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Evaluation of Healing and Recurrence Following Gingival Depigmentation Procedure: A Comparison of Ceramic Bur, Diode Laser Techniques Single Blinded Split Mouth Randomized Control Trial

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ABSTRACT

Introduction: *An ideal smile is assessed using eight key components, including lip line, smile arc, upper lip curvature, lateral negative space, symmetry, occlusal plane, dental, and gingival features. Additional factors like papilla size and soft tissue color and form also influence esthetic outcomes. Gingival hyperpigmentation is a benign darkening of the gums caused primarily by melanin accumulation. Thus, for aesthetic purposes, gingival depigmentation is done via various techniques. In this study we have compared the efficacy wound healing and recurrence of pigmentation followed by depigmentation using ceramic bur, diode laser and scalpel.*

Methodology: *A split-mouth, randomised clinical trial was conducted in 18 to 50 year olds. Rigorous inclusion and exclusion criteria were implemented, and participants were randomly assigned in 3 groups, Bur (Ceratip) depigmentation, Diode Laser depigmentation and traditional surgical (scapel) depigmentation. The Clinical assessment was done at baseline and after 2 week, 1 month,3 months,6 months and 9 months by indices such as, Dummet Oral Pigmentation Index (DOPI) and Takashi Index, 2005, Visual Analogue Scale (VAS), Healing Index (HI) by Landry et al, and Hydrogen Bubble test.*

Results: *The Bubble Test revealed that scalpel and ceramic bur groups had 100% tissue exposure, significantly higher than the laser group's 69.2% ($p = 0.012$). Pain scores were lower for scalpel and ceramic bur groups at 24 hours, with all groups pain-free by two weeks. Healing was rated "Excellent" for scalpel and bur patients, while only 69.2% of the laser group achieved this. Complete depigmentation was seen in scalpel and bur groups initially, but re-pigmentation occurred by three months ($p = 0.001$). The scalpel technique was cost-effective but required postoperative dressing due to bleeding.*

Discussion: *Diode laser and ceramic bur treatments yielded superior clinical outcomes, including pain resolution and faster healing, compared to scalpel use. While all groups healed completely by one month, pigmentation recurrence was higher in scalpel and diode laser groups by nine months.*

Keywords: *Dental aesthetics, Diode laser, Hyperpigmentation*

INTRODUCTION

A smile signifies joy, sociability, and self-confidence, positively impacting how others perceive an individual. Its aesthetic appeal relies on the condition of teeth, lips, and gingival tissue. Dark gums can be a concern for dental patients. An ideal smile is evaluated through eight components, including symmetry and dental features, with additional factors like papilla size affecting aesthetics. [1] Gingival hyperpigmentation, a benign condition caused by melanin, varies by ethnicity and lifestyle, posing

aesthetic issues for some. To standardize evaluations, the Pink Esthetic Score (PES) and White Esthetic Score (WES) were developed for assessing soft tissues and implant crowns, respectively.

Gingival depigmentation can be defined as a periodontal plastic surgical procedure whereby the gingival hyperpigmentation is removed or reduced by various techniques.

The selection of a technique for gingival depigmentation is influenced by various factors, including the patient's skin color, the extent of pigmentation, lip line, upper lip curvature, and aesthetic expectations. The chosen method should be simple, cost-effective, and comfortable for both the clinician and the patient, minimizing pain and tissue loss while avoiding injury to surrounding tissues and teeth.[2]

Various techniques are available for gingival depigmentation, each offering unique benefits and limitations. Traditional methods like gingival abrasion and the scalpel technique are cost-effective and simple but may involve discomfort and require precise execution. Free gingival grafting provides long-term masking of pigmentation but involves two surgical sites and potential esthetic drawbacks. The use of acellular dermal matrix allografts addresses these concerns by eliminating the donor site, though at higher cost and technical demand. Advanced modalities such as electrosurgery and laser therapy offer superior hemostasis and precision, with lasers providing particularly favorable outcomes but requiring expensive equipment. Cryosurgery stands out for its affordability and minimal complications, despite challenges in depth control. Radiosurgery, though efficient, is more expensive and often necessitates multiple sessions. Selection of technique should be guided by clinical presentation, patient preferences, and available resources.[3]

Recent studies have focused on employing a pulsed diode laser (810 nm) for oral surgical procedures involving the tongue and gingiva, as well as for the excision of infected epithelium in chronic periodontitis. This laser offers advantages such as facile gingival reshaping, diminished requirement for local anaesthesia, superior haemostasis, low thermal damage to deeper tissues, and minor post-operative pain and inflammation. Furthermore, current material provides evidence of effective depigmentation with diode lasers.

