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Comparative Assessment of Gingival Depigmentation Using Laser Versus Micro Needling with Ascorbic Acid: A Randomised Controlled Clinical Trial

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KEYWORDS

Gingival depigmentation, Diode laser, Microneedling, Ascorbic acid, Dummett–Gupta Oral Pigmentation Index, Smile aesthetics, Patient compliance, Periodontal esthetics.

ABSTRACT:

Introduction - Physiological gingival pigmentation is harmless but may compromise smile aesthetics, particularly in individuals with a high smile line. Though it poses no oral health risk, dark gingiva can affect self-confidence, prompting patients to seek cosmetic improvement. Gingival depigmentation aims to achieve uniformly pink gums using techniques such as scalpel surgery, electrosurgery, cryosurgery, chemical methods, or lasers.

Objective - To compare the effectiveness of gingival depigmentation using a diode laser versus microneedling with topical ascorbic acid in improving gingival aesthetics, as assessed by the Dummett–Gupta Oral Pigmentation Index (DOPI) over a three-month period.

Methodology - A randomized controlled clinical trial was conducted on 20 systemically healthy patients with physiological gingival hyperpigmentation and a high smile line. Participants were divided into two groups (n=10): Group A—diode laser depigmentation; Group B—microneedling with topical ascorbic acid. Pigmentation was assessed by DOPI at baseline and three months, and postoperative pain by Visual Analogue Scale (VAS) at 1, 2, and 3 weeks. Data were analyzed using SPSS v19 with significance at $p<0.05$.

Results:

Both methods significantly reduced pigmentation ($p<0.05$), but diode laser achieved greater mean DOPI reduction, faster healing, and lower VAS scores. Laser treatment required a single session with minimal bleeding and higher patient satisfaction, while microneedling needed multiple visits, affecting compliance.

Conclusion:

Both techniques effectively reduced gingival pigmentation; however, diode laser provided superior results with quicker depigmentation, less discomfort, and greater patient acceptance, making it a more efficient and patient-friendly option.

INTRODUCTION

The appearance of gingiva plays a vital role in smile esthetics, and excessive pigmentation is often perceived as unaesthetic, especially in patients with a high smile line. Although gingival pigmentation is usually physiological and harmless, it can adversely affect self-confidence and motivate patients to seek esthetic correction (Ashok, 2023).

Gingival pigmentation results from various factors, including physiological melanin deposition, genetics,

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systemic conditions, and external influences such as smoking. Of these, melanin is the most common endogenous pigment, produced by melanocytes in the basal and spinous layers of the gingival epithelium (Dummett, C.O., 1960). Clinically, hyperpigmentation manifests as brown to black discoloration, which many patients find undesirable.

Several depigmentation techniques have been proposed, including scalpel excision, bur abrasion, cryotherapy, electrosurgery, and lasers. The scalpel method, while cost-effective, is associated with bleeding, pain, and delayed healing (Hirschfeld, I. & Hirschfeld, L., 1951). Lasers offer distinct advantages, such as precise ablation, minimal bleeding, less postoperative discomfort, and faster recovery, making them a widely preferred modality (Ho, D.K. et al., 2015).

Microneedling, a minimally invasive technique originally used in dermatology, has recently been explored in periodontal esthetics. It induces controlled micro-injury, enhancing wound healing and penetration of topical agents such as ascorbic acid (vitamin C), which inhibits tyrosinase activity and reduces melanin synthesis (Lin, Y.H. et al., 2014, Lin, Y.H. et al., 2014). Despite promising results, clinical evidence for its application in gingival depigmentation remains limited.

Therefore, the present study aimed to compare the clinical effectiveness of diode laser and microneedling with ascorbic acid in managing gingival hyperpigmentation.

MATERIALS AND METHODOLOGY

The study was conducted at the Department of Periodontics at KLE Vishwanath Katti Institute of Dental Sciences, Belgagavi, Karnataka, India. The study protocol received approval from the Ethical Committee at KLE Vishwanath Katti Institute of Dental Dental Sciences, Belagavi. The trial was registered in the Clinical Trials Registry of India (REF/2025/03/102009). Before their participation, all individuals provided informed consent. The consent form detailed the treatment regimen, including its benefits, stages, and potential adverse effects. The study enrolled 20 healthy participants with a primary concern related to the treatment of gingival pigmentation. The sample size was estimated using G*Power statistical software, with a power set at 85%.

