laser.

Keywords: Melanin depigmentation; Microscopic evaluation; Thermal effects; Blue laser.

Introduction

The appearance of gingiva is an important part of a beautiful smile.[1] The gingival color depends on the epithelial thickness, degree of keratinization, number and size of blood vessels, and pigments within the gingival epithelium, which cause various colors among different individuals.[2,3] Physiologic pigmentation is mainly genetically determined; however, smoking, medications, and endocrine glands are also contributing factors in gingival pigmentation.[4]

Pigmented areas appear when melanin granules, which are synthesized by melanocytes, are transferred to the keratinocytes in the basal and suprabasal layers of the gingival epithelium.[5]

It is a real esthetic concern for most individuals, especially in the anterior keratinized gingiva of the maxilla and mandible.[6]

Currently, different methods, including gingivectomy, gingival graft, electrosurgery, cryosurgery, radiosurgery, lasers, diamond bur abrasion, and chemical treatment (90% phenol and 95% alcohol), have been proposed for gingival depigmentation.[6,7]

Among these techniques, lasers have been mentioned as the most effective, compatible, valid methods and choice of treatment among clinicians[8,9] since they have many advantages such as easy handling, short treatment time, optimal hemostasis, decontamination and they do not need periodontal dressing. However, they are costly since they require expensive equipment.[10,11]

In general, laser-tissue interaction is based on the absorption of the radiation in the tissue chromophores. In the wavelengths between 800 to 1000 nm, the absorption occurs primarily in melanin and hemoglobin.[12]

Diode laser wavelengths are between 600 to 980 nm. These types of lasers are absorbed mainly in the chromophores of tissues (e.g. hemoglobin and melanin), so the diode laser can properly affect darker pigmented tissues.

Photothermal effects occur after the absorption of diode laser photons and cause an increase in soft tissue temperature, which in turn leads to excision and coagulation.[13-15] The hemostasis occurs because of the affinity of the wavelength for hemoglobin, which leads to a temperature of more than 100 °C at the point of incidence of the laser beam which vaporizes the tissue.[16] The most important concern about the clinical application of lasers is the intense heat produced by their irradiation.[17]

Heat production can alter soft tissue microscopically through changes such as coagulation, vaporization, necrosis, carbonization, and denaturation.[18] At present,

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only a few studies have been published regarding assessing the effect of the diode laser histologically. Therefore, the aim of this study was to evaluate the changes in gingival tissue made by diode lasers used for gingival depigmentation.

Materials and Methods

We obtained our samples from gingiva of freshly slaughtered sheep after the approval of Shahid Beheshti University of Medical Sciences Ethical Committee (IR.SBMU.RIDS.REC.1394.177). Sixteen sheep jaws had been prepared (Figure 1). According to the split technique, we lased the pigmented gingiva bilaterally by diode lasers (Figure 2); the right side of the jaws was laced with a blue laser (445 nm) and the left side by an 808 nm diode laser. Afterwards, the gingival tissue was put in formalin to fix the tissue, and then we molded it in paraffin in a sample container to bring them to Bonn University and Laser lab to evaluate the samples histologically (Figure 3).

In histological evaluation, we compared the effect of 445 nm and 808 nm diode lasers on tissue carbonization, ablation of epithelium and connective tissue, thermal effects, and removal of the basal membrane.

Figure 1. Taking the Tissue Samples From Freshly Slaughtered Sheep Jaw

Figure 2. Lase the Sample Immediately After Taking the Tissue From the Jaw

Laser Settings and Techniques

We used 1 W, with an initiated tip with a 400-µm fiber. The lasers we used in this research were diode lasers from ARC Company (Fox laser); one of them was a 445-nm blue laser and the other one was an 808-nm laser. The fiber motion was backward-forward on the pigmented area.

Histological Evaluation Process

All histological evaluations have been done at Bonn University at Periodontal Department. The samples, which were prepared and fixed in formalin, were delivered to the histological lab. The slides were prepared for microscopic evaluation.

Each slide had two pieces of samples, one of them lased by a 445-nm blue laser and the other lased by an 808-nm diode laser. All samples have already been documented and filed.

