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THE POWER OF PINK: TRANSFORMING SMILE ESTHETICS THROUGH LASER-ASSISTED GINGIVAL DEPIGMENTATION. FIRST AUTHOR & CORRESPONDING AUTHOR

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ABSTRACT

INTRODUCTION: Physiologic gingival pigmentation is predominantly found in dark-skin populations. It raises esthetic concerns, and therefore various treatment modalities have been explored to address it. Lasers have emerged as the most preferred approach for gingival depigmentation. Hence, this study was conducted to assess the effect of 980 nm diode laser for the management of gingival pigmentation.
MATERIALS AND METHODS: Ten healthy non-smoker individuals with physiologic gingival pigmentation were enrolled in the study, and were managed using diode laser (980nm, 1.5W, continuous wave mode). Clinical evaluation of the intensity of pigmentation was performed preoperatively and at 1 and 3 months postoperatively using Dummett-Gupta oral pigmentation index.
RESULTS: There was a decrease in pigmentation index scores with a significant statistical difference between pre-operative visit and follow-up visits. (P<0.0001*)
CONCLUSION: 980 nm diode laser was effective in reducing gingival pigmentation. The selective absorption of 980 nm diode laser by melanin led to efficient depigmentation with minimal pain and tissue damage. Hence, 980 nm diode laser would be an optimal tool for the management of physiologic gingival pigmentation.
KEYWORDS: Diode laser ; Gingival depigmentation ; Laser ablation; Pink esthetics.
RUNNING TITLE: 980 nm Diode Laser for Pink Esthetics.

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INTRODUCTION

Gingival hyperpigmentation is a common esthetic concern that can significantly impact an individual's self-confidence and quality of life (1). The normal gingival color is typically referred to as coral pink (2), and it is predominantly determined by various factors such as the size and number of blood vessels, the thickness of the epithelial layer, the extent of keratinization, and the pigments present within the gingival epithelium (3). The primary pigments responsible for the natural gingival color include melanin, carotene, oxyhemoglobin, and reduced hemoglobin with melanin being the most prevalent pigment (4).

Gingival hyperpigmentation occurs as a consequence of an excessive deposition of melanin in the gingival tissues (5). This condition can have various underlying causes, including genetic factors such as physiologic pigmentation, which represents the most prevalent form of diffuse oral mucosal pigmentation, predominantly found in dark-skin populations (6, 7).

Gingival depigmentation is the treatment of choice for patients who are primarily focused on improving their esthetic appearance. The techniques for depigmentation include conventional sclapel surgery, bur abrasion, electrosurgery, radiosurgery, cryosurgery, and, more recently, the application of lasers of different types and wavelengths (8, 9).

Among the available methods, lasers have emerged as the most desired and widely accepted approach for gingival depigmentation, unlike the invasive nature of the conventional scalpel surgery, which is often associated with pain, bleeding and significant postoperative wounds (10), laser ablation therapy offers a less invasive alternative that requires minimal amount of local anesthesia, and results in reduced postoperative pain and discomfort. Moreover, lasers

exhibit enhanced hemostatic activity, creating a bloodless surgical field that improves the operator's vision, and thus enhances the esthetic outcomes (11).

Various types of lasers including diode lasers, CO2 lasers, Erbium lasers, and Nd:YAG lasers have been employed for gingival depigmentation. Laser-tissue interaction is influenced by the laser's affinity for particular chromophores present within the tissue. Chromophores are molecules or substances that can absorb specific wavelengths of laser light (12). Diode lasers have high affinity for chromophores such as melanin and oxy-hemoglobin making it an optimum option for gingival depigmentation procedures (11).

Although previous studies have reported positive results with diode laser treatment, there is a scarcity of robust clinical trials focusing exclusively on its effectiveness for gingival depigmentation (13). Hence, the present clinical trial was conducted to assess the effect of 980nm diode laser for the management of physiologic gingival hyperpigmentation based on the patients' esthetic needs.

The null hypothesis of this study states that there will be no significant difference in gingival pigmentation before and after management with the 980 nm diode laser.

MATERIALS AND METHODS

2.1. Ethics approval

This clinical trial was approved by Research Ethics Committee at the Faculty of Dentistry, Alexandria University (IRB 00010556)-(IORG 0008839) in accordance to the principles of the modified Helsinki code for human clinical studies.

