Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 4 June 2026
Revised 14 July 2026
Accepted 20 August 2026

Natural Resources for Human Health 2026, Vol. 6 (3s): 1023–1041

KEYWORDS:
Gingival depigmentation, melanin pigmentation, diode laser, scalpel technique, periodontal esthetics, Dummett–Gupta Oral Pigmentation Index.

Evaluation & Comparison of Gingival Depigmentation Using Conventional Scalpel Technique and Diode Laser – A Clinical Study

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ABSTRACT:

Background: Gingival melanin pigmentation is a common physiologic finding that may present as dark discoloration of the gingiva. Although it does not represent a pathological condition, it can be an esthetic concern for individuals, particularly those with a high smile line or excessive gingival display. Various techniques have been proposed for the management of gingival hyperpigmentation, among which the conventional scalpel technique and diode laser therapy are frequently used. The scalpel technique has long been considered the gold standard because of its simplicity and cost-effectiveness, whereas diode lasers have gained popularity due to advantages such as improved haemostasis, precision, and patient comfort. In view of these considerations, a comparative evaluation of these two treatment modalities becomes clinically relevant.

Objective: The present study was undertaken to evaluate and compare gingival depigmentation performed using the conventional scalpel technique and diode laser with respect to pigmentation reduction, wound healing, and patient-related outcomes.

Materials and Methodology: The study was conducted on 20 patients aged between 18 and 35 years who presented with gingival melanin pigmentation and reported to the Department of Periodontology and Implantology, Sri Siddhartha Dental College and Hospital, Tumkur. A randomized split-mouth design was employed in which each patient received both treatment modalities. One site was treated using the conventional scalpel technique (Group A), while the contralateral site was managed using a diode laser (Group B). Gingival pigmentation was evaluated using the Dummett–Gupta Oral Pigmentation Index (DOPI). Wound healing was assessed using the Wound Healing Index (WHI), and patient response was recorded using the Visual Analog Scale (VAS) for pain along with a questionnaire evaluating discomfort and esthetic satisfaction. Clinical assessments were carried out preoperatively and postoperatively at 1 week, 1 month, 3 months, and 6 months. Statistical analysis was performed using the Wilcoxon signed-rank test for intergroup comparisons and the Friedman test for intragroup comparisons.
Results: Both treatment modalities resulted in a noticeable reduction in gingival pigmentation. Baseline pigmentation scores were comparable between the two groups. At all postoperative evaluation periods, the diode laser group demonstrated lower pigmentation scores compared with the scalpel group, and the difference was statistically significant. Wound healing progressed satisfactorily in both groups, with no significant difference between the techniques. Patients treated with the diode laser generally reported less postoperative pain and discomfort. The overall esthetic outcome was favourable in

both groups, with most patients expressing complete satisfaction with the treatment results.

Conclusion:

Within the limitations of the present study, both the conventional scalpel technique and diode laser were found to be effective methods for gingival depigmentation. The diode laser showed advantages in terms of reduced postoperative discomfort and improved patient experience. However, the scalpel technique remains a dependable and economical approach for the management of gingival hyperpigmentation.

INTRODUCTION

An attractive smile plays a pivotal role in shaping an individual's self-esteem and social confidence. While tooth form and alignment are central to smile design, the colour and contour of the gingiva are equally decisive in determining overall facial esthetics. Dark or black gingival pigmentation frequently poses an esthetic concern, particularly in individuals exhibiting a high lip line or gummy smile, where excessive gingival display accentuates colour discrepancies. Gingival colour, therefore, constitutes a critical component of smile harmony and contributes substantially to the perception of an ideal smile.

The colour of the gingiva is influenced by a complex interplay of racial, systemic, local, physiological, and pathological factors. Clinically, gingival colour may range from pale pink to coral pink, deep red, or even violet, depending on the relative contribution of five principal pigments melanin, melanoid, oxyhemoglobin, reduced hemoglobin, and carotene of which melanin is the most dominant and commonly implicated in gingival pigmentation. The degree of gingival pigmentation is primarily governed by melanocyte activity rather than the absolute number of melanocytes. Notably, although darker-skinned individuals often exhibit increased oral pigmentation, studies have demonstrated no significant difference in melanocyte count between fair-skinned and dark-skinned populations, with observed variations attributable to differences in melanocytic activity.[1]

Physiologic gingival pigmentation is generally considered genetically determined; however, as suggested by Dummett, its expression may be modulated by mechanical, chemical, and physical stimuli. The relationship between age and oral pigmentation remains controversial. While Steigmann and Shulamit reported the presence of oral pigmentation even in young children, Prinz proposed that physiologic pigmentation becomes clinically apparent only after puberty. Despite being entirely benign, physiologic hyperpigmentation often assumes clinical relevance due to esthetic dissatisfaction, with dark gingiva being the most conspicuous manifestation.

In response to such esthetic concerns, numerous depigmentation techniques have been proposed, including gingivectomy, scalpel-assisted epithelial removal, abrasion methods, free gingival grafts, chemical cauterization, electrosurgery, cryotherapy, and, more recently, laser-based therapies. Among these, the conventional scalpel technique remains a time-honored and widely accepted method, often regarded as the gold standard owing to its simplicity, cost-effectiveness, and minimal armamentarium requirements. Nevertheless, scalpel surgery is invariably associated with intraoperative and postoperative bleeding and healing by secondary intention. Moreover, despite encouraging initial outcomes, the possibility of gingival re-pigmentation remains a recognized limitation.[2]

Since their introduction into dentistry in the 1980s, lasers have revolutionized periodontal and soft-tissue surgical procedures. Diode lasers, in particular, have gained widespread acceptance in procedures such as frenectomy and gingivectomy due to their precision, superior operator control, and reduced postoperative discomfort. In gingival depigmentation, lasers offer distinct advantages, including selective and localized energy delivery that enables effective removal of pigmented tissues while preserving adjacent healthy structures. Additionally, the photothermal coagulative effect of lasers results in excellent hemostasis, improved surgical visibility, and favorable wound healing responses.[3]

Wound healing is a critical determinant of success in periodontal soft-tissue procedures, especially in the context of contemporary regenerative therapies. Delayed or aberrant healing may predispose to increased complications, patient morbidity, and compromised treatment outcomes, ultimately impacting quality of life. Therefore, systematic clinical assessment of wound healing following depigmentation procedures is essential to better understand patient symptoms and treatment responses.