Results

Evaluation of tissue with different magnifications can show laser effects on different layers of tissue (Figures 4 and 5), which gives us more details about how lasers can remove melanin from the basal membrane with minimum thermal damage.

Histological Analysis

Carbonization area evaluation showed that the 808-nm diode laser had more carbonization spots than blue laser 445 nm (Figure 6).

With regards to epithelial ablation, both lasers (445 nm and 808 nm) were the same and both could ablate the epithelial layer as we could expect. Meanwhile, in the ablation of connective tissue, we could find more

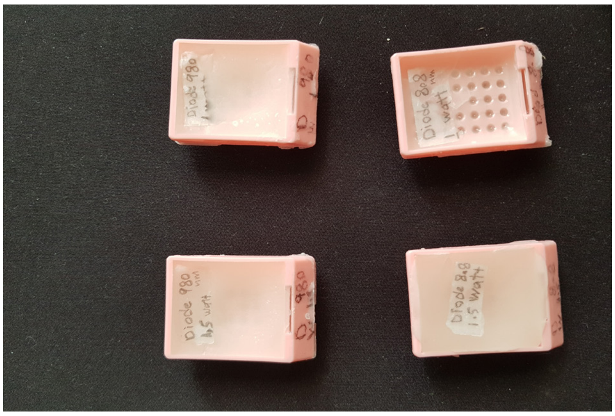

Figure 3. Samples Fixed in Formalin and Molded in Paraffin Ready for Histological Evaluation

