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Minimally Invasive Aesthetic Management of Gingival Pigmentation with Er: YAG Laser

Sarfi Dounia, Haitami Sofia, Ihssane Ben Yahya

Department of Oral Surgery, Faculty of Dentistry, University of Hassan II, Casablanca, Morocco
Email: *sarfidounia@gmail.com*

ABSTRACT

Gingival melanin pigmentation is a frequent aesthetic concern, resulting from increased melanin production by melanocytes located in the basal and suprabasal layers of the oral epithelium. Its etiology ranges from physiological pigmentation to systemic pathologies. Gingival depigmentation aims to improve smile aesthetics using various surgical techniques, among which the Er:YAG laser is recognized for its precision and minimal thermal damage.

We report the case of a 34-year-old female patient with diffuse melanin hyperpigmentation in the anterior maxillary gingiva, treated with an Er:YAG laser. The procedure led to effective pigment removal, favorable wound healing, and high patient satisfaction. Clinical follow-up showed minimal postoperative discomfort, complete re-epithelialization within two weeks, and no gingival recession. However, slight residual pigmentation was noted.

This case highlights the effectiveness of the Er:YAG laser in gingival depigmentation, offering advantages in terms of patient comfort, healing quality, and aesthetic outcomes. Nevertheless, limitations include suboptimal hemostasis and a relatively high risk of repigmentation.

Keywords : Gingival depigmentation, Melanin hyperpigmentation, Er:YAG laser

Introduction

The normal physiological color of the gingiva is coral pink or salmon pink, with physiological variations depending on the degree of vascularization, epithelial thickness, keratinized layer thickness, and the amount of melanin pigment.

Excessive deposition of melanin by active melanocytes, mainly located in the basal and suprabasal cell layers of the oral epithelium, can cause dark-colored areas most commonly appearing on the gingiva, known as melanin hyperpigmentation/"black gums" [1].

Melanin hyperpigmentation is known to be associated with various etiological factors such as medications, ingestion or exposure to heavy metals, genetics, UV radiation exposure, intentional cultural tattooing, and smoking [1].

It can also be caused by malignant melanoma, Kaposi's sarcoma, Peutz-Jeghers syndrome, trauma, hemochromatosis, chronic lung disease, and endocrine disorders (Addison's disease, Albright's and Nelson's syndromes, acromegaly) [2]. Therefore, a detailed patient history is essential to determine whether the cause of the melanin hyperpigmentation (MH) is physiological or pathological.

Gingival depigmentation is a surgical procedure through which gingival hyperpigmentation is eliminated or reduced using different treatment methods such as bur abrasion, cold blade surgery, partial-thickness flap, gingivectomy, cryotherapy, electrosurgery, free gingival autograft, chemical methods, subepithelial connective tissue graft, lasers, and combined techniques [1]. Although the choice of technique is mainly based on clinical experience and individual preferences, most authors agree that laser ablation is the most effective, comfortable, and reliable technique for gingival depigmentation [1].

To date, several lasers have been used for gingival depigmentation, including carbon dioxide (CO_2, wavelength: 10,600 nm), semiconductor diode lasers (wavelengths: 810–980 nm), neodymium-doped yttrium aluminum garnet lasers (Nd:YAG, wavelength: 1064 nm), erbium-doped yttrium aluminum garnet lasers (Er:YAG, wavelength: 2940 nm), and erbium, chromium-doped yttrium, scandium, gallium, and garnet lasers (Er,Cr:YSGG, wavelength: 2780 nm) [1].

A recent literature review conducted by Pavlic V. et al. in 2017 highlighted the advantages and disadvantages of the Er:YAG laser in gingival depigmentation [3].

Case Presentation

A 34-year-old female patient presented with a chief complaint of unaesthetic melanin pigmentation in the anterior region of the maxillary gingiva. She was systemically healthy with no significant medical history.

Clinical examination revealed diffuse melanin hyperpigmentation on the labial surface of the maxillary arch (Fig. 1).