In light of these considerations, the present study was undertaken to evaluate and compare gingival depigmentation using the

conventional scalpel technique and diode laser therapy.[4] The outcomes of this investigation aim to assist clinicians in selecting the most appropriate depigmentation modality based on wound healing characteristics and patient-centered outcomes, thereby enhancing the quality of care in esthetic periodontal practice.

AIM AND OBJECTIVES

AIM:

This study aims to evaluate and compare Gingival Depigmentation using Conventional scalpel technique and diode laser.

OBJECTIVES:

1 To evaluate and compare clinical outcomes with respect to gingival pigmentation using conventional scalpel technique and diode laser.

2 To evaluate and compare wound healing outcomes following gingival depigmentation using conventional scalpel technique and diode laser at different time intervals.

3 To evaluate and compare patients' response in relation to pain perception, comfort and experience following conventional scalpel technique and diode laser.

MATERIALS AND METHODS

The clearance from Institutional Ethical committee was obtained prior to the study and the ethical principles as enumerated in the Helsinki declaration were meticulously followed throughout the course of the study.

Method of collection of data

The study was conducted on patients reporting to the Department of Periodontology and Implantology, Sri Siddhartha Dental College and Hospital, Tumkur with chief complaint of black gums / dark gums and diagnosed with Gingival pigmentation were selected for the study. A written informed consent was obtained after being informed about the nature of study.

INCLUSION CRITERIA:

1. Subjects between age of 18-35 years, of both sexes. with complaint of black gums / dark gums and motivated for esthetic correction of dark gums.
2. Subjects with healthy gingiva.
3. Subjects with mild to heavy gingival pigmentation.
4. Non -smokers.

EXCLUSION CRITERIA:

1. Patients suffering from any systemic diseases / systemic conditions causing oral hyperpigmentation pigmentation.
2. Subjects on Drugs which may cause Oral pigmentation.
3. Chronic smokers/alcoholics/tobacco users.
4. Pregnant/ lactating women.

SAMPLE TECHNIQUE:

A total minimum calculated sample size of 20 patients (20 sides per group) was required to yield 86% power to detect a significant difference, with an effect size of 0.9 and a significance level 0.05(5%).

METHODOLOGY:

A total of 20 patients presenting with complaint of dark or blackish gums and clinically diagnosed gingival pigmentation were enrolled in the study. The participants were randomly assigned by a coin-toss method to either of two groups as a component of randomized split-mouth depigmentation protocol.

- Group (A) – Depigmentation performed traditional scalpel method.

- Group (B) – Diode-laser assisted depigmentation procedure (Guilin LX 16 Woodpecker manual Diode laser of wavelength 650-976nm).

Preparation of the patient: All the subjects will receive initial scaling with oral hygiene instructions. Participants were reviewed four weeks later following the hygiene phase therapy for re-evaluation and examination of oral hygiene.

FIGURE 1: ARMAMENTARIUM

FIGURE 2: PRE-OPERATIVE PHOTOGRAPHS

SURGICAL PROCEDURE – GROUP (A)

- Group(A) Subjects were administered with 2% Lignocaine with 1: 80000 Adrenaline local anesthesia (Lignox 2% A).
- At the selected site of the study a 15 number surgical Bard- Parker Surgical Blade were used for depigmentation.

- Following the local anesthesia infiltration the gingival epithelium in the selected site were scraped, up to the level of mucogingival junction.
- The depigmentation of the entire site was done leaving behind the connective tissue without exposing bone in any of the area.
- Bleeding was controlled by placing pressure pack.

SURGICAL PROCEDURE – GROUP (B)

- Diode laser (Guilin LX 16 Woodpecker manual Diode laser of wavelength 650-976nm) was used in the study.
- During the entire procedure laser safety guidelines such as Protective eyewear was used by the patient, operator, and assistant.
- Reflective or mirror-surfaced instruments were not used to prevent unintended reflection of the laser beam.
- Lidocaine 15% Topical Anesthetic spray were done on the selected site of depigmentation and during the procedure if the subject complains of any discomfort or pain local anesthesia infiltration were administered.
- The fiber optic laser tip with a setting of 1.8 -2.5w were utilized as the setting mode in a continuous wave mode with in the wave length of (810 – 940nm).
- The laser tip was used in a paint brush stroke on the selected area in a horizontal direction to depigment the site.
- Bleeding was controlled by placing pressure pack.

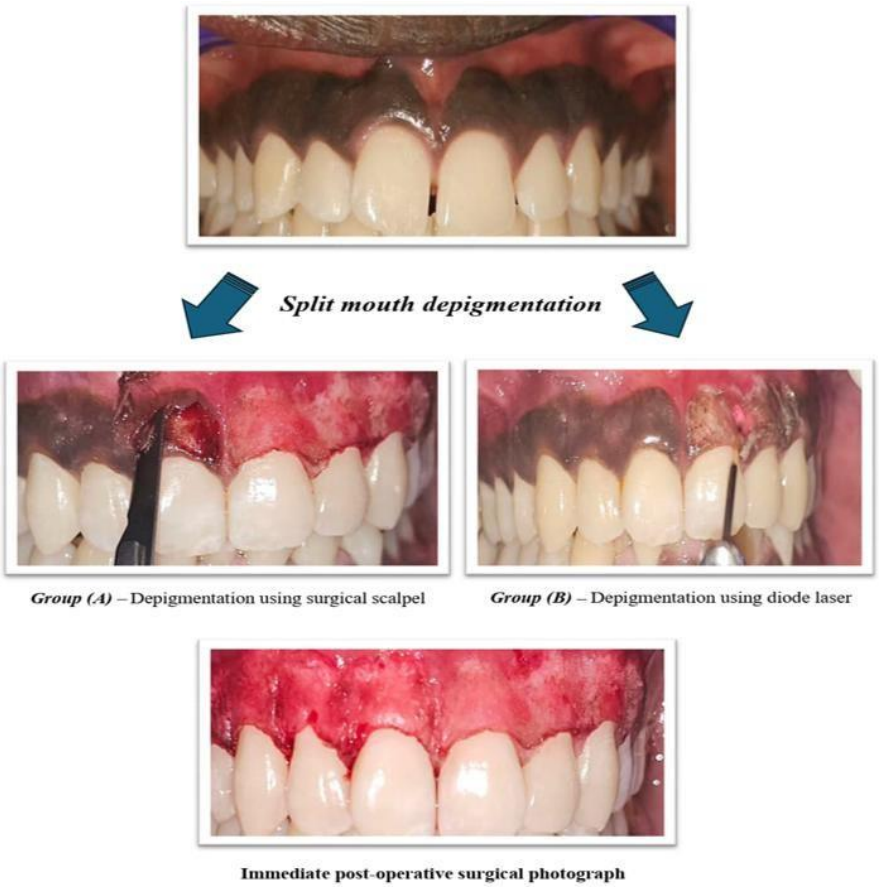

FIGURE 3: SURGICAL PROCEDURE GROUP (A) & GROUP (B)

