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Case Series

Non-ablative gingival depigmentation using 445 nm diode laser: A case series

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ABSTRACT

Aim: Gingival depigmentation is a periodontal plastic therapeutic procedure by which the hyperpigmented gingiva is treated using various surgical and laser ablative techniques. The present case series aims at yielding esthetically acceptable results obtained using a 445 nm diode laser at specific laser parameters.

Clinical Findings: Two females and one male systemically healthy patient reported with the chief complaint of physiologic gingival hyperpigmentation in both upper and lower arches. Clinical examination revealed black–brown gingival pigmentation with a Dummett–Gupta oral pigmentation index (DOPI) score >3 and a melanin index (MI) score >3 in both arches in all three patients, with no signs of underlying pathology.

Intervention: Non-ablative gingival depigmentation (NAGD) was performed using a 445 nm diode laser with a fiber-optic tip of 320 µm diameter at 1 watt in continuous wave mode, with a tip angulation of 90° directed at the target. The procedure was performed without contact with the tissue surface within a total time of 2–3 minutes per arch.

Outcome: The clinician reported outcomes (DOPI and MI) were recorded at baseline, one week, and three months following intervention. All three patients reported uneventful healing with satisfactory, stabilized results, without any episode of reappearance, up to the last reported 90 days after the intervention.

Conclusion: Laser-assisted NAGD, performed using a 445 nm diode laser, is an effective and minimally invasive treatment option for patients with hyperpigmented gingiva, resulting in minimal post-surgical discomfort.

Keywords: Diode laser, Gingival hyperpigmentation, Laser parameter, Melanin, Outcome

INTRODUCTION

The health and appearance of the gingiva are essential components of a smile, alongside the lips, teeth, and face.[1] Gingival color varies from person to person and is believed to be linked to skin pigmentation. Just as the texture and color of skin differ among ethnic groups and geographic regions, the color of the gingiva can range from light to dark brown or black. Gingival melanin pigmentation is present across all ethnicities.[2] The main factors influencing gingival color include the thickness of the gingival epithelium, the size and amount of blood vessels, the degree of keratinization, and the presence of pigments. Melanin, a brown pigment, is the most common natural pigment responsible for endogenous gingival pigmentation. The gingiva is the most pigmented area of the mucosa. Melanin production occurs in the basal layer of the gingival epithelium, where melanin granules, produced by melanoblasts, become dispersed between epithelial cells.[3]

Gingival hyperpigmentation, often referred to as physiological or racial gingival pigmentation, is considered a genetic trait in some populations, regardless of age or gender. In addition, individuals with darker skin tones often experience gingival melanosis (neurofibromatosis), which is commonly associated with conditions such as Addison's disease, Peutz–Jeghers syndrome, and von Recklinghausen's disease.[4] Gingival depigmentation is a periodontal plastic surgery procedure aimed at removing or reducing gingival hyperpigmentation using various techniques. It is typically performed when patients are concerned about their appearance, but it is not a medical necessity.[5] Several methods for depigmentation have been utilized, including chemical agents such as alcohols, phenols, and ascorbic acid, as well as conventional techniques such as surgical scalpel, gingival abrasion, free gingival grafting, acellular dermal matrix allograft, laser depigmentation, electrosurgery, cryosurgery, and radiosurgery.[5-7] Although gingival depigmentation has been widely studied, clinical data on non-ablative 445 nm diode laser in non-contact mode remain limited. This case report employed the use of 445 nm in non-contact mode with the tissue surface using a fiber-optic tip of diameter 320 μm at 1 watt in continuous wave mode, having a tip angulation of 90° with the target within the total time of 2–3 minutes/arch. All the parameters implemented in this case series represent innovative contributions unique to the current investigation.

The present case series is written in accordance with CARE guidelines, with a 90-day follow-up and recall intervals of one week, one month, and three months.

CASE SERIES

Case 1

Patient information

A systemically healthy 22-year-old male patient presented to the department of periodontology with the chief complaint of dark-colored gums in both the upper and lower jaws. Additional historical accounts indicated that it had existed since childhood. The patient disclosed that he was a non-smoker, non-alcoholic, and was not using any medications that could have influenced the pigmentation. The patient sought a solution to improve the aesthetic appearance of his smile, expressing concern over the visible dark pigmentation, particularly when smiling.