Treatment was performed under local anesthesia using an Er:YAG laser (Pluser, Doctor Smile) set at 50 mJ, 50 Hz, SP mode, with 15% water and 90% air spray, operated in a non-contact manner. The fiber tip was held perpendicular to the tissue surface, maintaining continuous movement of the beam. Care was taken to avoid damage to tooth surfaces or exposure of underlying bone during the ablation. Particular attention was paid to the papillary tips and free gingival margins, with constant monitoring of tissue color changes to minimize the risk of gingival recession (Fig. 2).

Clinical parameters, including wound healing, gingival color, pain, discomfort, and tissue deformity, were evaluated at 1, 2, 3, and 4 weeks postoperatively. The total ablation time was approximately 10 to 15 minutes.

At one week postoperatively, the patient reported mild discomfort in the treated area without any pain, and no postoperative bleeding was observed. Connective tissue remained partially exposed at this stage.

By two weeks, complete re-epithelialization was achieved, and the gingiva exhibited a healthy pink color with keratinization and restoration of normal tissue thickness (Fig. 3).

The patient expressed satisfaction with the marked improvement in gingival color. No signs of tissue deformities, such as gingival recession or papilla loss, were observed after four weeks. The papillary tips and free gingival margins remained intact. However, some residual pigmentation persisted on the attached gingiva and in the papillary regions.

Figure 1: Two diffuse melanin pigmentation lesions on attached gingival, free gingival margin and interdental papilla on teeth 11 and 21.

Figure 2: Minimally invasive Er:YAG laser ablation of pigmented gingival tissue.

Figure 3: Complete re-epithelisation with a normal pink colour appearance and recovered thickness after two weeks.

Discussion

Bleeding: The Er:YAG laser has proven to be an effective tool for precise cutting and ablation of gingival tissue. Although the Er:YAG laser is not considered the laser of choice when ideal hemostasis is required, authors agree that coagulation and immediate sealing of small blood vessels (up to 0.5 mm in diameter) can be achieved when necessary.

Comparative studies between the Er:YAG laser and diode laser show a higher bleeding score after Er:YAG laser irradiation [4][5]. This can be partially explained by the weaker hemostatic effect of the Er:YAG laser compared to diode lasers.

Diode lasers penetrate water and reach deeper into soft tissues, unlike the Er:YAG laser, which does not penetrate deeply and does not produce enough heat to allow rapid vessel constriction (especially vessels larger than 0.5 mm in diameter). Moreover, the wavelength of diode lasers falls within the absorption spectrum of hemoglobin.

These authors [4][5] also reported a global subjective preference by patients for the diode laser over the Er:YAG laser (measured through questionnaires).

Hegde [6] compared three gingival depigmentation techniques (scalpel surgery/Er:YAG laser/CO_2 laser) and showed that the conventional scalpel technique resulted in more bleeding surfaces and exposed nerve endings compared to laser techniques. This bleeding was proportional to the depth of penetration into the connective tissue.

This finding can be explained by the formation of a protein coagulum on the wound surface, acting as a biological dressing, which forms during laser use [6].

Wound Healing: The laser enables precise ablation of soft tissues, and wound healing is favorable due to minimal thermal alteration of the treated surface.

Most authors agree that the Er:YAG laser allows complete epithelialization of treated sites, thanks to the immediate formation of a protein coagulum after surgery and a thin fibrin layer covering parts of the treated sites [7][4][8].

During the first week, the gingiva appears healthy, without signs of infection, edema, or scarring.

By the second week, a translucent, non-keratinized epithelium is observed, with the gingival color, when compared to adjacent untreated gingiva, appearing reddish.

At four weeks, the gingiva appears identical to normal, untreated, non-pigmented gingiva [7][4][8].

While some comparative studies (Er:YAG vs. diode laser) reported no difference in wound healing between groups [9], some authors noted faster healing with the Er:YAG laser compared to the diode laser [9].