Fig.4: 1 -week post-operative follow up **Fig.5:** 1 -month post-operative follow up

Fig.6: 3 -months post-operative follow up **Fig.7**: 6 -months post-operative follow up

POST OPERATIVE INSTRUCTIONS

- Instructed to maintain good oral hygiene.
- Hot, spicy, or irritating foods were avoided for a minimum of 24 hours after the procedure to minimize tissue irritation and promote proper healing. They were also advised to prevent any mechanical trauma to the treated area during the recovery period.
- Subjects were assessed on regular intervals, 1 week, 1 month, 3months and 6 months on post-operative visits, for clinical and subjective parameters assessment

DATA COLLECTION

Gingival pigmentation was assessed pre operatively and postoperatively using:

1) **DUMMETT-GUPTA ORAL PIGMENTATION INDEX – DOPI (1964)**

SCORE	SCALE OF PIGMENTATION
0	No clinical pigmentation (pink tissue)
1	Mild clinical pigmentation (light brown)
2	Moderate clinical pigmentation (medium brown)
3	Heavy clinical pigmentation (blackish brown)

2) **WOUND HEALING INDEX (WHI)**

Evaluation of wound healing were assessed by the following score:

- 0 - Tissue Defect or Necrosis
- 1 - Ulcer
- 2 - Incomplete Or Partial Epithelization
- 3 - Complete Epithelization.

SUBJECTIVE PARAMETERS:

1) POSTOPERATIVE PAIN (VISUAL ANALOG SCALE-1921),

- Pain intensity was evaluated using the Visual Analog Scale (VAS), allowing for a subjective yet quantifiable assessment of the patient's perceived discomfort.
- Depicted by a 10-cm horizontal line starting at the left end with the descriptor denoting "no pain" (0) and the right end with "unbearable pain" (score 10).
- Patients' scores of pain was accurately requested as follows:

i. (0) - there is no pain.
ii. (1–3) - experienced mild pain.
iii. (4–6) - experienced moderate to severe pain.
iv. (7–9) – experienced very severe pain.
v. (10) – experienced worst pain

2) DISCOMFORT:

Assessment of patient discomfort based on questionnaires:

- Yes
- No

3) FINAL ESTHETIC OUTCOME -

Assessment of patient's final aesthetic outcome based on questionnaires:

1) Dissatisfied. 2)Partially satisfied. 3) Completely satisfied.

RESULTS AND OBSERVATION-

Table 1: Distribution of baseline oral pigmentation scores in the study groups

DOPA at baseline	***N***	***Median***	***IQR***	***Wilcoxon test***
Group A(Scalpel)	20	2.5	(2-3)	p value = 0.190
Group B (Diode Laser)	20	3	(2-3)	Not Significant

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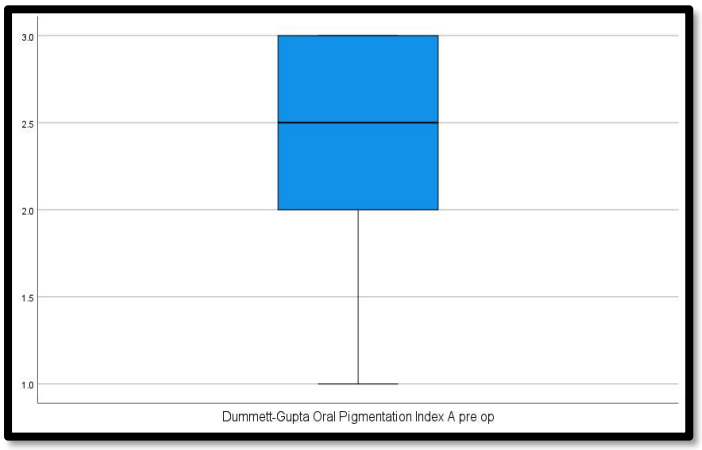
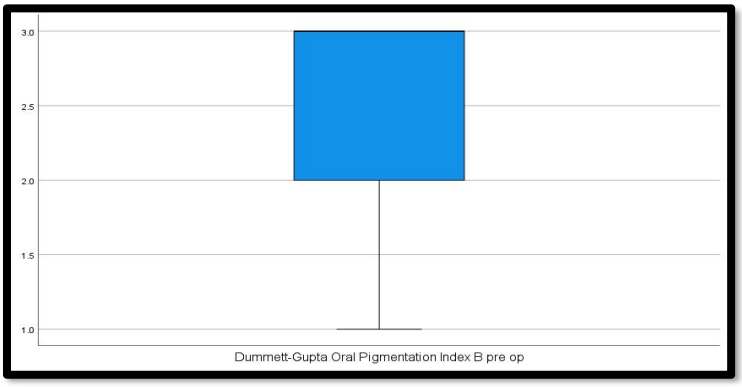
eISSN: 2583-1194



Graph 1: Distribution of baseline oral pigmentation scores in the Scalpel group



Graph 2: Distribution of baseline oral pigmentation scores in the Diode group

Table 1 & Graph 2 & Graph 3: shows that at baseline, the median Dummett–Gupta Oral Pigmentation Index (DOPI) score in the scalpel group was 2.5 (IQR: 2–3), while in the diode laser group it was 3 (IQR: 2–3). The difference between the two treatment sites was not statistically significant (Wilcoxon signed-rank test, p = 0.190), indicating that both treatment sites were comparable before the intervention.