While there is a paucity of literature comparing the Gingival Depigmentation done using Diode Laser and Bur. Ceramic bur was recently introduced into practice offering advantages like low discomfort, cost effectiveness, haemostatis and low operating time.[4] Hence this study was conducted to compare the efficacy wound healing and recurrence of pigmentation followed by depigmentation using ceramic bur, diode laser and scalpel.

METHODOLOGY

It was a prospective split-mouth randomized clinical trial (RCT). The dental arches of each patient were randomly allocated to the three groups with ratio 1:1:1 according to lottery method. The participants were randomly assigned for diode laser depigmentation in 1st quadrant [test group], Ceramic Bur Depigmentation in 2nd quadrant [test group] scalpel depigmentation in the mandibular arch [control group (CG)]. Descriptive and analytical statistics will be done. The normality of data will be tested by Shapiro-Wilk test. If the data followed normal distribution parametric tests – one-way ANOVA with Tukey post hoc test will be used and if the data does not follow normal distribution non-parametric test – Kruskal Wallis test with Dunn's post hoc test will be used. The chi-square test was used to check relationship between nominal variables. The p value <0.05 will be considered statistically significant. using Software: SPSS (Statistical Package for Social Sciences) Version 20.1 (IBM Corporation, Chicago, USA) Based on mean VAS scores given in table no. 4 of the reference article the minimum sample size calculated is 13 in each group, and 80% power of the study.

This study was conducted on dental arches of thirteen patients seeking treatment for gingival hyperpigmentation for aesthetic purposes. The patients were recruited from the outpatient clinic of the department of Periodontology and Oral implantology, D.Y Patil school of dentistry. The patients who had no systemic diseases, between the ages of 18-50 years of age, with Gingival hyperpigmentation in esthetic zone, Thick gingival phenotype and Dummet score 2, Takashi score 2. Those individuals who had dental caries, proximal restorations, fixed or removable prosthesis in the area of interest, any orthodontic appliances, or periodontitis or any parafunctional habits, were excluded. The individuals with smoking habits, pregnant or lactating mothers those with poor oral hygiene or who had any previous treatment of gingival hyperpigmentation (surgical or non-surgical) were not included.

All Patients received non-surgical periodontal debridement two weeks before the depigmentation session and they were instructed to perform proper oral hygiene measures.

The participants in Group 1: Ceramic soft tissue trimming bur (Ceratip) depigmentation, had Local anesthesia administered via infiltration on the buccal side. A Ceratip bur was used with a high-speed handpiece (300,000-450,000 RPM) without water coolant, generating heat for thermal coagulation while trimming the epithelial layer and contouring gingival soft tissues. A 45-degree angulation was recommended for effective tissue removal, with the bur tip parallel to the tissue surface. Gentle, feather-light brushing strokes were employed to prevent overheating, maintaining steady pressure for uniform removal. The friction from the bur caused immediate tissue coagulation, minimizing bleeding, while sterile gauze soaked in saline was used to clean debris during the procedure.[12]

For the patients in the Group 2: Diode Laser depigmentation, a Diode Laser wavelength of 980 nm (Biolase epic X)3 was used. The depigmentation treatment utilized a 400-µm initiated laser tip with an average power of 1 W in continuous mode, achieving a power density of 796.17 w/cm2. The laser was applied at a 30° angle against the gingival surface to avoid overheating. The ablation technique resembled brushing or painting, starting at the mucogingival junction and moving towards the free gingival margin, covering the area from the distal 1st premolar to the mesial central incisor. Hyperpigmented interdental papillae were also included in the ablation process.

