Effect of 810 nm diode laser on physiologic gingival pigmentation

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Background and aims: Physiologic gingival pigmentation (PGP) is the most common type of gingival pigmentation causing esthetic concerns particularly in gummy smile patients. Laser therapy is an effective and noninvasive treatment modality for such patients. This study aimed to evaluate the efficacy of diode laser for treatment of PGP.

Subjects and methods: This quasi-experimental study (one-group pretest-post-test design) was conducted on 20 patients complaining of gingival melanin pigmentation. The gingiva of the anterior segment of the arch was ablated with 810 nm diode laser until the entire visible pigmentation was removed. Clinical observations for the intensity of pigmentation were made at baseline, one month and three months, postoperatively. Data were analyzed using SPSS and Friedman test.

Results: Preoperatively, the mean score of gingival melanin pigmentation in the maxilla and mandible was 2.95. At one month postoperatively, the mean scores of the maxilla and mandible were 1.53 and 1.55, respectively. After three months, the mean rank of scores of the maxilla and mandible was 1.53 and 1.50, respectively. The difference between the pre- and postoperative mean scores was statistically significant (P < 0.001).

Conclusion: Diode laser therapy is an effective and minimally invasive modality for gingival depigmentation. But further investigations with long-term follow ups are warranted in this respect.

Key words: Gingival Pigmentation • Melanin • Hyperpigmentation • Depigmentation • Diode Laser

Introduction

A beautiful smile highly depends on the appearance of the teeth and gingival show. The shape, position and color of the teeth, and level and color of the gingival tissue play an important role in smile harmony. Gingival pigmentation is caused by endogenous or exogenous factors. Physiologic gingival pigmentation (PGP) is the most common type, which results from excessive melanin deposition. Although pathological disorders are also implicated in the pathogenesis of oral pigmentation, most cases are physiologic. Irrespective of its origin, many local and/or systemic factors including genetics, tobacco use, antimalarial agents and tricyclic antidepressants may cause gingival pigmentation. Although PGP is a normal condition, complaints of “black gums” are common among adolescents. Patients are often concerned about gingival hyperpigmentation and color variations of their gingiva and many of them with moderate or severe gingival pigmentation especially those with a high smile line (gummy smile) may seek cosmetic treatments.

Many therapeutic methods including scalpel surgery, electrosurgery, gingivectomy, free gingival autografting, cryosurgery, chemical agents, and abrasion with diamond burs are used for gingival depigmentation but these procedures may cause alveolar bone loss, prolonged healing, pain, excessive bleeding, tissue destruction and swelling. They also need high technical skills.
Laser therapy is another effective treatment option for hyperpigmented epithelium. Various dental lasers have been suggested for successful treatment of gingival hyperpigmentation. These lasers include heat producing lasers such as carbon dioxide (CO₂) laser and Nd:YAG laser, semiconductor diode laser, argon laser and non-heat producing lasers such as Er:YAG and Er,Cr:YSGG lasers.

Energy and wavelength characteristics of 810 nm diode laser target the soft tissues and it is used for cutting and coagulation of the gingival tissue due to its affinity for hemoglobin and melanin.

At present, only a few studies have been published assessing the correction of PGP using diode laser. Therefore, the aim of this study was to evaluate the effect of diode laser on PGP in adult patients.

Materials and Methods

A quasi-experimental study (one-group pretest-post-test design) was designed to evaluate the efficacy of diode laser for treatment of PGP. Twenty adult patients referred to the Oral Medicine Department of Shahid Beheshti Dental School with the chief complaint of gingival pigmentation were included in this study.

The exclusion criteria were:

1. Hyperpigmentation that was associated with systemic diseases, drug use, and diseases that could compromise wound healing (i.e. uncontrolled diabetes mellitus, autoimmune diseases)
2. Pregnancy or lactation
3. Evidence of association of hyperpigmentation with malignancy
4. History of previous treatment of hyperpigmentation
5. Smoking
6. Periodontal problems

The ethical committee of Shahid Beheshti University of Medical Sciences approved this study (ethical code: NCT02143375). The procedure was verbally explained to patients and all patients signed written informed consent forms prior to participation. Standard digital photographs were taken preoperatively with a digital camera (350D; Canon, Tokyo, Japan) and one and three months, postoperatively. The procedure was performed under topical anesthesia using 10% lidocaine spray (Sina darou, Tehran, Iran). Special eye glasses were worn by the patients and the staff according to the FDA laser safety guidelines. The pigmented gingiva in the esthetic zone (facial gingiva of the maxillary and mandibular canine to canine region) was ablated by laser. Depigmentation was done using 810 nm diode laser (Dr Smile diode laser Model:LASD0001.1; Italy) with 810 nm wavelength and 1 W power depending on the pigmentation depth. The diode laser operated in contact mode as continuous wave using a 320 nm fiber optic hand piece. The tip of the laser hand piece was held away from the gingival margin to avoid gingival recession.