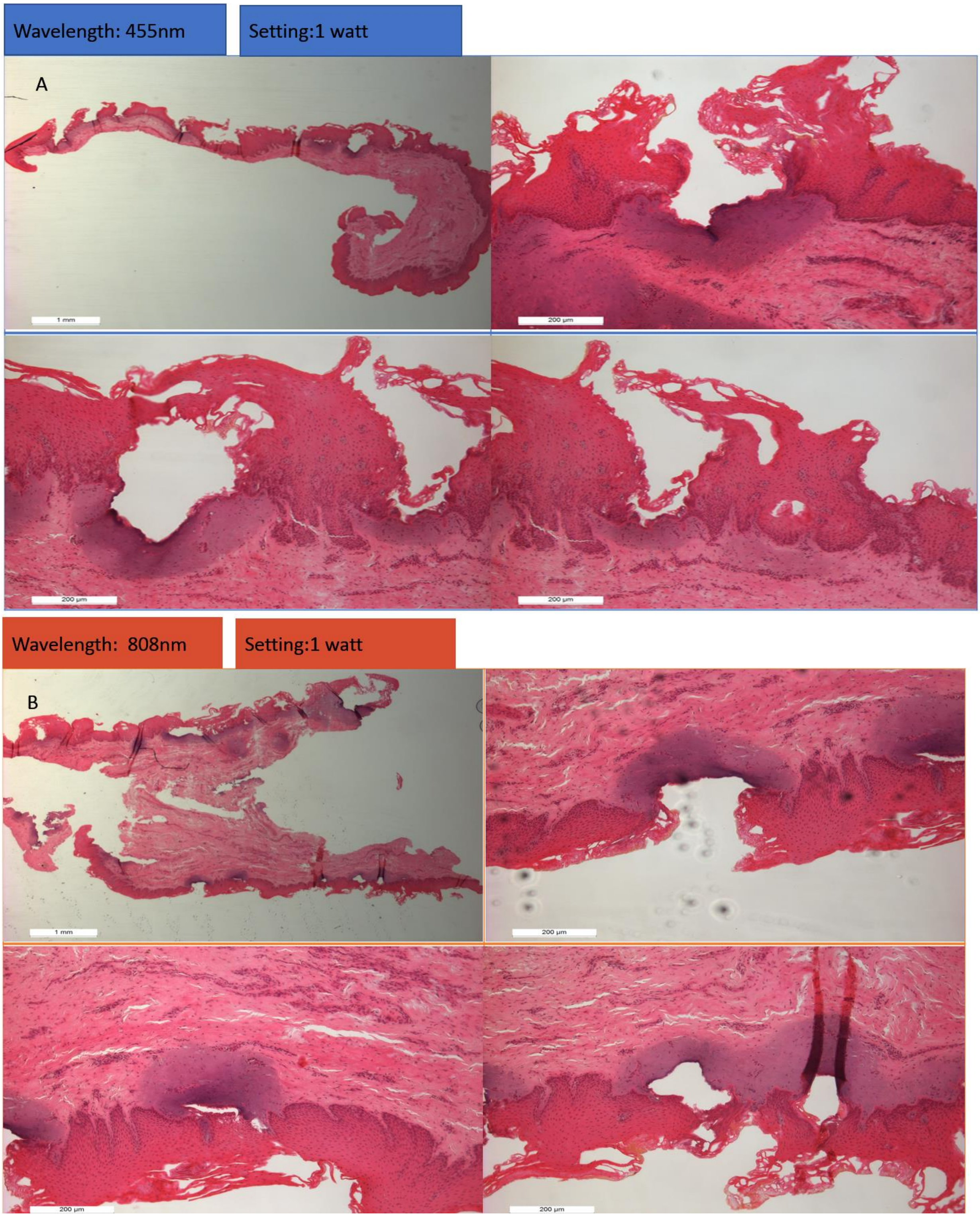

Figure 4. Histological evaluation of tissue layers A) after 445nm diode laser ablation, B)After 808nm diode laser ablation

effectiveness of the 808-nm laser compared to the 445-nm laser (Figures 7 & 8).

Even the extended thermal zone in both lasers was almost the same in tissues and there was no significant difference between 445-nm and 808-nm diode lasers, which makes none of the lasers superior to the other (Figure 9).

We also saw a similar result in the basal membrane, and both lasers similarly could remove the basal membrane where melanocytes and melanin pigments are located (Figure 10).

Discussion

Several de-epithelialization techniques are currently used for gingival pigmentation. A laser is a modality that has