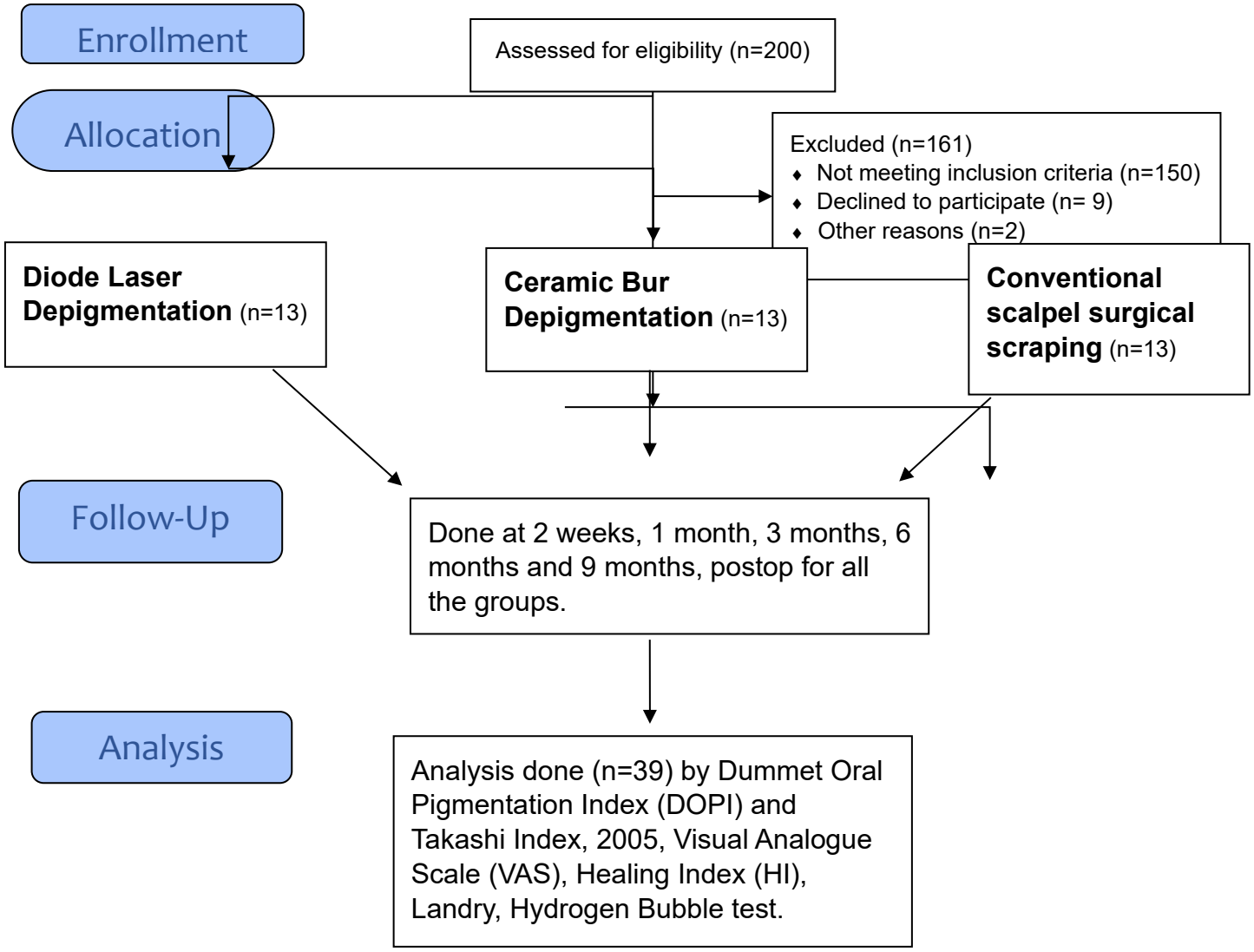
And for the third group, of Conventional scalpel surgical scraping technique. Local anesthesia was applied, followed by scraping pigmented gingival epithelium with a no. 15 blade, ensuring thorough removal at key areas. An eyelet curette was used for residual epithelium, and hemostasis was achieved using sterile gauze and direct pressure.

Post-surgery instructions include irrigating the exposed surface with saline, avoiding hot/spicy foods, spitting, and using straws for 24 hours. Patients should maintain oral hygiene, refrain from inspecting the area, and take prescribed ibuprofen for pain management. Clinical assessment was done at baseline and after 2 week, 1 month,3 months,6 months and 9 months.