Table 2: Intragroup and Intergroup comparison of Dummett–Gupta Oral Pigmentation Index (DOPA) scores at different follow-up intervals

Follow-up intervals	*DOPA*				
	Group A		*Group B*		
	Median	*IQR*	*Median*	*IQR*	*Wilcoxon signed Rank test*
1 Week	0.5	(0-1)	0	(0-0)	p value = 0.020; Significant
1 Month	1	(0-1)	0	(0-0)	p value = 0.005; Significant
3 Month	1	(0.25-1)	0	(0-0)	p value = 0.003; Significant
6 Month	1	(0.25-1)	0	(0-1)	p value = 0.008; Significant
Friedman test	p value=0.001 Significant		p value=0.096 Not significant		

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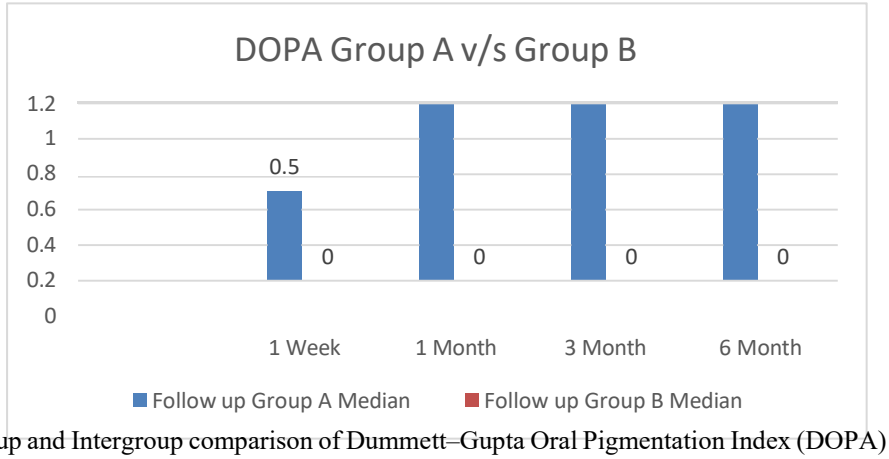

***Graph 3*:** Intragroup and Intergroup comparison of Dummett–Gupta Oral Pigmentation Index (DOPA) scores Group (A) VS Group (B) at different follow-up intervals.

The comparison of Dummett-Gupta Oral Pigmentation Index (DOPA) between Group A (scalpel) and Group B (laser) at different follow-up periods was performed using the Wilcoxon signed-rank test, while changes over time within each group were analyzed using the Friedman test. At 1 week, the median DOPA score in Group A was 0.5 (IQR: 0–1) compared to 0 (IQR: 0–0) in Group B, and the difference was statistically significant (p = 0.020). At 1 month, the median DOPA score in Group A was 1 (IQR: 0–1), whereas Group B remained 0 (IQR: 0–0), showing a statistically significant difference (p = 0.005). At 3 months, the median score in Group A was 1 (IQR: 0.25–1) compared to 0 (IQR: 0–0) in Group B, which was statistically significant (p = 0.003). At 6 months, Group A showed a median of 1 (IQR: 0.25–1) while Group B showed 0 (IQR: 0–1), and the difference remained statistically significant (p = 0.008). The Friedman test showed a statistically significant change in DOPA scores over time in Group A (p = 0.001), indicating variation in pigmentation scores across follow-up periods. In sharp contrast, Group B failed to demonstrate any statistically meaningful temporal variation (p = 0.096), indicating that the pigmentation indices remained largely unaltered and remarkably consistent throughout the entire follow-up duration, with no appreciable trend toward either progression or regression.

Follow up	Patient Aesthetic Outcome												Wilcoxon signed Rank test
	Group A						Group B						
	Dissatisfied		Partially Satisfied		Completely Satisfied		Dissatisfied		Partially Satisfied		Completely Satisfied		
	N	%	N	%	N	%	N	%	N	%	N	%	
1 Week	1	5	2	10	17	85	0	0	1	5	19	95	p value = 0.0257; NS
1 Month	1	5	2	10	17	85	0	0	0	0	20	100	p value = 0.102; NS
3 Month	1	5	2	10	17	85	0	0	0	0	20	100	p value = 0.102; NS
6 Month	0	0	3	15	17	85	0	0	0	0	20	100	p value = 0.083; NS
Friedman test	p value=0.39; Not Significant						p value=0.3; Not significant						

Table 3: Intergroup and intragroup comparison of patient aesthetic outcome at different follow-ups

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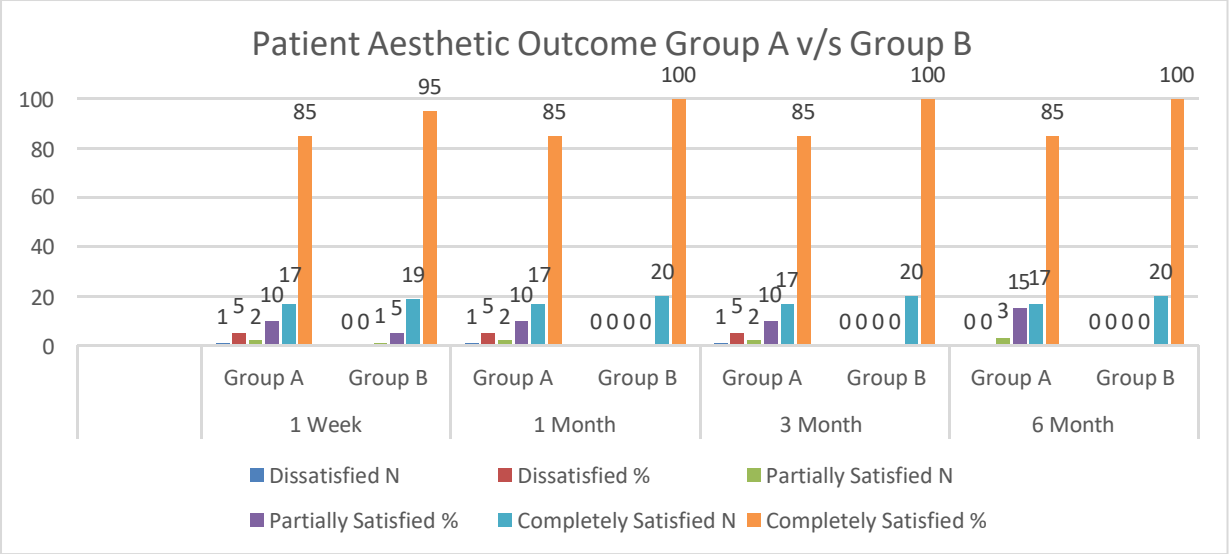
The comparison of patient aesthetic outcome between Group A (scalpel) and Group B (laser) at different follow-up intervals was performed using the Wilcoxon signed-rank test. At 1 week, the majority of patients in both groups reported being completely satisfied, with 85% in Group A and 95% in Group B. The difference between groups was not statistically significant ($p = 0.0257$; NS). At 1 month and 3 months, 85% of patients in Group A and 100% in Group B were completely satisfied, while a small proportion in Group A remained partially satisfied or dissatisfied. The intergroup difference remained statistically non-significant ($p = 0.102$). At 6 months, most patients in both groups were completely satisfied (85% in Group A and 100% in Group B), and the difference between groups was not statistically significant ($p = 0.083$). The Friedman test showed no statistically significant change in patient aesthetic outcome across follow-up periods within either Group A ($p = 0.39$) or Group B ($p = 0.30$).