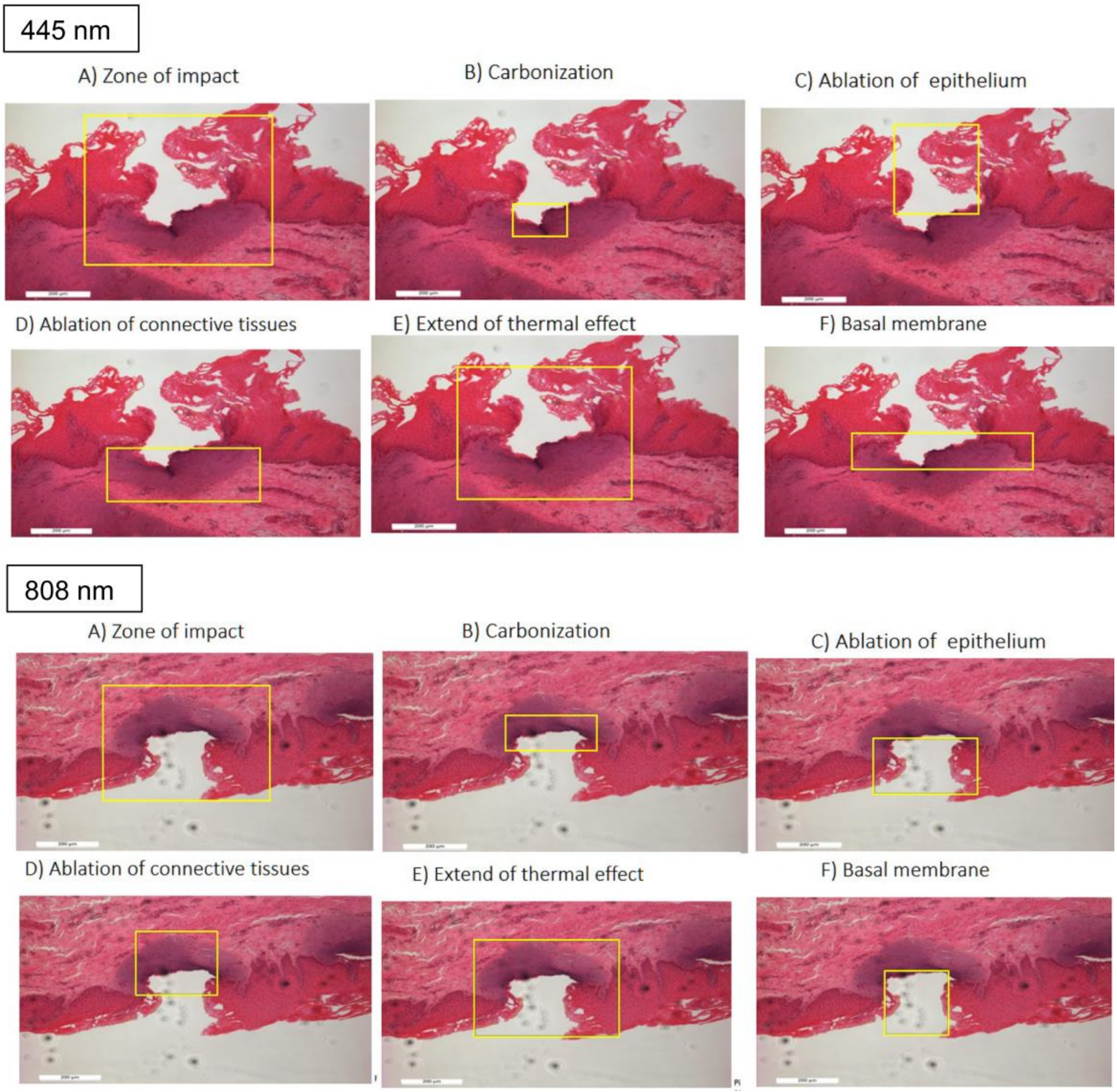

Figure 5. Comparison of the Effect of Blue Laser 445 nm and Red Laser 808 nm on Different Layers of Gingival Tissue

been used to remove the pigments from gingiva.

Histological evaluation brought us more details about how cells change when a laser irradiates tissue. One of the main factors that should be considered in laser treatment is the thermal effect which might lead to tissue damage. Although laser application has shown high clinical compliance of both patients and clinicians in many studies, there has been no study comparing the two wavelengths of 445 nm and 808 nm histopathologically. Considering the thermal effect of an 808-nm laser, which is widely used clinically for gingival depigmentation, it seems that it is necessary to look for a convenient, safer economical laser.

A comparison case study by Simsek showed that the healing process was faster in the Er:YAG group than the diode group, but in both lasers, they did not have any remarkable side effects.[9] The comparison study between Er.Cr.YSGG and diode laser by Bakhshi and Mojahedi showed almost clinically the same results.[7] Although these lasers are good choices for gingival depigmentation,

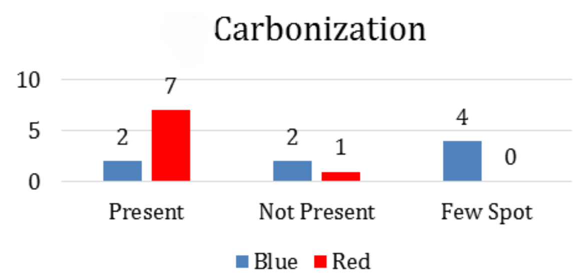

Figure 6. Comparison of carbonization level between 445 nm and 808 nm diode lasers. Red laser (808 nm) significantly causes more carbonization compared to blue laser (445 nm)

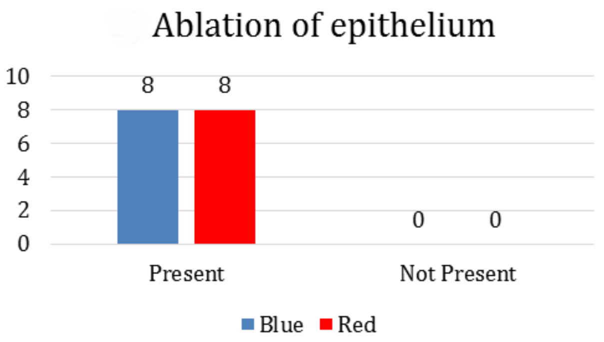

Figure 7. Ablation of epithelium comparison between two lasers. No significant difference; both lasers had ablation in the epithelium