The study protocol was explained to the patients in details, and an informed consent was obtained from all patients.

2.2. Study design, study setting and patient selection

This study was conducted as a one arm clinical trial. Sample size was calculated to be 10 patients assuming 5% alpha error and 80% study power (G*power 3.1.9.7). Ten patients were recruited from the outpatient clinic of the Department of Oral Medicine, Periodontology, Oral Diagnosis and Oral Radiology, Faculty of Dentistry, Alexandria University. After an initial evaluation including medical history, dental history, clinical examination and radiographic examination that was conducted to determine subject eligibility, ten subjects met the following inclusion criteria: adults of either sex between 18 and 40 years old with physiologic melanin pigmentation in the anterior esthetic zone of the maxillary or mandibular gingiva, who were systemically free.

On the other hand, the exclusion criteria included smokers, pregnant and lactating women, and patients taking drugs associated with gingival melanin pigmentation.

2.3. Patient preparation

Patients were detailed about the entire procedure, and after a thorough oral examination and following routine blood investigations (CBC, Bleeding profile, Fasting blood sugar), a pre-operative preparation phase was performed which included phase 1 therapy; professional scaling using ultrasonic scalers and oral hygiene instructions for all patients.

2.4. Operative procedure

Before the procedure, protective eyewear was provided to the patient, operator, and assistant. At first the site of interest was anesthetized using infiltration anesthesia (Articaine hydrochloride 1.7ml with Adrenaline 1:100 000), followed by laser ablation. 980 nm Diode laser (MEDENCY dental laser, Italy). The laser parameters are summarized in (Table 1).

The tip was moved using small brush strokes back and forth to prevent overheating of the tissues. The fiber tip was frequently cleaned during the procedure with the help of gauze soaked in saline. The ablation process was terminated when a whitish pink color was achieved throughout the area. Normal saline-soaked gauze was utilized to remove epithelial remnants in order to improve visualization and to cool the tissues.

The depigmentation was performed for the anterior esthetic zone in both arches, and to avoid causing damage to the delicate gingival margin and interdental papilla, which can result in gingival recession, the elimination of gingival hyperpigmentation was performed at a distance of 1 mm from the free gingiva. No periodontal pack was employed.

2.5. Post-operative care

The following postoperative instructions were given to all patients; to avoid eating hot, spicy, hard, or rough foods for the first 24 hours. Also, to avoid traumatizing the area during the first week of the healing period. No medications were prescribed.

2.6. Assessment

Primary outcome measurement

Clinical assessment was done at baseline, 1 month, and 3 months post-operatively using **Dummett- Gupta Oral Pigmentation Index (DOPI)** (14) to assess the degree/intensity of gingival pigmentation scored as:0 = pink tissue [no clinical pigmentation]; 1 = mild light brown tissue [mild clinical pigmentation]; 2 = medium brown or mixed brown and pink tissue [moderate clinical pigmentation]; 3 = deep brown/blue–black tissue [heavy clinical pigmentation].

Secondary outcome measurement

Subjective assessment of postoperative pain using the **Visual Analogue Scale (VAS)** (15), which is a simple measurement tool that assesses the intensity of pain as experienced and recorded by the patient. On a scale from (0 to 10), 0 marked as "no pain" and 10 marked as the "worst pain imaginable", each patient was

instructed to chart his/her perception of pain immediately after treatment, on the first, and seventh postoperative days.

2.8. Statistical analysis

Data were analyzed using IBM SPSS version 25, Armonk, NY, USA. DOPI and VAS were non-normally distributed and presented mainly using median, minimum, and maximum in addition to mean and standard deviation. Changes across time intervals were assessed using Friedman test followed by post hoc test with Bonferroni correction. All tests were two tailed and the significance level was set at p value ≤0.05.

RESULTS

3.1. Demographic data

10 Egyptian participants were enrolled in the study and treated with 980nm diode laser. The mean age of participants was 21.60 years. The gender distribution was 20% males and 80% females (Table 2).

It is worth noting that a higher percentage of female participants took part in the study, which could be attributed to their generally heightened concern for esthetics and appearance. Nevertheless, no differences were observed in the outcomes based on gender.

All eligible participants who were included in the study adhered to the treatment protocol, and there were no dropouts or serious adverse effects reported.