Inclusion and Exclusion Criteria

For patient selection, an initial screening was performed that included a detailed review of dental records along with clinical and radiographic examinations. Twenty systemically healthy participants between 18 and 35 years of age, presenting with physiologic gingival hyperpigmentation in the esthetic zone, were recruited. To minimize confounding factors, individuals with systemic conditions such as bleeding disorders, those undergoing chemotherapy, pregnant women, smokers, and patients with gingivitis or periodontitis were excluded from the study.

Clinical Assessments

Intensity of Pigmentation was measured using Dummet and Gupta Oral Pigmentation Index or DOPI score where A DOPI score is a numeric rating from 0 to 3, where 0 represents no pigmentation (pink gums) and 3 indicates heavy, deep brown or blue-black pigmentation.

For LASER depigmentation, local anaesthesia (2% lignocaine hydrochloride with 1:80,000 adrenaline) was administered. Gingival depigmentation was performed with a diode laser (Biolase) operating at a wavelength of 810 nm and a power setting of 1.5–2.0 W in continuous wave mode, delivered through a flexible fiber-optic system with a 400 µm diameter tip. The laser tip was applied in a sweeping motion over the pigmented gingiva until slight blanching and blister formation were observed. The treated epithelium was then gently removed using sterile gauze moistened with saline to expose the underlying connective tissue (figure 1). After completion of the procedure, patients were provided with appropriate postoperative care instructions. (Figure1-Figure3)

For Microneedling (MN) with Ascorbic Acid, local infiltration anesthesia was administered. MN was performed using a Dermapen device (Dr. Pen, Las Vegas, NV), and a topical mixture of ascorbic acid powder (1,000 mg/mL) with saline was applied over the gingiva for 10 minutes. The device allows adjustable needle penetration from 0.2 mm to 3 mm, depending on gingival thickness, with six-speed modes ranging from 412 to 700 cycles per minute. The disposable needle tip, containing 12 to 24 needles arranged in rows, ensures sterile use for each patient.

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Gingival thickness was measured 1.5 mm apical to the gingival margin using an endodontic spreader (No. 15) with a rubber stopper. The instrument was inserted perpendicularly until resistance was felt, and the distance from the stopper to the tip was recorded using a digital caliper. Based on these measurements, the appropriate microneedle penetration depth was selected.

The Dermapen was applied perpendicularly to the gingival surface, and microneedling was performed in horizontal, vertical, and diagonal directions for four to five passes until mild erythema and pinpoint bleeding were observed. Each participant underwent three MN sessions at 10-day intervals.