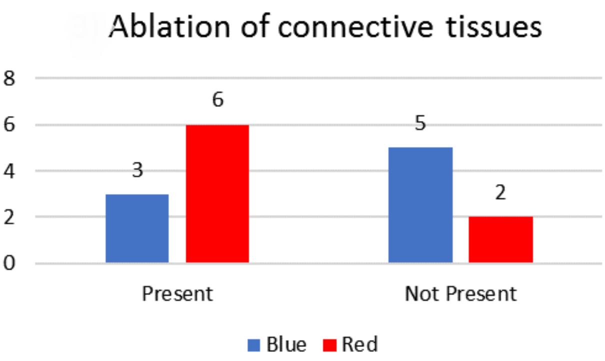

Figure 8. Ablation of connective tissue comparison between two lasers. It shows a difference; the red laser (808 nm) has more effects on connective tissue than the blue laser (445 nm)

they are expensive and not readily accessible.

Abduljabbar et al had two separate systemic reviews on laser application for depigmentation, and in both papers, they reported less pain in laser treatment.[19,20] This may be due to less damage to underlying tissue while using the laser with appropriate settings.

In one of the studies done by Taher Agha and Polenik, they tried to compare three wavelengths, Er,Cr.Y,S,GG 2780 nm, and diodes (940 nm and 445 nm) for a depigmentation purpose. They concluded that all three wavelengths were fast, effective and well tolerated by the patients, and the patients were highly satisfied with the esthetical results.[21]

We should take into consideration that the main factor to be safe to use a laser in the depigmentation of gingiva would be the setting of the laser, which includes the power, time, technique, and practitioner's skill to minimize the thermal effect or other possible damages to tissue. We used the power of 1 W for gingival depigmentation. In the power range of up to 1 W, the cutting depth of the incisions of the laser light at wavelengths 405 to 980 nm are comparable.[12]

The laser fiber diameter can influence the energy density and energy output of the laser used.[22] Increasing the fiber diameter increases the area of the tissue surface and reduces the amount of energy dispensed to tissues. In contrast, larger fibers increase the power, which

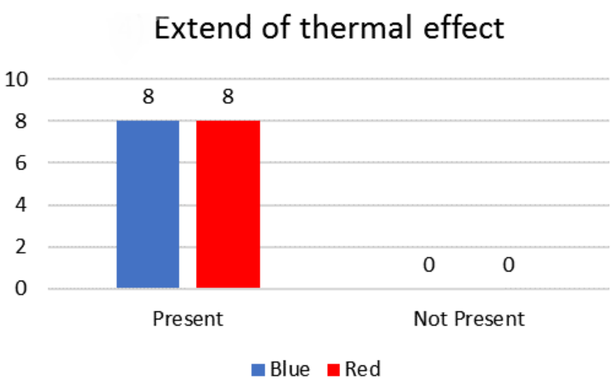

Figure 9. Extend of thermal effects comparison between two lasers. Both lasers show thermal effects on tissue and none of them is superior to the other in the extended thermal effects zone

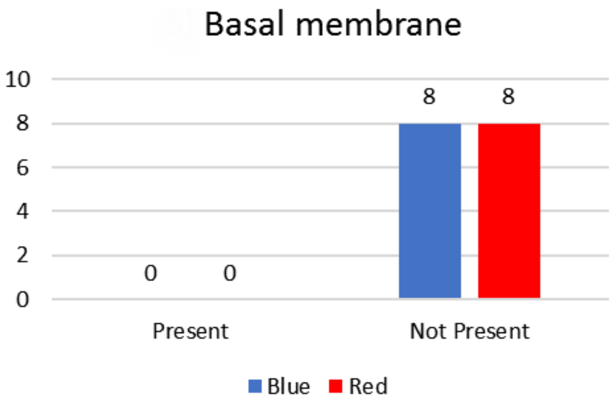

Figure 10. Comparison of basal membrane effects between two Lasers. Both lasers could remove the basal membrane where melanocytes are located, and there was no significant difference between them

results in a higher amount of energy. This can lead to the destruction of desired cells.[23]

According to our results, it seems that blue lasers are safer, so we have fewer side effects on connective tissue when we remove melanocytes from the basal membrane, which is the aim of the depigmentation procedure.