Clinical findings and diagnostic assessment

The clinical examination revealed good oral hygiene, with no abnormal mucosal lesions. Clinically, the gingiva appeared healthy without any signs of overt inflammation, except for hyperpigmentation on maxillary and mandibular gingival areas. Hyperpigmented gingival analysis showed Dummett–Gupta oral pigmentation index (DOPI) scores of 3 on the buccal aspect of the maxillary and mandibular arches and a melanin index (MI) score of 4 for both arches as depicted in the Figure 1a-f.[4,8]

Case 2

Patient information

A 27-year-old systemically healthy female patient undergoing orthodontic treatment reported to the department of periodontology for the management of black gums. Patient reported fear of invasive surgical dental treatment, and urged for the non-surgical treatment of the hyperpigmented gingiva.

Clinical findings and diagnostic assessment

On clinical examination, the patient exhibited good oral hygiene with no evidence of gingival inflammation. However, the gingiva appeared hyperpigmented, with a baseline DOPI score of 3 and an MI score of 3 in both the maxillary and mandibular arches as shown in Figures 2a-e.

Case 3

Patient information

A 30-year-old male patient undergoing orthodontic therapy presented to the department of periodontology for cosmetic correction of black gums in both the upper and lower arches. There was no contributory medical history, no adverse habits, and no history of any condition/medications that could detrimentally affect the pigmentation of gums.

Clinical examination and diagnostic assessment

Oral examination revealed fair oral hygiene and gingival hyperpigmentation with average DOPI scores of 4 and 4 in maxillary and mandibular arches, respectively, as well as MI scores of 4 and 4 in maxillary and mandibular gingiva, respectively as illustrated in the Figures 3a-e.

Therapeutic intervention and post-operative care

All three patients reported with hyperpigmented gingiva as explained above were informed about various treatment modalities, including laser-assisted ablative and non-ablative gingival depigmentation (NAGD) techniques. Patients were also informed about the limitations and advantages of the procedures in detail. Owing to a relatively non-invasive and less time-consuming procedure, all three patients opted for the laser-assisted NAGD technique. Written informed consent was obtained from all patients. On the appointed day, the laser-assisted NAGD procedure was performed

using a 445 nm diode laser (Sirolaser Blue: Dentsply Sirona, Germany). Wavelength-specific protective eyewear (OD=5) was provided for the participant, operator, and assistant as per laser safety protocol, and all standard safety measures were followed as recommended by the International Electrotechnical Commission and the Center for Devices and Radiological Health.[9] Before the start of treatment, the laser unit was checked and a test fire was performed according to the manufacturer's instructions. Ice cubes wrapped in gauge pieces were used to pre-cool the area to be treated. Lignocaine jelly (LOX 2% jelly, Neon Pharmaceutical, Uttarakhand, India) was then applied on the pigmented gingival area to be irradiated for a topical anesthetic effect. The NAGD procedure was performed using a 445 nm wavelength in non-contact mode at a 90° angle with a fiber-optic tip of diameter 320 µm, positioned at a distance of 2–3 mm from the target gingival surface at one watt in continuous mode. Immediate coagulation of the gingiva was observed, resulting in discoloration of the pigmented area to grey after delivering 120–140 Joules/arch of energy in 2–3 minutes [Table 1]. A continuous movement of the tip was executed in order to avoid any thermal injury to the deeper tissues. Intermittent ice packs were also used as a coolant during the treatment.

Precautionary post-operative instructions were provided, which included avoiding hot and spicy foods for the first 24 hours. The patients were also advised to abstain from toothbrush trauma for three days following the intervention and were asked to rinse with 0.2% chlorhexidine as a chemical plaque control agent. Patients were also advised to apply topical Vitamin E (Evion 400 mg capsules) three times a day for one week. Strict instructions were given to the patient to avoid rubbing the treated sites for three days. On the 4th day following the intervention, the patients were asked to report to the department for observation and to clean the gray sloughed membrane, if it had not already peeled off, from the treated gingival area.

Outcome

On the 7th day, the irradiated gingival mucosa turned pink without any signs of surface mucosal ablation except one or two spots that were in the healing phase following which further intervention was done through NAGDP at same parameters. Subsurface coagulation of blood vessels gave a pink-colored appearance. No analgesics were required as the pain was self-limiting after the procedure. Two weeks post-operative follow-up showed complete recovery of the gingival mucosa as shown in the Figures. At one month, significant diminution of DOPI scores as well as MI scores was observed in all three cases [Table 2]. All three patients reported uneventful healing and satisfactory esthetic results that remained stable for nine months without any sign of re-pigmentation. The patients did not report any complications of gingival thinning or compromised gingival biotype without any significant change.

Table 1: Laser parameters for NAGD technique.