***Graph 4**:* Intergroup and intragroup comparison of patient aesthetic outcome Group (A) & Group (B) at different follow-up Intervals.

Follow up	Patient Discomfort												Wilcoxon signed Rank test
	Group A						Group B						
	None		Yes		No		None		Yes		No		
	N	%	N	%	N	%	N	%	N	%	N	%	
1 Week	17	85	3	15	0	0	19	95	1	5	0	0	p value = 0.317; NS
1 Month	0	0	3	15	17	85	0	0	0	0	20	100	p value = 0.083; NS
3 Month	0	0	1	5	19	95	0	0	0	0	20	100	p value = 0.317; NS
6 Month	0	0	0	0	20	100	0	0	0	0	20	100	p value = 1.00; NS
Friedman test	p value<0.001; Significant						p value<0.001; Significant						

Table 4: Intergroup and intragroup comparison of patient discomfort between Group A and Group B at different

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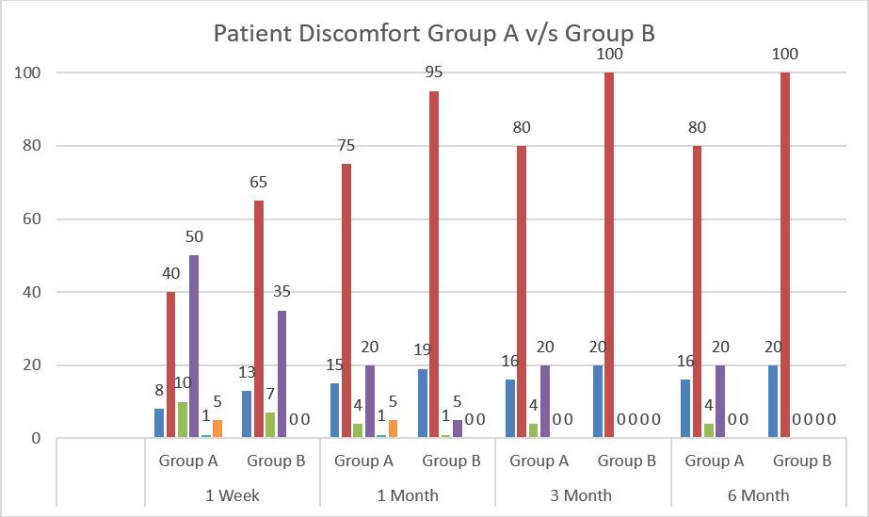

Graph 5: Intergroup and intragroup comparison of patient discomfort between Group A vs Group B at different follow-up intervals

Table 4 & Graph 5 shows Patient discomfort reduced significantly over time in both groups (Friedman test, $p<0.001$). However, intergroup comparison showed no statistically significant difference between scalpel and laser groups at any follow-up interval (Wilcoxon test, $p>0.05$).

Table 5: Intergroup and intragroup comparison of wound healing index between Group A (scalpel) and Group B (laser) at different follow-up interval.

Follow up	Wound Healing Index															Wilcoxon signed Rank test
	Group A								Group B							
	Complete Epithelisation		Incomplete Epithelisation		ulcer		Tissue Necrosis		Complete Epithelisation		Incomplete Epithelisation		Ulcer		Tissue Necrosis	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
1 Week	8	40	10	50	1	5	1	5	13	65	7	35	0	0	0	0	p value = 0.5; NS
1 Month	15	75	4	20	1	5	0	0	19	95	1	5	0	0	0	0	p value = 0.09; NS
3 months	16	80	4	20	0	0	0	0	20	100	0	0	0	0	0	0	p value = 0.04; S
6 months	16	80	4	20	0	0	0	0	20	100	0	0	0	0	0	0	p value = 0.046; S
Friedman test	p value<0.001; Significant								p value<0.001; Significant							

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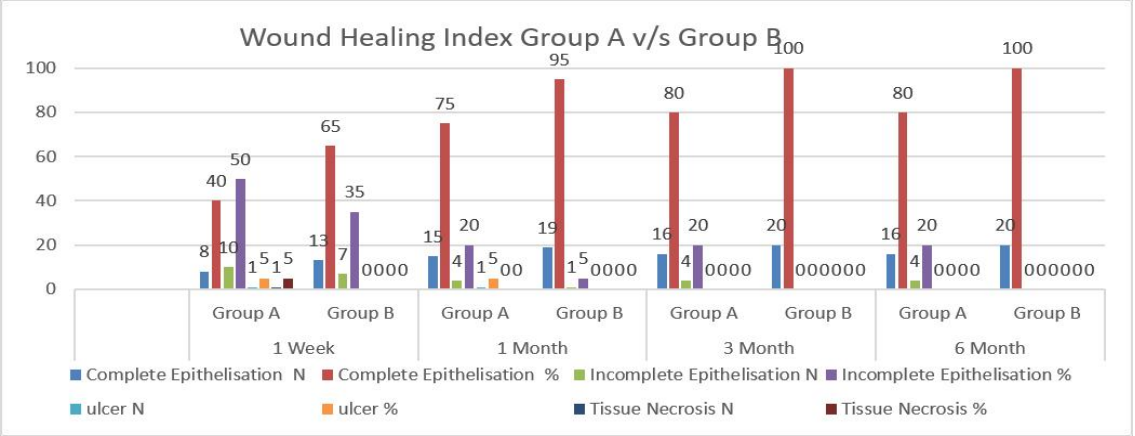

Graph 6: Intergroup and intragroup comparison of wound healing index between Group (A) and Group (B) at different follow-up intervals.