3.2. Dummett-Gupta oral pigmentation index (Table 3)

All patients showed a significant reduction in DOPI scores across time (P <0.001*), with a significant difference observed between the baseline and 1 and 3 months follow-up visits.

However, there was no significant difference in DOPI scores between the 1 and 3 months follow-up visits (P=1.000). (Fig 1) and (Fig 2)

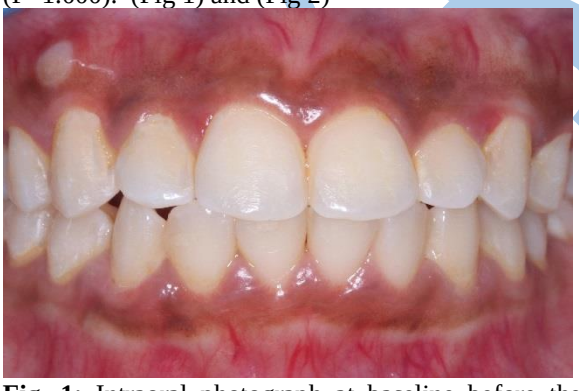

Fig. 1: Intraoral photograph at baseline before the gingival depigmentation procedure.

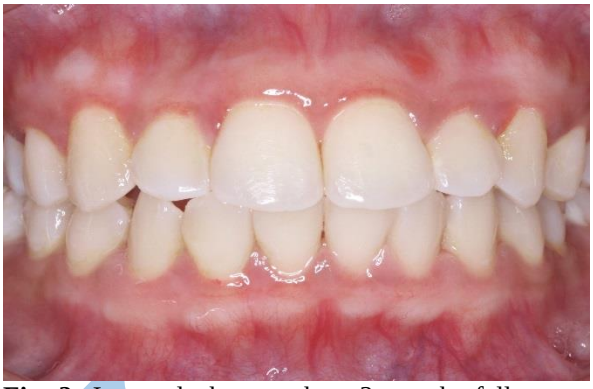

Fig. 2: Intraoral photograph at 3 months follow up following diode laser ablation therapy.

3.3. Visual Analogue Scale (Table 4)

The mean pain scores recorded by the patients immediately post-operatively and on the 1st day postoperatively were 1.20(1.32) and 2.10(3.70), respectively. However, all patients reported no pain by the 7th day post-operatively.

There was no significant difference detected between pain scores recorded by the patients at the different time intervals; immediately postoperatively, on the first and seventh days post-operatively (P = 0.072).

Table 1: Laser parameters.

Laser wavelength	980 nm
Continuous wave/ pulsed mode	Continuous wave mode
Power	1.5 W
Contact/non-contact mode	Contact mode
Fiber-optic tip diameter	300 µm

Table 2: Demographic data.

		Laser group(n=10)
Age: mean (SD)		21.60 (0.97)
Gender: n (%)	Males	2 (20%)
	Females	8 (80%)

Table 3: Comparison of DOPI scores at different time intervals:

		Laser Group (n=10)
Baseline	Mean (SD)	2.20 (0.44)
	Median (IQR)	2.00 (0.65)
	Min – Max	1.60 – 3.00
1 month Follow up	Mean (SD)	0.34 (0.39)
	Median (IQR)	0.23 (0.80)
	Min – Max	0.00 – 1.00
3 months Follow up	Mean (SD)	0.29 (0.38)
	Median (IQR)	0.08 (0.65)
	Min – Max	0.00 – 1.00
P value		<0.0001*

*Statistically significant difference at p value≤0.05

Table 4: Visual Analogue Scale.

		Laser Group (n=10)
Immediately Post-operatively	Mean (SD)	1.20 (1.32)
	Median (IQR)	1.00 (2.25)
	Min - Max	0 – 3
1st day Post-operatively	Mean (SD)	2.10 (3.70)
	Median (IQR)	0.00 (3.75)
	Min - Max	0 - 9
7th day Post-operatively	Mean (SD)	0.00 (0.00)
	Median (IQR)	0.00 (0.00)
	Min - Max	0 – 0
P value		0.072

*Statistically significant difference at p value≤0.05

DISCUSSION

Pink esthetics play a paramount role in attaining a harmonious smile (16). Various treatment modalities have been proposed in the literature for the management of gingival hyperpigmentation, with lasers being the most commonly used nowadays. However, clinical trials conducted on the use of laser for gingival depigmentation are scarce, with the majority of studies found in the literature being case reports or case series. Therefore, the objective of this clinical trial was to assess the effectiveness of 980nm diode laser in the management of gingival hyperpigmentation.