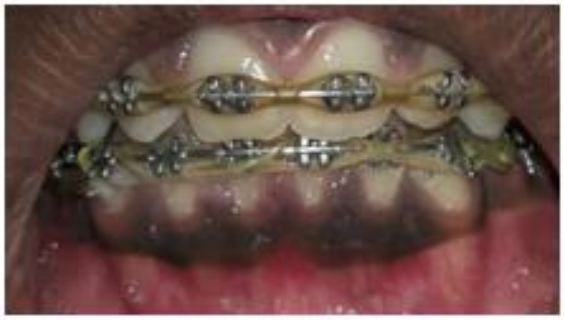

Figure 1-Pre-op image

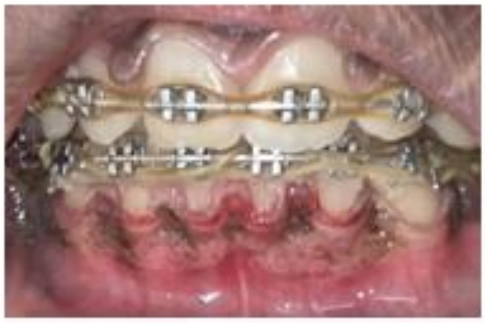

Figure 2-Immediate Post-op image

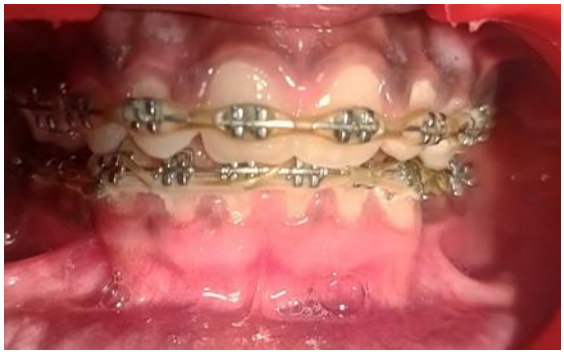

Figure 3-Post-op image

Results

Statistical analysis : The data collected were entered in Microsoft Excel (2021) and analysed using SPSS® (IBM Corp. Released 2012 IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY, USA: IBM Corp.). The normality of the data was assessed prior to analysis using the Shapiro-Wilk's test/Kolmogorov-Smirnov test. Data were found to be not normally distributed. Thus, non-parametric test was chosen. Descriptive statistics were used to calculate the mean values. Fried man test and Mann-Whitney U test were carried out to determine the difference within and between the control and test groups and Chi-square test was used to determine the association between qualitative data. All statistical tests were performed at a significance level of 5% ($p < 0.05$).

Table 1: Comparison of DOPI Pigmentation scores between control and test groups at different time intervals

Time Interval	Test group		Control group		Chi-square	*p-value*
	Laser		Microneedling +Vit C			
	N	N %	N	N %		

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Baseline	No pigmentation	0	0.0%	0	0.0%	0.48	0.788
	Mild	1	10.0%	2	20.0%		
	Moderate	5	50.0%	5	50.0%		
	Heavy	4	40.0%	3	30.0%		
1st month	No pigmentation	3	30.0%	3	30.0%	1.17	0.558
	Mild	5	50.0%	3	30.0%		
	Moderate	2	20.0%	4	40.0%		
	Heavy	0	0.0%	0	0.0%		
3rd month	No pigmentation	2	20.0%	0	0.0%	5.07	0.167
	Mild	4	40.0%	6	60.0%		
	Moderate	4	40.0%	2	20.0%		
	Heavy	0	0.0%	2	20.0%		

*All values are expressed as frequency with percentages (in parentheses); The statistical test used: Chi square test; level of significance: * $p \leq 0.05$ is considered statistically significant.*

Table 1 presents the comparison of **DOPI Pigmentation scores** laser and microneedling groups at baseline, 1st month, and 3rd month. At baseline, most participants in both groups exhibited moderate pigmentation (50.0% each), followed by heavy pigmentation in 40.0% of the laser group and 30.0% of the control group, with no significant difference between the groups (p = 0.788). At the 1st month, both groups showed improvement, with an increase in the proportion of subjects showing mild or no pigmentation; however, the intergroup difference remained statistically insignificant (p = 0.558). By the 3rd month, further improvement was observed in both groups, with 20.0% of participants in the laser group showing no pigmentation compared to none in the control group, though the difference did not reach statistical significance (p = 0.167). Overall, both treatment modalities demonstrated a reduction in pigmentation intensity over time, but the difference between groups was not statistically significant at any interval.

Table 2: Comparison of Visual analog scale between control and test groups at different time intervals

Groups	**Baseline** (Mean ± SD)	**1st Month** (Mean ± SD)	**3rd month** (Mean ± SD)	X^2**-value (df = 2)**	***p*-value**†
Laser group (n=10)	2.3 ± 0.67	0.90 ± 0.74	1.2 ±0.79	18.72	**<0.001***
Microneedling Group (n=10)	2.1 ± 0.74	1.1 ± 0.87	1.6 ± 0.84	13.00	**<0.001***
***Z*-value**	-0.62	-0.56	-0.82		
***p*-value**‡	0.534	0.574	0.412		

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*All values are expressed as Mean ± SD. The statistical test used: †Fried man test and ‡Mann-Whitney U test; level of significance: *p ≤ 0.05 is considered statistically significant.*

Table 2 summarizes the comparison of mean scores of **Visual analog scales** between the laser and microneedling groups at baseline, 1st month, and 3rd month. The laser group showed a substantial reduction in mean values from 2.3 ± 0.67 at baseline to 0.90 ± 0.74 at the 1st month and 1.2 ± 0.79 at the 3rd month, which was statistically significant ($p < 0.001$). Similarly, the microneedling group exhibited a decrease from 2.1 ± 0.74 at baseline to 1.1 ± 0.87 at the 1st month and 1.6 ± 0.84 at the 3rd month, also showing a significant change over time ($p < 0.001$). However, intergroup comparisons at individual time points revealed no statistically significant difference between the laser and microneedling groups ($p > 0.05$ at all intervals). These findings indicate that both interventions were effective in improving the evaluated parameter over time, with comparable outcomes between the two treatment modalities. [Table 2 and Figure 1]