Table 5 and Graph 6 shows that at 1 week, most patients showed incomplete epithelization in both groups. Group A showed 40% complete epithelization, 50% incomplete epithelization, 5% ulcer, 5% tissue necrosis. Group B showed 65% complete epithelization, 35% incomplete epithelization

The difference between groups was not statistically significant (p = 0.5). At 1 month, healing improved in both groups. Group A showed 75% complete epithelization. Group B showed 95% complete epithelization The difference remained not statistically significant (p = 0.09). At 3 months; healing was almost complete in both groups. Group A showed 80% complete epithelization.

Group B showed 100% complete epithelization, this difference became statistically significant (p = 0.04), indicating better healing in Group B. At 6 months, findings were similar to the 3-month follow-up: Group A: 80% complete epithelization Group B showed 100% complete epithelization The difference was again statistically significant (p = 0.046), suggesting superior healing in the laser group. The Friedman test showed p < 0.001 in both groups, which means: There was a statistically significant improvement in wound healing over time in both Group A and Group B.

Follow up	Visual Analog Scale																		Wilcoxon signed Rank test
	Group A										Group B								
	None		Mild		Moderate		Severe		Worst		None		Mid		Moderate		Severe		Worst		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
1 Week	17	85	2	10	0	0	1	5	0	0	19	95	1	5	0	0	0	0	0	0	p value = 0.257; NS
1 Month	17	85	2	10	1	5	0	0	0	0	20	100	0	0	0	0	0	0	0	0	p value = 0.102; NS
3 Month	19	95	1	5	0	0	0	0	0	0	20	100	0	0	0	0	0	0	0	0	p value = 0.317; NS
6 Month	20	100	0	0	0	0	0	0	0	0	20	100	0	0	0	0	0	0	0	0	p value = 1.00; NS
Friedman test	p value<0.036; Significant										p value<0.392; Not Significant										

Table 6: Intergroup and Intragroup Comparison of Postoperative Pain Scores (Visual Analog Scale) Between Scalpel (Group A) and Laser (Group B) at Different Follow-up Intervals

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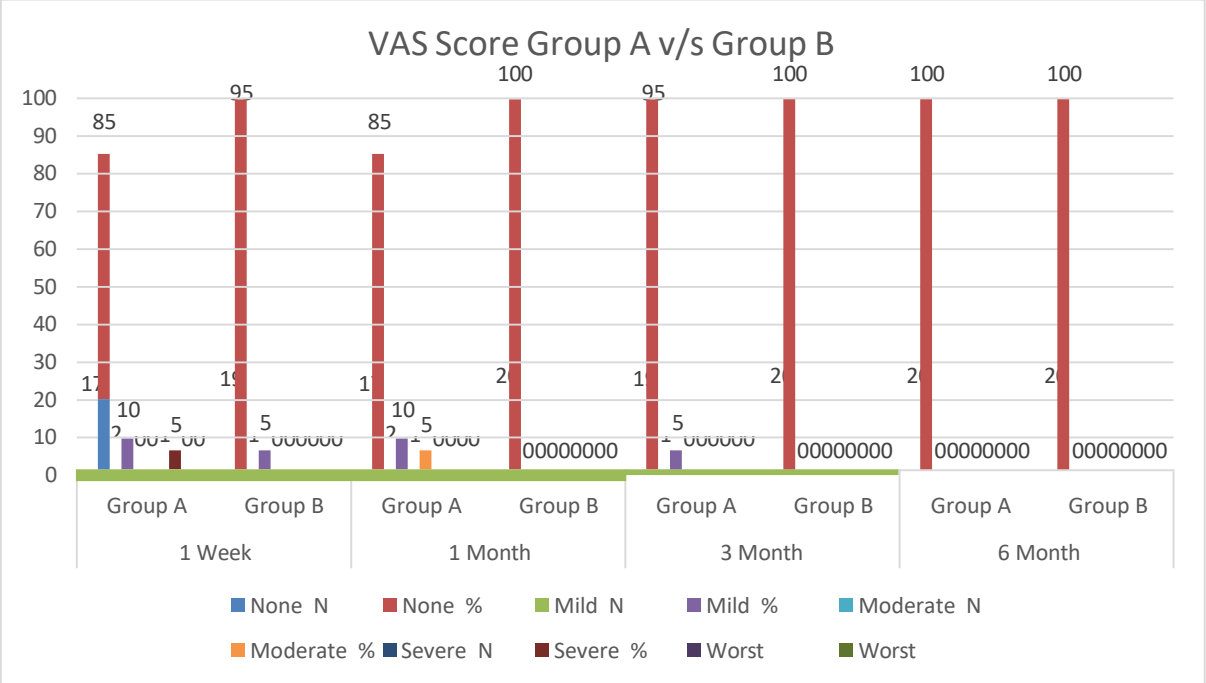
Table 6 and Graph 7 show that at all follow-up intervals (1 week, 1 month, 3 months, and 6 months), the Wilcoxon signed-rank test showed no statistically significant difference between Group A (Scalpel) and Group B (Laser) ($p > 0.05$ at all intervals). Although numerically group B showed slightly higher percentage of patients with no pain and group A had few cases of mild/moderate pain in early follow-ups. These differences were not statistically significant. Therefore, both techniques demonstrated comparable pain levels at all follow-up intervals.

In Group A (Scalpel) Friedman test showed $p < 0.036$ that is Statistically significant indicating change in pain levels in scalpel group over time. There was improvement (increase in "no pain" category from 85% at 1 week to 100% at 6 months). Group B Friedman test showed $p < 0.392$ that is Not statistically significant as the Pain levels did not change significantly over time. Laser group already had very high "no pain" percentages from the beginning (95–100%). Since laser group had minimal pain from the start, the change over time was not statistically significant.



***Graph 7*: Intergroup and Intragroup Comparison of Postoperative Pain Scores (VAS) Between Group (A) and Group (B) at Different Follow-up Intervals.**

DISCUSSION

Periodontal therapy has undergone substantial evolution over the past few decades, transitioning from a discipline primarily concerned with the control of periodontal disease to one that also emphasizes the achievement of optimal gingival esthetics. Gingival melanin pigmentation is a common physiologic condition resulting from increased deposition of melanin within the basal and suprabasal layers of the gingival epithelium. Although this pigmentation does not represent a pathological condition

in a systematically healthy individual, it may present an esthetic concern for many individuals, particularly those with a high smile line or excessive gingival display. Consequently, several therapeutic modalities have been proposed for gingival depigmentation, including scalpel surgery, electrosurgery, cryosurgery, abrasion techniques, chemical cauterization, and laser-assisted procedures. Ho et al. (2015) [36] reported that gingival colour and its distribution play a critical role in determining smile esthetics and overall facial harmony.