Gingival melanin pigmentation was evaluated on photographs taken pre- and postoperatively according to the Dummett-Gupta Oral Pigmentation Index and its relevant scoring system provided by Dummett in 1964. We classified PGP in patients as follows:

1. Mild: Pink to slightly brown
2. Moderate: Dark brown or black
3. Severe: Mixed in color

Two calibrated examiners were chosen to determine the pigmentation score pre- and postoperatively (one and three months) and mean rank score of gingival pigmentation was calculated and compared.

Figure 1 shows a 41-year-old woman complaining of heavily pigmented gums.

During the procedure, laser ablation of the gingival epithelium was done carefully to reach the pigmented area without causing any bleeding. The wound looked fresh with no bleeding (Figure 2).
Statistical analysis:
Quantitative variables were expressed as mean ± standard deviation (SD), and categorical variables were expressed as percentage. The Friedman test was used for one-way repeated measures ANOVA by ranks. Statistical analysis was performed using SPSS software version 16.0 (SPSS Inc., Chicago, IL, USA), and P < 0.05 was considered statistically significant.

Results

Of 20 patients, one was lost to follow-up and excluded. Of the remaining 19 participants, five (26.3%) were males and 14 (73.7%) were females. The mean age of males and females was 25 (± 3.93) and 25.71 (± 6.97) years, respectively.

Preoperatively, two patients had mild pigmentation in the maxilla, 11 had moderate pigmentation and six had severe pigmentation.

At one month postoperatively, four patients had no pigmentation, 14 had mild pigmentation and one showed moderate pigmentation. There was no case of severe pigmentation.

At three months postoperatively, four patients had no pigmentation, 14 had mild pigmentation, one showed moderate pigmentation and no patient showed severe pigmentation.

The mean score of preoperative gingival melanin pigmentation of the maxilla and mandible was 2.95.

At one month postoperatively, the mean score of gingival melanin pigmentation of the maxilla and mandible was 1.53 and 1.55, respectively. After three months, the mean score of gingival pigmentation of the maxilla and mandible was 1.53 and 1.50, respectively.

The difference between the preoperative and postoperative mean scores of gingival melanin pigmentation in the maxilla and mandible was found to be statistically significant (P < 0.001; Table 2).

| Table 1: Comparison of the intensity of gingival pigmentation before and one and three months after treatment with 810 nm diode laser (n=19*) |
|---|---|---|---|---|
| Without pigmentation | Mild | Moderate | Severe |
| Maxilla | Before treatment | - | 2 (10.5) | 11 (57.9) | 6 (31.6) |
| | One month after treatment | 4 (21.1) | 14 (73.1) | 1 (5.3) | 0 |
| | 3 months after treatment | 4 (21.1) | 14 (73.1) | 1 (5.3) | 0 |
| Mandible | Before treatment | - | 1 (5.3) | 8 (42.1) | 10 (52.6) |
| | One month after treatment | 4 (21.1) | 12 (63.2) | 3 (15.7) | 0 |
| | 3 months after treatment | 4 (21.1) | 13 (68.4) | 2 (10.5) | 0 |

* Each patient had gingival pigmentation in the maxilla and mandible and data are reported separately for the two locations.
** Gingival pigmentation score 1. Mild: Pink to slightly brown; Score 2. Moderate: Dark brown or black; Score 3. Severe: Mixed in color

| Table 2: Freidman test results for comparison of the intensity of gingival pigmentation at one and three months after treatment with 810 nm diode laser (n=19) |
|---|---|---|---|---|
| Gingival melanin pigmentation (mean rank) | Before treatment | One month after treatment | 3 months after treatment | Z | P-value |
| Maxilla | 2.95 | 1.53 | 1.53 | 36 | < 0.001 |
| Mandible | 2.95 | 1.55 | 1.50 | 35.38 | < 0.001 |
No postoperative complications such as infection, swelling, pain or bleeding occurred. At the three-month follow-up, patients showed no signs of recurrence of pigmentation.

In 10 patients, no sign of recurrence was noted at the seven-month follow-up.