S. No.	Chracteristics	Value
1	Wavelength	445 nm
2	Tip diameter	320 µm
3	Power	1 Watt
4	Mode	Continuous wave
5	Tip angulation	90°
6	Tissue contact	Non-contact

NAGD: Non-ablative gingival depigmentation

DISCUSSION

Gingival depigmentation is often sought for esthetic reasons, and various laser wavelengths can be used depending on the type and depth of pigmentation. Frequently used diode laser depigmentation, often accompanied by better clinical esthetics outcomes in addition to lower pain, faster healing, and patients' preference and satisfaction.[2] The present case series confirms that NAGD, achieved with a non-contact application of a 445 nm diode laser at 1 watt in continuous wave mode, yields excellent aesthetic outcomes, with complete pigment clearance within four weeks as illustrated in Figure 1f and no recurrence at 90 days. All three patients reported no or minimal post-operative discomfort and clinical healing re-epithelialization without bleeding that was completed by day 7–10. This is similar to findings from Luk and Anagnostaki[10] where similar protocols resulted in rapid recovery and low pain complaints. In the year 2023, a split-mouth trial by Nasab *et al.*,[11] utilized similar settings and achieved 100% pigment resolution with the 445 nm laser, outperforming the 810 nm diode, while pain scores remained statistically equivalent. Histological comparisons in animal models further confirm that a 445 nm wavelength provides a reduction in thermal impact compared to an 808 nm wavelength.[12]

Conventionally, laser depigmentation using diode and neodymium-doped yttrium aluminum garnet (Nd: YAG) laser employed ablation of the gingival mucosa. Diode laser within the wavelength range from 810 nm to 980 nm targets melanocytes, resulting in absorption of energy by melanocytes, causing rapid increase of temperature, resulting in ablation and vaporization of the pigmented melanocytes, melanophages, and melanin granules.[12] In contrast, gingival depigmentation using 445 nm works by selectively targeting and denaturing melanin within the gingival tissue, without removing the surface layer of the gingiva. Diode lasers in the 445 nm range have a high affinity for melanin, making them particularly effective for depigmentation. Compared to other wavelengths, the 445 nm laser offers a non-ablative option

Table 2: Diminution of DOPI scores and MI scores with timeline.

	Baseline				1 month			
	DOPI (max)	DOPI (man)	MI (max)	MI (man)	DOPI (max)	DOPI (man)	MI (max)	MI (man)
Case 1	3	3	4	3	1	1	1	1
Case 2	3	3	3	3	1	1	1	1
Case 3	4	4	4	4	1	0	1	0

DOPI: Dummet-Gupta oral pigmentation index, MI: Melanin index

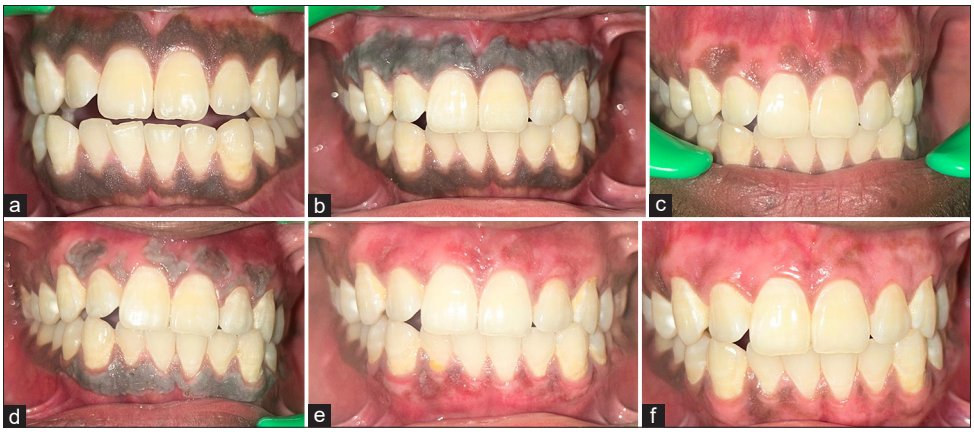

Figure 1: (a) Pre-operative, (b) Immediate post-operative picture for maxillary arch, (c) 1 week post-operative follow-up of maxillary arch, (d) Immediate post-operative of mandibular arch and retreated leftover islands of maxillary arch, (e) 1 week post-operative follow-up of retreated maxilla and mandible, (f) 1 month post-operative follow-up.