Among the various treatment modalities available, the conventional scalpel technique and diode laser therapy remain the most widely practiced techniques for gingival depigmentation. The scalpel technique has historically been regarded as the gold standard because of its simplicity, minimal equipment requirements, and cost-effectiveness. In contrast, diode laser therapy has gained increasing popularity owing to advantages such as improved hemostasis, enhanced surgical precision, reduced intraoperative bleeding, and minimal postoperative discomfort. Muruppel et al. (2020) [2] highlighted the scientific basis and clinical effectiveness of laser-assisted depigmentation and emphasized that laser therapy provides predictable esthetic outcomes with improved patient acceptance.

The present randomized split-mouth clinical study was undertaken to evaluate and compare gingival depigmentation performed using the conventional scalpel technique and diode laser therapy. The comparison was based on clinical parameters including the Dummett–Gupta Oral Pigmentation Index (DOPI) and Wound Healing Index (WHI), along with subjective parameters such as Visual Analog Scale (VAS), patient discomfort, and esthetic satisfaction. Clinical evaluations were performed preoperatively and postoperatively at 1 week, 1 month, 3 months, and 6 months follow-up intervals.

At baseline, both treatment groups demonstrated comparable Dummett–Gupta Oral Pigmentation Index (DOPI) scores, indicating uniform pigmentation severity across the study population. This homogeneity established a reliable foundation for intergroup comparison and ensured that postoperative differences could be attributed primarily to the therapeutic modalities employed rather than pre-existing clinical variability. Such baseline equivalence is critical in split-mouth and comparative clinical studies, as it enhances internal validity and strengthens the interpretability of outcomes at similar levels of pigmentation before treatment. Following the depigmentation procedures, both treatment modalities demonstrated a statistically significant reduction in pigmentation scores ($p < 0.05$), at one week, one month, three month and 6 month follow up intervals indicating that both techniques were effective in eliminating melanin-containing epithelial cells.

The results are in agreement with study done by, Grover et al. (2014) [3] conducted a clinical study evaluating gingival depigmentation using scalpel and laser techniques and reported significant improvement in gingival colour following both procedures. Similarly, Ganachari and Malleshappa (2020) [5] performed a split-mouth randomized clinical study comparing scalpel surgery and diode laser therapy and observed marked reduction in gingival pigmentation following both techniques.

Barath Chandra et al. (2016) [6] also compared scalpel and diode laser depigmentation techniques and concluded that both treatment modalities were effective in eliminating gingival pigmentation with favorable esthetic outcomes. Likewise, Mikhali et al. (2023) [7] evaluated scalpel, ceramic bur, and diode laser techniques for gingival depigmentation and reported significant reduction in pigmentation in all treatment groups. The results of these studies are in agreement with the findings of the present study, where both treatment modalities demonstrated significant improvement in DOPI scores throughout the follow-up period. The reduction in pigmentation observed in the present study may be attributed to complete removal of the pigmented epithelial layer and elimination of melanocytes responsible for melanin synthesis. Subjects were evaluated for Wound healing index using Lagdive et al (2009), Partial epithelialization was observed during the first postoperative week, while complete epithelialization and restoration of normal gingival architecture were evident during the one-month follow-up. Gingival tissues appeared healthy and stable during the three-month and six-month follow-up periods. Results exhibited no statistically significant difference between the techniques ($p > 0.05$). These results were in agreement with studies done by, Rodriguez et al. (2024) [4] emphasized the importance of standardized wound healing indices in evaluating postoperative healing following oral surgical procedures. Jain et al. (2021) [11] compared surgical blade and diode laser depigmentation techniques and reported satisfactory wound healing outcomes in both groups with no statistically significant difference between the techniques. Similarly, Suragimath et al. (2016) [12] conducted a split-mouth randomized clinical study comparing scalpel and diode laser depigmentation procedures and reported favorable healing outcomes with both treatment modalities. These findings correspond with the results of the present investigation, where both scalpel and diode laser techniques demonstrated predictable and uneventful healing. Healing was uneventful in both the groups. The scalpel depigmentation occurs through secondary intention, whereas diode laser therapy promotes healing through protein coagulation, sterilization of the surgical field, and stimulation of fibroblast

proliferation, which may contribute to favorable healing outcomes. Pain perception following gingival depigmentation procedures was assessed using the Visual Analog Scale (VAS). In the present study, patients treated with diode laser therapy reported significantly lower postoperative pain scores compared with scalpel-treated sites ($p < 0.05$), particularly during the early postoperative period. Mudassar et al. (2021)[19] compared scalpel and diode laser depigmentation techniques and reported significantly lower VAS scores in patients treated with diode laser therapy. Similarly, Desai et al. (2013)[20] evaluated patient perception following gingival depigmentation procedures and observed reduced postoperative discomfort in patients treated with diode laser therapy compared with scalpel surgery. This observation may be attributed to the photothermal effect of laser irradiation, which results in coagulation of blood vessels and sealing of sensory nerve endings, thereby reducing postoperative discomfort. These findings support the observations of the present study and indicate that diode laser therapy offers improved patient comfort during the postoperative period. Patient perception of esthetic outcomes is an important parameter in evaluating the success of gingival depigmentation procedures. In the present study, the majority of patients reported high levels of satisfaction with the esthetic outcomes following treatment in both groups.

Kumar et al. (2022)[29] evaluated different techniques for gingival depigmentation and reported significant improvement in gingival appearance with high levels of patient satisfaction. Similarly, Chagra et al. (2020)[22] reported favorable esthetic outcomes following diode laser depigmentation procedures with high patient acceptance. These findings are consistent with the results of the present investigation, where both treatment modalities resulted in satisfactory esthetic improvement.