The assessment was done by pigmentation indices like, Dummet Oral Pigmentation Index (DOPI) and Takashi Index, 2005. Pain perception was reported using Visual Analogue Scale (VAS) at 24 hours, 2 weeks. The patients were asked to keep a diary of the perceived pain levels as well as their analgesic consumption if any. The degree of epithelialization was evaluated visually on the 2^{nd} week postoperatively, by the Hydrogen Bubble test, where the region to be tested was dried, and 3% hydrogen peroxide (H2O2) was administered for wound healing purposes. The absence of the peroxide test indicated complete epithelialization was done at 2 weeks. And the healing was assessed by the Healing Index (HI) by Landry et al, given in 1988.

Numerical data were presented as mean and standard deviation values. They were analysed for normality using Shapiro-Wilk's test. Data were non-parametric and were analysed using Friedman's test followed by Nemenyi post hoc test. The significance level was set at $P < 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.3.0 for Windows6.

CONSORT 2010 Flow Diagram



RESULTS

Table 1: Distribution of the Participants depending upon Gender

	Frequency	Percentage
Male	10	76.92
Female	3	23.08

Table 2: Mean Age Distribution of the Study Participants

N	Min	Max	Mean	Std. Dev
13	18	35	24.84615	4.963973

Table 3: Comparison of the Bubble Test at 2 Weeks in Group 1, 2 and 3

			Bubble Test 2 weeks		Total	p Value
			Positive	Negative		
Group/Sites	Group 1	n	13	0	13	0.012
		%	100.0%	0.0%	100.0%	
	Group 2	n	13	0	13	
		%	100.0%	0.0%	100.0%	

	Group 3	n	9	4	13	
		%	69.2%	30.8%	100.0%	
Total		n	35	4	39	
		%	89.7%	10.3%	100.0%	

Table 4: Mean Distribution of the VAS Score in Group 1, 2 and 3 at 24 hours and 2 weeks.

	Group/Sites	N	Minimum	Maximum	Mean	SD
VAS 24 hrs	Group 1	13	1	5	2.54	1.613
	Group 2	13	1	4	2.54	1.05
	Group 3	13	3	6	4.31	0.855
VAS 2 weeks	Group 1	13	0	0	0	0
	Group 2	13	0	0	0	0
	Group 3	13	0	0	0	0

Table 5: Within Group Comparison of the VAS Scores

Within Subjects Effects					
	Sum of Squares	df	Mean Square	F	p
RM Factor 1	190.8	1	190.821	258.1	< .001
RM Factor 1 ✻ Group/Sites	13.6	2	6.782	9.17	< .001
Residual	26.6	36	0.739		
Note. Type 3 Sums of Squares					

Table 6: Between Group Comparison of the VAS Scores

Between Subjects Effects					
	Sum of Squares	df	Mean Square	F	p
Group/Sites	13.6	2	6.782	9.17	< .001
Residual	26.6	36	0.739		
Note. Type 3 Sums of Squares					

Table 7: Pairwise Comparison of the VAS Scores

RM Factor 1	Group/Sites	RM Factor 1	Group/Sites	Mean Difference	SE	df	t	p_{tukey}
VAS 24 Hours	Group 1	VAS 24 Hours	Group 2	-6.66e−16	0.477	36	-1.40e−15	1.00
		VAS 24 Hours	Group 3	-1.77	0.477	36	-3.71	0.01
		VAS 2 Weeks	Group 1	2.54	0.337	36	7.53	< .001
		VAS 2 Weeks	Group 2	2.54	0.337	36	7.53	< .001
		VAS 2 Weeks	Group 3	2.54	0.337	36	7.53	< .001
	Group 2	VAS 24 Hours	Group 3	-1.77	0.477	36	-3.71	0.01
		VAS 2 Weeks	Group 1	2.54	0.337	36	7.53	< .001
		VAS 2 Weeks	Group 2	2.54	0.337	36	7.53	< .001
		VAS 2 Weeks	Group 3	2.54	0.337	36	7.53	< .001
	Group 3	VAS 2 Weeks	Group 1	4.31	0.337	36	12.77	< .001
		VAS 2 Weeks	Group 2	4.31	0.337	36	12.77	< .001
		VAS 2 Weeks	Group 3	4.31	0.337	36	12.77	< .001