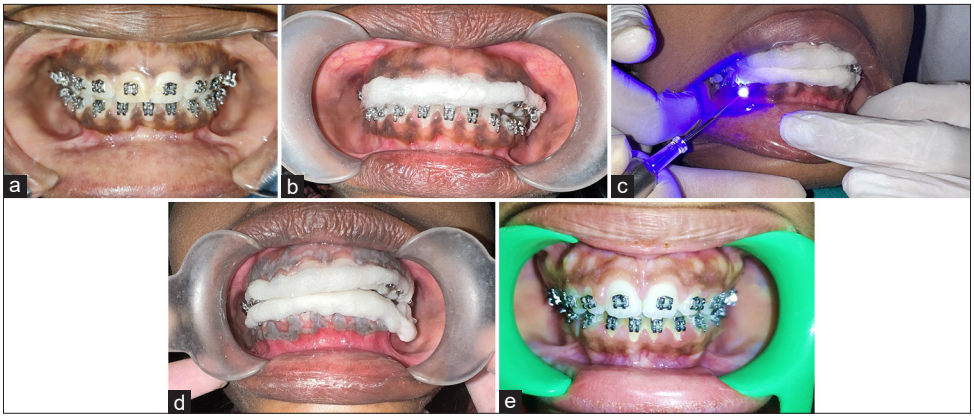

Figure 2: (a) Pre-operative, (b) Covering of metal brackets with the help of cotton rolls so as to avoid laser beam interaction with metal, (c) Blue laser used for non-ablative gingival depigmentation procedure at wavelength in non-contact mode, (d) Immediate post-operative of maxillary and mandibular arch, (e) 1 week post-operative follow-up of both maxillary and mandibular arch showing pigment reduction.

that resulted in less thermal damage to surrounding tissues and promotes faster recovery. Research has shown that non-ablative laser treatments result in minimal post-operative pain and complications, as was seen in these case series. In addition, the use of specific parameters such as the lower power setting (1 W) in non-contact mode helped achieve optimal results with minimal side effects. The healing period for the patient was short, and no significant complications such as infection or scarring were observed.[13] All the three patients in this case series achieved remarkable cosmetic outcomes while maintaining their original gingival biotype post-treatment, demonstrating no measurable loss of tissue

Figure 3: (a) Pre-operative, (b) Covering of metal brackets with the help of cotton rolls so as to avoid laser beam interaction with metal, (c) Immediate post-operative view of maxillary and mandibular arch through non-ablative gingival depigmentation (NAGD) procedure, (d) 1 week post-operative follow-up (e) Retreatment of remaining islands by NAGD procedure.

thickness following nonablative laser depigmentation. This aligns with earlier findings of Atsawasuwan *et al*.[14] using Nd: YAG lasers and Esmaeili *et al*.[15] with the diode laser, both of which documented unaltered gingival architecture and high esthetic satisfaction by non-ablative approach of gingival depigmentation. Furthermore, recent investigations by Ul Haque *et al*.[13] Involving a 445 nm blue diode laser for NAGD reinforces these observations. In a histopathological splitmouth clinical comparative study by Mojahedi Nasab *et al*.[12] In 21 patients, it was confirmed that the 445 nm wavelength diode laser achieved satisfactory pigment clearance, elicited no gingival recession or thinning, and received strong patient approval. Furthermore, the 445 nm wavelength at 1 W produced significantly less thermal damage compared to the 808 nm laser, suggesting better gingival tissue preservation. The non-ablative laser-assisted approach demonstrated superior patient acceptance and higher satisfaction compared to other laser-assisted methods, as evidenced by the clinical studies mentioned above. Additionally, it yielded excellent aesthetic outcomes and minimal patient discomfort. This procedure of depigmentation does not require periodontal dressing because the laser's thermal effect naturally creates a thin protein coagulum over the wound. This acts as a biological dressing, sealing blood vessels and nerve endings to control bleeding and minimize discomfort. Clinical studies show that this coagulum provides a clean, dry surface that promotes accelerated re-epithelialization within two weeks, without the added bulk or discomfort of a conventional dressing.[16]

The understanding of the optical properties of the wavelength, power parameters, and laser tissue interaction is important information for the clinician to achieve the desired treatment outcome. Laser-assisted NAGD with a 445 nm diode laser proved to be an effective and safe treatment option for the patient in this case report. With the proper laser parameters, this technique provides a minimally invasive approach to treating gingival pigmentation with favorable cosmetic outcomes and minimal recovery time. Further studies and case reports can help refine treatment protocols and better understand the long-term effects of this technique.

CONCLUSION

The present case series demonstrates that non-ablative gingival depigmentation using a 445 nm diode laser in non-contact mode is a safe, effective, and minimally invasive technique for managing physiological gingival hyperpigmentation. All patients showed satisfactory esthetic outcomes, rapid healing, and no recurrence during the 90-day follow-up. The laser protocol employed preserved gingival biotype without any adverse effects or post-operative complications. Use of specific laser parameters contributed to minimal discomfort and excellent patient acceptance. The findings reinforce the efficacy of 445 nm wavelength lasers in periodontal esthetic procedures. Further longitudinal studies are needed to validate the long-term stability of results.

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