Repigmentation remains one of the most commonly reported limitations of gingival depigmentation procedures. In the present study, mild repigmentation was observed in 2 cases during the later follow-up intervals in both scalpel and diode laser depigmentation procedure. This can be attributed to migration of melanocytes from adjacent untreated pigmented tissues, activation of residual melanocytes in the basal layer, or genetic predisposition influencing melanin production. Karthik et al. (2021) [23] reviewed various depigmentation techniques and reported that recurrence of pigmentation may occur due to melanocyte migration from adjacent tissues. Similarly, Sagar et al. (2016) [44] reported recurrence of pigmentation following both scalpel and diode laser depigmentation procedures. Bakutra et al. (2017) [47] conducted a comparative clinical and immunohistochemical study evaluating diode laser ablation and surgical stripping techniques and demonstrated that both techniques were effective in improving gingival esthetics; however, laser-treated sites showed reduced postoperative pain and improved patient preference. Mahajan et al. (2017) [48] reported lower incidence of repigmentation in diode laser-treated sites during early follow-up periods. Butchibabu et al. (2014) [49] also reported significantly lower VAS scores in patients treated with diode laser therapy. Suryavanshi et al. (2017) [50] compared scalpel surgery, electrosurgery, free gingival grafting, and diode laser therapy and concluded that diode laser therapy produced superior patient comfort and favorable esthetic outcomes. These findings support the observations of the present study.

Intergroup comparison between the scalpel technique (Group A) and diode laser therapy (Group B) was performed to evaluate the effectiveness of both modalities in gingival depigmentation and their influence on postoperative clinical outcomes.

Assessment of gingival pigmentation using the Dummett–Gupta Oral Pigmentation Index (DOPI) demonstrated a marked reduction in pigmentation scores in both treatment groups during the follow-up period. Both the scalpel and diode laser techniques produced a significant improvement in pigmentation from baseline to subsequent follow-up intervals ($p < 0.05$). However, intergroup comparison between the two modalities did not reveal a statistically significant difference ($p > 0.05$). This indicates that both techniques were equally effective in achieving gingival depigmentation and maintaining the results throughout the follow-up period.

Evaluation of wound healing using the Wound Healing Index (WHI) showed progressive improvement in healing scores in both groups over time. Most of the treated sites demonstrated complete epithelialization during the follow-up visits. Intergroup comparison revealed no statistically significant difference between the scalpel and diode laser groups ($p > 0.05$). These findings suggest that both techniques provide comparable healing outcomes following depigmentation procedures.

Postoperative pain was assessed using the Visual Analog Scale (VAS). The results indicated that patients treated with diode laser therapy experienced comparatively lower pain scores during the early postoperative period when compared with the scalpel group. Intergroup comparison demonstrated a statistically significant difference during the initial follow-up interval ($p < 0.05$), suggesting that diode laser therapy offers improved patient comfort and reduced postoperative pain.

Patient discomfort was evaluated through a questionnaire-based assessment. Although a slightly higher frequency of discomfort

was reported in the scalpel group during the early healing phase, intergroup comparison did not show a statistically significant difference between the two treatment modalities ($p > 0.05$). Overall, both procedures were well tolerated by the patients.

Assessment of the final esthetic outcome indicated that the majority of patients in both groups reported complete satisfaction with the esthetic results obtained after the depigmentation procedure. Intergroup comparison revealed no statistically significant difference in patient satisfaction between the two groups ($p > 0.05$), demonstrating that both treatment approaches provide favorable esthetic results.

SUMMARY AND CONCLUSION

Gingival pigmentation is a common physiological condition caused by the deposition of melanin pigment within the basal and suprabasal layers of the gingival epithelium. Although it is not considered a pathological condition, excessive gingival pigmentation may present an esthetic concern for many individuals, particularly those with a high smile line or excessive gingival display. The increasing awareness of dental esthetics and the demand for improved smile appearance have led to the development of several techniques for gingival depigmentation.

Various treatment modalities have been proposed for the management of gingival pigmentation, including scalpel surgery, electrosurgery, cryosurgery, abrasion techniques, and laser therapy. Among these, the conventional scalpel technique has traditionally been considered the gold standard because of its simplicity, effectiveness, and cost-effectiveness. In recent years, diode laser therapy has gained popularity due to advantages such as improved hemostasis, minimal intraoperative bleeding, and enhanced patient comfort.

The present randomized split-mouth clinical study was conducted to evaluate and compare gingival depigmentation using the conventional scalpel technique and diode laser therapy with respect to clinical outcomes, wound healing, and patient response. A total of twenty patients aged between 18 and 35 years presenting with gingival melanin pigmentation were included in the study. A split-mouth design was employed in which one site was treated using the conventional scalpel technique and the contralateral site was treated using diode laser therapy. Clinical and subjective parameters were evaluated preoperatively and postoperatively at 1 week, 1 month, 3 months, and 6 months follow-up intervals.

Both the techniques scalpel and diode laser were found to be effective methods in reduction in gingival pigmentation. In the current study it was noted that laser had an added advantage of lower post-operative pain compared to scalpel technique. choice of technique is based on the clinical requirements, clinician's decision-making, and professional expertise.

Both the conventional scalpel technique and diode laser therapy demonstrated a statistically significant reduction in gingival pigmentation scores from baseline to all postoperative follow-up intervals ($p < 0.05$), indicating that both techniques are effective in the management of gingival melanin pigmentation.

Intergroup comparison of Dummett–Gupta Oral Pigmentation Index scores revealed no statistically significant difference between the scalpel and diode laser groups at different follow-up intervals ($p > 0.05$), although diode laser–treated sites showed slightly lower pigmentation scores.

Evaluation of wound healing using the Wound Healing Index demonstrated progressive healing in both groups during the postoperative period, with no statistically significant difference observed between the two treatment modalities ($p > 0.05$).

Assessment of postoperative pain using the Visual Analog Scale revealed that patients treated with diode laser therapy experienced significantly lower pain scores during the early postoperative period ($p < 0.05$) compared with the scalpel technique.

Both treatment modalities were associated with minimal postoperative discomfort and high levels of patient satisfaction with the esthetic outcome, indicating favorable patient acceptance of the procedures.

Diode laser therapy offered additional clinical advantages such as improved hemostasis, minimal intraoperative bleeding, and enhanced patient comfort, while the conventional scalpel technique remained a simple, economical, and reliable method for gingival depigmentation in routine clinical practice.Based on the findings of the present study, both treatment modalities can be effectively utilized for gingival depigmentation, and the selection of technique may depend on clinical requirements, operator expertise, availability of equipment, and patient preference.

Future studies with larger sample sizes may provide further validation of the findings of the present study. Long-term follow-up studies are necessary to evaluate the recurrence or repigmentation of gingival tissues following depigmentation procedures. Comparative clinical trials involving different laser systems and other depigmentation techniques may provide additional insights into the most effective treatment modalities for gingival pigmentation. Furthermore, studies incorporating histological evaluation may help better understand tissue response and melanocyte activity following depigmentation procedures.

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