Table 8: Between Group Pairwise Comparison of the VAS Scores

Post Hoc Comparisons - Group/Sites							
Comparison							
Group/Sites		Group/Sites	Mean Difference	SE	df	t	p_{tukey}

Group 1	-	Group 2	-3.33e−16	0.238	36	-1.40e−15	1.000
	-	Group 3	-0.885	0.238	36	-3.71	0.002
Group 2	-	Group 3	-0.885	0.238	36	-3.71	0.002

Table 9: Within Group and Between Group evaluation of the Landry Index Score at 2 Weeks and 1 Month in Group 1, 2 and 3.

		Group/Sites								p Value
		Group 1		Group 2		Group 3		Total		
		N	%	N	%	N	%	N	%	
Landry Index Score 2 week	Very Poor	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.001
	Poor	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Good	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Very Good	0	0.0%	0	0.0%	4	30.8%	4	10.3%	
	Excellent	13	100.0%	13	100.0%	9	69.2%	35	89.7%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Landry Index Score 1 month	Very Poor	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1.00
	Poor	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Good	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Very Good	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Excellent	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
p Value		1.000		1.000		0.001				

Table 10: Comparison of the Takashi Score in Group 1, Group 2 and Group 3

		Group/Sites								p Value
		Group 1		Group 2		Group 3		Total		
		N	%	N	%	N	%	N	%	
Takashi Baseline	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1.000
	Score 1	8	61.5%	8	61.5%	8	61.5%	24	61.5%	
	Score 2	5	38.5%	5	38.5%	5	38.5%	15	38.5%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Takashi 2 week	Score 0	13	100.0%	13	100.0%	13	100.0%	39	100.0%	1.000
	Score 1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Takashi 1 month	Score 0	13	100.0%	13	100.0%	9	69.2%	35	89.7%	0.013*
	Score 1	0	0.0%	0	0.0%	4	30.8%	4	10.3%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Takashi 3 months	Score 0	0	0.0%	12	92.3%	1	7.7%	13	33.3%	0.001*
	Score 1	13	100.0%	1	7.7%	12	92.3%	26	66.7%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Takashi 6 months	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1.000
	Score 1	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Takashi 9 months	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.348
	Score 1	11	84.6%	13	100.0%	12	92.3%	36	92.3%	
	Score 2	2	15.4%	0	0.0%	1	7.7%	3	7.7%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
		0.001		0.001		0.001				

Table 11: Within Group Pairwise Comparison of the Takashi Score in Group 1, Group 2 and Group 3

		Group 1		Group 2		Group 3	
		Statistic	**p**	**Statistic**	**p**	**Statistic**	**p**
Takashi Baseline (Group 1)	Takashi 2 week (Group 1)	20.08	< .001	19.68	< .001	11.856	< .001
Takashi Baseline (Group 1)	Takashi 1 month (Group 1)	20.08	< .001	19.68	< .001	8.924	< .001
Takashi Baseline (Group 1)	Takashi 3 months (Group 1)	4.41	< .001	18.34	< .001	3.442	0.00
Takashi Baseline (Group 1)	Takashi 6 months (Group 1)	4.41	< .001	3.35	0.00	2.677	0.01
Takashi Baseline (Group 1)	Takashi 9 months (Group 1)	2.65	0.01	3.35	0.00	2.167	0.03
Takashi 2 week (Group 1)	Takashi 1 month (Group 1)	0	1.00	0	1.00	2.932	0.01
Takashi 2 week (Group 1)	Takashi 3 months (Group 1)	15.67	< .001	1.34	0.19	8.414	< .001
Takashi 2 week (Group 1)	Takashi 6 months (Group 1)	15.67	< .001	16.32	< .001	9.179	< .001
Takashi 2 week (Group 1)	Takashi 9 months (Group 1)	17.43	< .001	16.32	< .001	9.689	< .001
Takashi 1 month (Group 1)	Takashi 3 months (Group 1)	15.67	< .001	1.34	0.19	5.482	< .001
Takashi 1 month (Group 1)	Takashi 6 months (Group 1)	15.67	< .001	16.32	< .001	6.247	< .001
Takashi 1 month (Group 1)	Takashi 9 months (Group 1)	17.43	< .001	16.32	< .001	6.756	< .001
Takashi 3 months (Group 1)	Takashi 6 months (Group 1)	0	1.00	14.98	< .001	0.765	0.45
Takashi 3 months (Group 1)	Takashi 9 months (Group 1)	1.77	0.08	14.98	< .001	1.275	0.21
Takashi 6 months (Group 1)	Takashi 9 months (Group 1)	1.77	0.08	0	1.00	0.51	0.61