Carbonization area evaluation shows that the 808-nm diode laser has more carbonization spots than the 445-nm blue laser, so it means more surface thermal increase in an 808-nm laser compared to a 445-nm blue lase. Hanke et al showed that at the wavelengths of 532 nm and 810 nm, the thermal effect zone was widened in the lower power range. They also showed that at the wavelength of 445 nm, the thermal damage dimensions were almost the same as the core diameter of the optical fiber,[12] which was also observed in our study.

Furthermore, carbonization could delay the healing process in tissues, so in this item, the 445-nm laser should maintain fewer side effects on the surface of the tissue and scientifically would have faster healing due to less carbonization compared to the 808-nm diode laser.

Conclusion

According to the results of our study, both 808-nm and

445-nm diode lasers, while running with 1-W power for the purpose of gingival depigmentation, have the same results regarding the ablation of epithelium, thermal effects, and removal of basal membrane.

However, in terms of carbonization and ablation of connective tissue, the blue laser (445 nm) significantly produces less thermal effect and less damage to tissue, which means it is safer to use for gingival depigmentation in comparison with diode laser 808 nm.

Authors' Contribution

Conceptualization: Seyed Masoud Mojahedi Nasab, Somayeh Rahmani, Fahimeh Anbari, Jörg Meister.
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Funding acquisition: Seyed Masoud Mojahedi Nasab.
Investigation: Seyed Masoud Mojahedi Nasab, Matthias Frentzen, Somayeh Rahmani, Fahimeh Anbari, Saranaz Azari-Marhabi.
Methodology: Matthias Frentzen.
Project administration: Seyed Masoud Mojahedi Nasab, Somayeh Rahmani, Fahimeh Anbari.
Resources: Matthias Frentzen.
Software: Matthias Frentzen.
Supervision: Seyed Masoud Mojahedi Nasab, Jörg Meister.
Visualization: Somayeh Rahmani,Fahimeh Anbari.
Writing–original draft: Somayeh Rahmani, Fahimeh Anbari, Saranaz Azari-Marhabi.
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 Eethical Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RIDS.REC.1394.177).