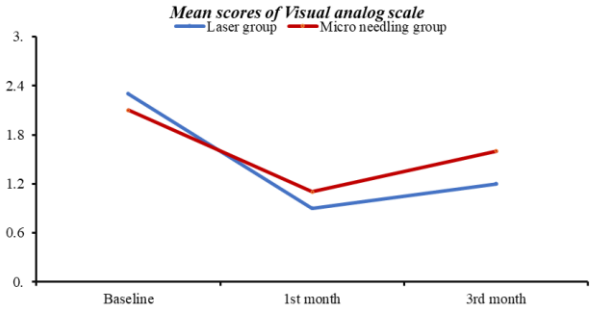

Figure 1: Comparison of visual analog scale mean scores between laser and microneedling group

Discussion

The present randomized controlled clinical trial compared the clinical effectiveness of diode laser and microneedling with ascorbic acid for gingival depigmentation. Both techniques demonstrated a significant reduction in gingival pigmentation scores from baseline to three months, indicating that each approach is effective in improving gingival esthetics. However, no statistically significant difference was found between the two groups, suggesting comparable outcomes in terms of depigmentation efficacy.

The results of this study align with those of Subasree (2024), who also reported similar levels of pigmentation reduction with microneedling combined with ascorbic acid compared to conventional techniques. Although both modalities were effective, the diode laser exhibited practical advantages such as a single-visit procedure, minimal intraoperative bleeding, reduced postoperative discomfort, and faster healing — consistent with previous findings by Lin et al. (2014) and Malhotra et al. (2014). Laser depigmentation provides precise ablation of the pigmented epithelial layer while minimizing collateral tissue damage due to its controlled wavelength and penetration depth.

Microneedling with ascorbic acid, on the other hand, offered an equally effective yet more gradual improvement in gingival color. The mechanism involves controlled micro-injury that stimulates collagen remodeling and enhances the absorption of topically applied vitamin C, which acts as an antioxidant and inhibits melanin synthesis by blocking tyrosinase activity. Studies in dermatology (Aust et al., 2008; Kato et al., 2013) and dentistry (Diana et al., 2022) have demonstrated the safety and efficacy of this minimally invasive method for treating pigmentation. However, the need for multiple treatment sessions in microneedling may affect patient compliance, as also noted in our study.

Laser therapy remains a preferred approach for many clinicians due to its precision, rapid results, and favorable patient acceptance (Tal et al., 2003; Al-Hazmi et al., 2018). Yet, the cost of laser equipment and operator training can limit its availability in routine practice, whereas micro-needling offers a low-cost alternative with minimal equipment requirements. Hence, while the diode laser provides superior convenience and faster outcomes, microneedling with ascorbic acid serves as an accessible, safe, and effective option for patients seeking esthetic correction of gingival pigmentation.

The limitations of this study include a small sample size and short follow-up period. Long-term studies with larger populations are required to evaluate the recurrence rate and histological changes following both techniques. Future research may also explore the combination of microneedling with other depigmenting agents to enhance the effectiveness and longevity of results.

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Conclusion

Both diode laser and microneedling with ascorbic acid proved to be effective techniques for gingival depigmentation, resulting in significant reduction of pigmentation and improved gingival esthetics. Although the diode laser offered the advantages of being a single-visit, minimally invasive, and relatively painless procedure, the overall clinical outcomes of both techniques were comparable. Microneedling with ascorbic acid demonstrated similar esthetic improvements, though it required multiple sessions and greater patient compliance. Hence, both approaches can be considered reliable options for managing gingival hyperpigmentation, with the choice of technique depending on clinical judgment and patient preference.

Data Availability Statement - All supporting data are available on request.

Funding - KAHER, Belagavi

Conflict of Interest - NIL

Contribution Details (to be ticked marked as applicable)

	Contributor 1		Contributor 2		Contributor 3
Concepts	✓	✓			
Design	✓		✓		
Definition of intellectual content	✓		✓		
Literature search	✓	✓			
Clinical studies	✓		✓		
Experimental studies			✓		
Data acquisition			✓		
Data analysis			✓	✓	
Statistical analysis					✓
Manuscript preparation	✓		✓		
Manuscript review	✓		✓		
Guarantor	✓	✓			

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