Our findings indicate that there was a significant reduction in pigmentation scores following treatment. These results were consistent with other published studies (11, 17-21). Gul et al (2019) conducted a systematic review and meta-analysis examining the optimal approach for managing physiologic gingival hyperpigmentation, various depigmentation methods, including lasers, were evaluated. The findings indicated that while conventional surgical stripping remained the conventional treatment of choice, alternative new techniques demonstrated comparable efficacy and, in certain studies, even superior outcomes. Notably, the use of lasers, particularly the diode laser, emerged as the most commonly employed method, exhibiting notable advantages such as enhanced esthetic results, reduced pain, accelerated healing, and heightened levels of patient satisfaction following treatment (13). Another systematic review was conducted to assess the effect of two distinct laser types: the Diode and Erbium on the treatment of melanin pigmentation in terms of their ability to remove discoloration, pain, bleeding, longevity, and overall patient experience. The findings indicated that diode laser was significantly more effective as compared to Erbium lasers (22).

Alasbahi et al. compared between the effectiveness of Nd:YAG laser and Diode laser in managing physiologic gingival melanin pigmentation, and concluded that both laser types were effective without any significant difference observed between them (18). Moreover, Moeintaghavi et al. conducted a study comparing the effectiveness of CO2 and diode lasers for gingival depigmentation. Their findings revealed that the use of diode laser resulted in higher esthetic outcomes, along with significantly shorter operative chair time compared to CO2 laser (23).

The efficacy of laser depigmentation relies on the ability of melanocytes to absorb laser light, which is determined by the wavelength of the laser and its depth of penetration. Melanin, being the target chromophore, has an absorption spectrum spanning from 351 to 1,064 nm. Hence, the 980nm diode laser was selected due to its high affinity for chromophores like melanin and oxyhemoglobin, along with its remarkable tissue penetration capability of up to 10mm (11). This unique combination of properties makes the diode laser an optimal choice for effectively ablating melanin pigments in the gingival tissues within a short procedure time.

Additionally, there were minimal reports of pain, with no reports of discomfort, or bleeding during or after the procedure among all patients. This minimal pain experienced by patients could be explained by the protein coagulum that forms on the treated surface, acting as a biologic barrier and sealing the sensory nerves endings. Additionally, the photobiomodulation effects of laser irradiation could result in pain reduction (11).

Furthermore, noteworthy changes were observed during the healing process, with gradual epithelization observed after 1 week, followed by the restoration of a normal pink-colored gingival appearance and keratinization after 2 weeks. The photobiomodulation effects of the diode laser have been shown to stimulate fibroblast activity, promote angiogenesis, and enhance lymphatic flow, all of which contribute to enhanced tissue repair and regeneration, and consequently allow faster healing process of the gingival tissue (21).

Nevertheless, one of the significant challenges in the management of gingival pigmentation is the occurrence of relapse or gingival repigmentation. This arises as a result of the migration of active melanocytes from surrounding pigmented tissues to the previously treated areas (24). The duration of relapse remains a subject of debate and is influenced by various factors such as the technique employed, and the length of the follow-up period. In our study, no signs of relapse were detected over a 3-month follow-up period.

However, it is important to acknowledge the limitations of this study, namely the relatively short duration of the follow-up period, which may hinder the comprehensive evaluation of the relapse rate following the treatment. Therefore, further future studies with extended periods of follow-up are recommended to assess the long-term effectiveness of the diode laser for gingival depigmentation. Moreover, the absence of a control group restricts our ability to make direct comparisons with conventional treatment methods, which could have offered a more comprehensive understanding of the treatment's relative effectiveness.

CONCLUSION

The patients in this study experienced no complications during the treatment process, and their post-operative healing progressed uneventfully. Based on these findings, we conclude that the use of the 980 nm diode laser represents a safe and highly favorable therapeutic choice for the management of physiologic gingival hyperpigmentation.

DECLARATION

Competing interests

The authors declare they have no conflict of interest.

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