References

1. Verma S, Gohil M, Rathwa V. Gingival depigmentation. Indian J Clin Pract. 2013;23(12):801-3.
2. Prabhuji ML, Madhupreetha SS, Archana V. Treatment of gingival hyperpigmentation for aesthetic purposes using the diode laser. Int Mag Laser Dent. 2011;3(2):18-9.
3. Kumar S, Bhat GS, Bhat KM. Comparative evaluation of gingival depigmentation using tetrafluoroethane cryosurgery and gingival abrasion technique: two years follow up. J Clin Diagn Res. 2013;7(2):389-94. doi: 10.7860/jcdr/2013/4454.2779.
4. Houshmand B, Janbakhsh N, Khalilian F, Talebi Ardakani MR. Efficacy of conventional laser irradiation versus a new method for gingival depigmentation (sieve method): a clinical trial. J Lasers Med Sci. 2017;8(2):88-94. doi: 10.15171/jlms.2017.16.
5. Abdel Moneim RA, El Deeb M, Rabea AA. Gingival pigmentation (cause, treatment and histological preview). Future Dent J. 2017;3(1):1-7. doi: 10.1016/j.fdj.2017.04.002.
6. Elemek E. Gingival melanin depigmentation by 810 nm diode laser. Eur J Dent. 2018;12(1):149-52. doi: 10.4103/ejd.ejd_373_17.
7. Bakhshi M, Mojahedi SM, Asnaashari M, Rahmani S, Namdari M. Gingival depigmentation by Er,Cr:YSGG laser and diode laser: a split mouth, clinical trial study. Laser Ther. 2018;27(3):203-13. doi: 10.5978/islsm.27_18-OR-19.
8. Bakhshi M, Rahmani S, Rahmani A. Lasers in esthetic treatment of gingival melanin hyperpigmentation: a review article. Lasers Med Sci. 2015;30(8):2195-203. doi: 10.1007/s10103-015-1797-3.
9. Simşek Kaya G, Yapici Yavuz G, Sümbüllü MA, Dayi E. A comparison of diode laser and Er:YAG lasers in the treatment of gingival melanin pigmentation. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;113(3):293-9. doi: 10.1016/j.tripleo.2011.03.005.
10. Lagdive SB, Lagdive SS, Marawar PP, Bhandari AJ, Darekar A, Saraf V. Surgical lengthening of the clinical tooth crown by using semiconductor diode laser: a case series. J Oral Laser Appl. 2010;10(1):53-7.
11. Mojahedi SM, Bakhshi M, Babaei S, Mehdipour A, Asayesh H. Effect of 810 nm diode laser on physiologic gingival pigmentation. Laser Ther. 2018;27(2):99-104. doi: 10.5978/islsm.18-OR-08.
12. Hanke A, Fimmers R, Frentzen M, Meister J. Quantitative determination of cut efficiency during soft tissue surgery using diode lasers in the wavelength range between 400 and 1500 nm. Lasers Med Sci. 2021;36(8):1633-47. doi: 10.1007/s10103-020-03243-4.
13. Kumar S, Bhat GS, Bhat KM. Development in techniques for gingival depigmentation–an update. Indian J Dent. 2012;3(4):213-21. doi: 10.1016/j.ijd.2012.05.007.
14. Blayden J, Mott A. Soft-Tissue Lasers in Dental Hygiene. John Wiley & Sons; 2013.
15. Murthy MB, Kaur J, Das R. Treatment of gingival hyperpigmentation with rotary abrasive, scalpel, and laser techniques: a case series. J Indian Soc Periodontol. 2012;16(4):614-9. doi: 10.4103/0972-124x.106933.
16. Palaia G, Renzi F, Pergolini D, Del Vecchio A, Visca P, Tenore G, et al. Histological ex vivo evaluation of the suitability of a 976 nm diode laser in oral soft tissue biopsies. Int J Dent. 2021;2021:6658268. doi: 10.1155/2021/6658268.
17. Anbari F, Asfia M, Forouzani G, Talebi Rafsanjan K. Effect of an 810 nm diode laser on the healing of a periapical abscess. J Lasers Med Sci. 2021;12:e3. doi: 10.34172/jlms.2021.03.
18. Khalighi HR, Anbari F, Beygom Taheri J, Bakhtiari S, Namazi Z, Pouralibaba F. Effect of low-power laser on treatment of orofacial pain. J Dent Res Dent Clin Dent Prospects. 2010;4(3):75-8. doi: 10.5681/joddd.2010.019.
19. Abduljabbar T, Vohra F, Akram Z, Ghani SMA, Al-Hamoudi N, Javed F. Efficacy of surgical laser therapy in the management of oral pigmented lesions: a systematic review. J Photochem Photobiol B. 2017;173:353-9. doi: 10.1016/j.jphotobiol.2017.06.016.
20. Gul M, Hameed MH, Nazeer MR, Ghafoor R, Khan FR. Most effective method for the management of physiologic gingival hyperpigmentation: a systematic review and meta-analysis. J Indian Soc Periodontol. 2019;23(3):203-15. doi: 10.4103/jisp.jisp_555_18.
21. Taher Agha M, Polenik P. Laser treatment for melanin gingival pigmentations: a comparison study for 3 laser wavelengths 2780, 940, and 445 nm. Int J Dent. 2020;2020:3896386. doi: 10.1155/2020/3896386.
22. Qadri T, Poddani P, Javed F, Tunér J, Gustafsson A. A short-term evaluation of Nd:YAG laser as an adjunct to scaling and root planing in the treatment of periodontal inflammation. J Periodontol. 2010;81(8):1161-6. doi: 10.1902/jop.2010.090700.
23. Pirnat S. Versatility of an 810 nm diode laser in dentistry: an overview. J Laser Health Acad. 2007;4(2):1-9.