This difference was attributed to the completely different absorption coefficients of the lasers used. However, a global subjective preference by patients for the diode laser was also suggested [9].

When comparing the Er:YAG laser to the CO_2 laser [6][10], the CO_2 laser showed carbonization, delayed healing, and scar formation. Thus, the Er:YAG laser was considered more favorable, producing better aesthetic outcomes [11].

The hemostatic effects and enhanced healing observed after Er:YAG laser irradiation may also be partly attributed to photobiomodulation effects [11].

Pain Assessment Following Er:YAG Laser Treatment : All reviewed studies utilized the Visual Analog Scale (VAS) to assess pain. Treatment with the Er:YAG laser generally required only topical anesthesia [7][4][6] or local anesthesia upon patient request [4][9], as was the case with our patient. In some cases, no anesthesia was applied [5][8][10]. None of the patients experienced severe pain; only mild itching or minimal to slight pain was reported during treatment, and no postoperative analgesic use was recorded.

In comparative studies between the Er:YAG laser and the diode laser [5][9], no significant difference in pain levels was observed. Both laser treatment groups reported overall mild pain (mean pain scores were 1.4 for the diode laser and 1.5 for the Er:YAG laser). Pain sensations were particularly increased during the consumption of acidic, salty, or hot foods on the day of the procedure.

The Er:YAG laser causes the least thermal damage and has the lowest tissue penetration depth (1 μm), resulting in minimal tissue necrosis and thus reduced pain. A possible explanation for the reduced pain during Er:YAG laser irradiation may lie in the formation of a protein coagulum on the wound surface (acting as a biological dressing) or the sealing of sensory nerve endings [10].

The reduction in pain, referred to as "laser analgesia," may also partially result from the effects of photobiomodulation

Evaluation of Melanin Recurrence/Repigmentation Following Er:YAG Laser Treatment : Although the initial results of gingival depigmentation with the Er:YAG laser are very encouraging, a common concern remains the recurrence of pigmentation [4][8].

The rate of repigmentation is strongly influenced by ethnic factors (such as African, East Asian, and Hispanic populations), genetic predispositions, hormonal influences, and smoking habits [4][12]. Repigmentation is believed to result either from high melanocytic activity or from incomplete removal of melanocytes during surgery. It typically begins with the migration of melanocytes from adjacent untreated marginal gingiva into the treated areas [13][14].

Therefore, in order to minimize the effect of this migration, careful attention should be given to ensuring the maximal removal of melanocytes at the periphery of the treated area. A slight repigmentation is usually observed around six months postoperatively.

However, in comparative studies between the Er:YAG laser, the CO_2 laser, and scalpel surgery, the Er:YAG laser demonstrated less favorable outcomes regarding repigmentation.

Repigmentation often appeared as small pigmented spots on the attached gingiva [5][12]. At six months postoperatively, recurrence rates were similar across all techniques: 90.0% for conventional scalpel surgery, 84% for Er:YAG laser-treated sites, and 82.7% for CO_2 laser-treated sites.

Similarly, when comparing the Er:YAG laser to the diode laser, incomplete removal of gingival epithelium in Er:YAG laser-irradiated sites was reported [9]. Based on these findings, the authors favored the use of the diode laser over the Er:YAG laser [9].

Conclusion:

Gingival melanin pigmentation represents a significant aesthetic concern, making minimally invasive cosmetic approaches increasingly relevant. The Er:YAG laser has proven effective for gingival depigmentation through precise tissue ablation. Its strong affinity for water enables the removal of superficial tissue layers while preserving deeper structures and minimizing scarring. Additionally, it promotes wound healing, exhibits bactericidal activity, and supports photobiomodulation (low-level laser therapy). However, its use requires careful technical handling to ensure effective and safe de-epithelialization. Despite these advantages, its main limitations remain the lack of effective bleeding control and, more critically, the relatively high recurrence rate of pigmentation.

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