Table 12: Within Group and between group Comparison of the Dumment Score in Group 1, Group 2 and Group 3

		Group/Sites								p Value
		Group 1		Group 2		Group 3		Total		
		N	%	N	%	N	%	N	%	
Dummet Baseline	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.886
	Score 1	0	0.0%	0	0.0%	1	7.7%	1	2.6%	
	Score 2	11	84.6%	11	84.6%	10	76.9%	32	82.1%	
	Score 3	2	15.4%	2	15.4%	2	15.4%	6	15.4%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Dummet 2 week	Score 0	13	100.0%	13	100.0%	13	100.0%	39	100.0%	1.000
	Score 1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	

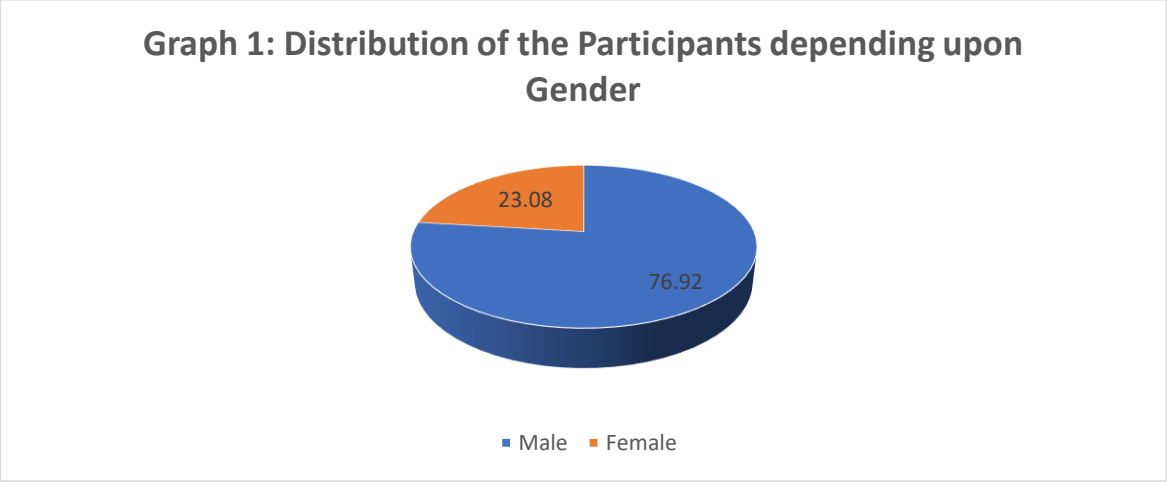
	Score 3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Dummet 1 month	Score 0	13	100.0%	13	100.0%	9	69.2%	35	89.7%	0.013
	Score 1	0	0.0%	0	0.0%	4	30.8%	4	10.3%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Score 3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Dummet 3 months	Score 0	0	0.0%	12	92.3%	0	0.0%	12	30.8%	0.001
	Score 1	13	100.0%	1	7.7%	13	100.0%	27	69.2%	
	Score 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Score 3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Dummet 6 months	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.178
	Score 1	10	76.9%	13	100.0%	10	76.9%	33	84.6%	
	Score 2	3	23.1%	0	0.0%	3	23.1%	6	15.4%	
	Score 3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
Dummet 9 months	Score 0	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.088
	Score 1	9	69.2%	13	100.0%	9	69.2%	31	79.5%	
	Score 2	3	23.1%	0	0.0%	2	15.4%	5	12.8%	
	Score 3	1	7.7%	0	0.0%	2	15.4%	3	7.7%	
	Total	13	100.0%	13	100.0%	13	100.0%	39	100.0%	
p Value		0.001		0.001		0.001				