After three months, healing of the gingiva was favorable and the gingiva was pink in color. The treatment significantly improved the aesthetic appearance of the gingiva (Figure 3).

Discussion

Gingival hyperpigmentation causes esthetic concerns for patients and many of them seek cosmetic treatments for this purpose. Several de-epithelialization techniques are currently practiced to correct gingival pigmentation. Laser treatment is a modality suggested for this purpose since it does not require any periodontal dressing and has advantages such as easy handling, short treatment time, optimal hemostasis, decontamination and sterilization. However, this approach is costly since it requires expensive equipment.

Although CO2 lasers are commonly used for depigmentation procedures, they can damage the tooth structure. CO2 lasers are used in non-contact mode and they may cause loss of tactile sense. The semiconductor diode laser is emitted in continuous-wave or gated-pulsed mode. It usually operates in contact mode using a flexible fiber optic hand piece. Laser light with 810 nm wavelength is poorly absorbed by the water, but is highly absorbed by hemoglobin and other pigments. Energy and wavelength characteristics of 810 nm diode laser target the soft tissues and it is used for cutting and coagulation of gingival tissue due to its affinity for hemoglobin and melanin. Diode laser has lower tissue penetration depth than Nd:YAG laser, but its rate of heat generation is higher. Diode lasers have a smaller size and lower cost and do not produce any harmful effects on the root surface. Thus, diode laser surgery is considered safe in close proximity to tooth structure. Diode laser does not damage the periosteum and bone under the gingiva being treated and can remove a thin layer of epithelium. Although laser wounds heal slower than scalpel wounds, a sterile inflammatory reaction occurs following laser ablation. Moreover, scalpel surgery may cause significant bleeding during and after surgery and it is necessary to cover the exposed lamina propria with periodontal pack for seven to 10 days.

Diode laser also has bactericidal effects and significantly decreases the bacterial count; these effects have been documented in-vivo and in-vitro. Laser irradiation occludes the blood vessels with up to 0.5 mm diameter in the surrounding tissue; thus, hemostasis occurs and the surgeon has a relatively dry operating field. Energy concentration at the tip of laser hand piece enables easy removal of superficial cell layer and part of the connective tissue without bleeding or excessive trauma.

In our study, depigmentation yielded optimal results at one and three months, postoperatively, and caused a significant improvement in aesthetic appearance of the smile. Our findings were similar to those of Gupta and Kher et al. All of the above mentioned studies were case reports which described simple and effective depigmentation technique using semiconductor diode laser in two or three patients. In the current study, we demonstrated improvement in 19 patients and this was the strength of our study.

In 2012, Murthy et al., compared three different surgical depigmentation techniques namely scalpel surgery, abrasion with rotary abrasive bur, and diode laser. Better results of depigmentation were obtained by diode laser than other techniques.

In almost all studies, follow-up duration was longer than in our study. In studies by Kon et al., Perlmutter et al., and Dummet et al., repigmentation occurred during the follow-up period. In the study by Atsawaswan et al, and Berk et al, no repigmentation occurred in any patient after gingival depigmentation using Nd:YAG or Er:YAG laser.

Nakamura et al., described depigmentation with CO2 laser in 10 patients. No repigmentation was seen in the first year, but four patients showed repigmentation after 24 months.

In our study, we found no signs of recurrence after three months of follow-up but further studies are needed to monitor the wound healing process. Also, long-term follow-ups are required to assess repigmentation after surgery.

The information about the behavior of melanocytes after
surgical injury is limited. Spontaneous repigmentation has been demonstrated to occur and the suggested mechanism is that the active melanocytes from the adjacent pigmented tissues migrate to the treated areas.

Variability in the time of repigmentation may be due to the technique used and the race of patients. Repigmentation may also be attributed to melanocytes, which are left during surgery. These melanocytes may become activated and start synthesizing melanin again. Another reason is the reproductive self-maintenance system of melanocytes.

**Conclusion**

In this study, we obtained favorable results by using diode laser for depigmentation. It is a minimally invasive modality for correction of unaesthetic gingival pigmentation and patients were satisfied with the outcome. However, studies with a larger sample size are needed to offer conclusive evidence of the efficacy and safety of the procedure; however, we suggest that diode laser can be used to efficiently correct gingival pigmentation.

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Competing Interest
The authors declare that there are no competing interests regarding the publication of this paper.

Acknowledgments
This study was based on a postgraduate thesis. The authors wish to thank the Research Center, Dental Faculty, Shahid Beheshti University of Medical Sciences, Tehran, Iran, for their support.