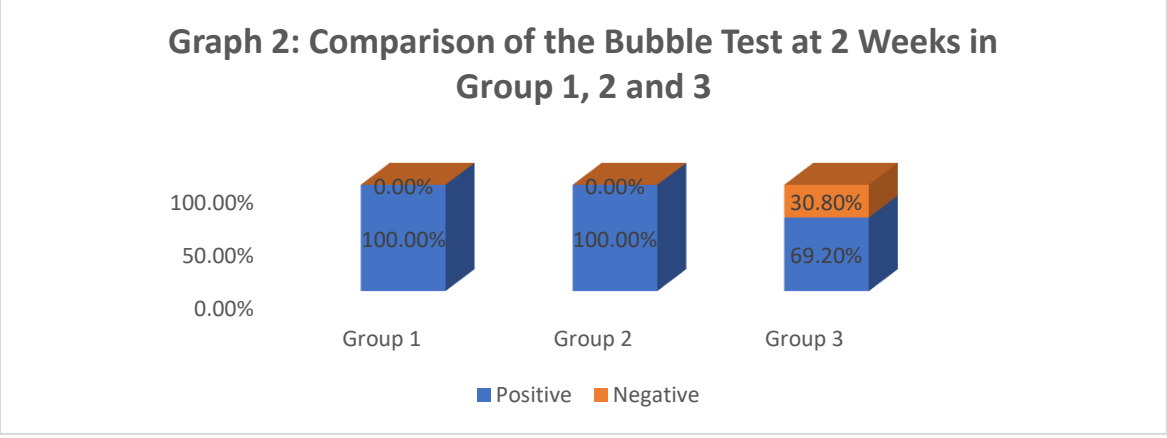
Table 13: Within Group Pairwise Comparison of the Dumment Score in Group 1, Group 2 and Group 3

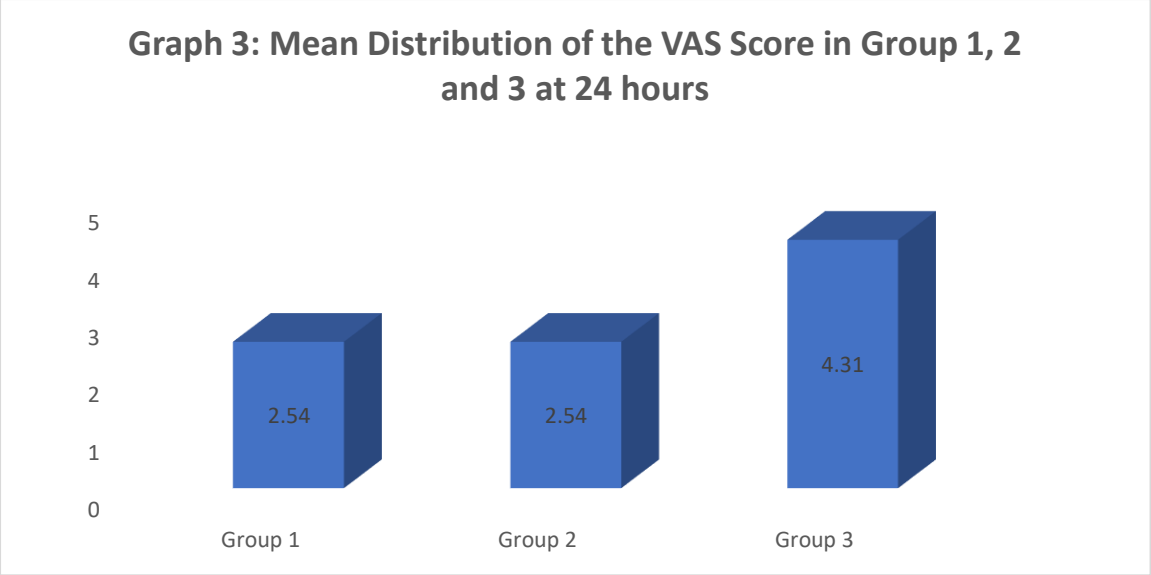
		Group 1		Group 2		Group 3	
		Statistic	**p**	**Statistic**	**p**	**Statistic**	**p**
Dummet Baseline (Group 1)	Dummet 2 week (Group 1)	28.43	< .001	37.12	< .001	15.89	< .001
Dummet Baseline (Group 1)	Dummet 1 month (Group 1)	28.43	< .001	37.12	< .001	13.36	< .001
Dummet Baseline (Group 1)	Dummet 3 months (Group 1)	13.84	< .001	35.36	< .001	7.59	< .001
Dummet Baseline (Group 1)	Dummet 6 months (Group 1)	11.57	< .001	14.14	< .001	6.33	< .001

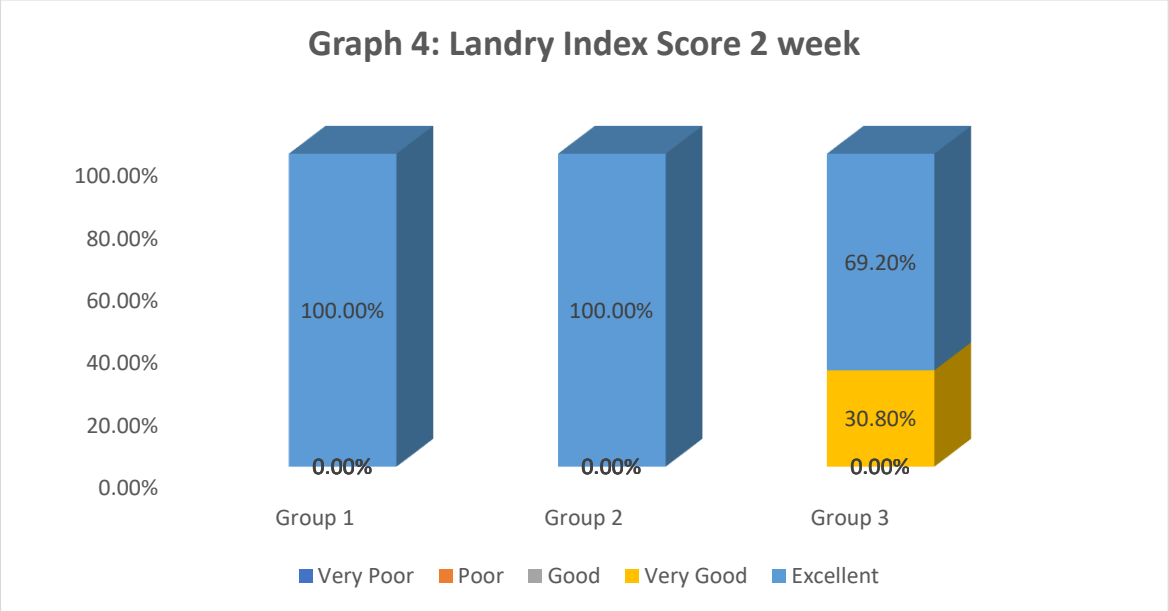
Dummet Baseline (Group 1)	Dummet 9 months (Group 1)	9.81	< .001	14.14	< .001	4.92	< .001
Dummet 2 week (Group 1)	Dummet 1 month (Group 1)	0	1.00	0	1.00	2.53	0.01
Dummet 2 week (Group 1)	Dummet 3 months (Group 1)	14.59	< .001	1.77	0.08	8.29	< .001
Dummet 2 week (Group 1)	Dummet 6 months (Group 1)	16.86	< .001	22.98	< .001	9.56	< .001
Dummet 2 week (Group 1)	Dummet 9 months (Group 1)	18.62	< .001	22.98	< .001	10.97	< .001
Dummet 1 month (Group 1)	Dummet 3 months (Group 1)	14.59	< .001	1.77	0.08	5.76	< .001
Dummet 1 month (Group 1)	Dummet 6 months (Group 1)	16.86	< .001	22.98	< .001	7.03	< .001
Dummet 1 month (Group 1)	Dummet 9 months (Group 1)	18.62	< .001	22.98	< .001	8.43	< .001
Dummet 3 months (Group 1)	Dummet 6 months (Group 1)	2.26	0.03	21.21	< .001	1.27	0.21
Dummet 3 months (Group 1)	Dummet 9 months (Group 1)	4.03	< .001	21.21	< .001	2.67	0.01
Dummet 6 months (Group 1)	Dummet 9 months (Group 1)	1.76	0.08	0	1.00	1.41	0.17

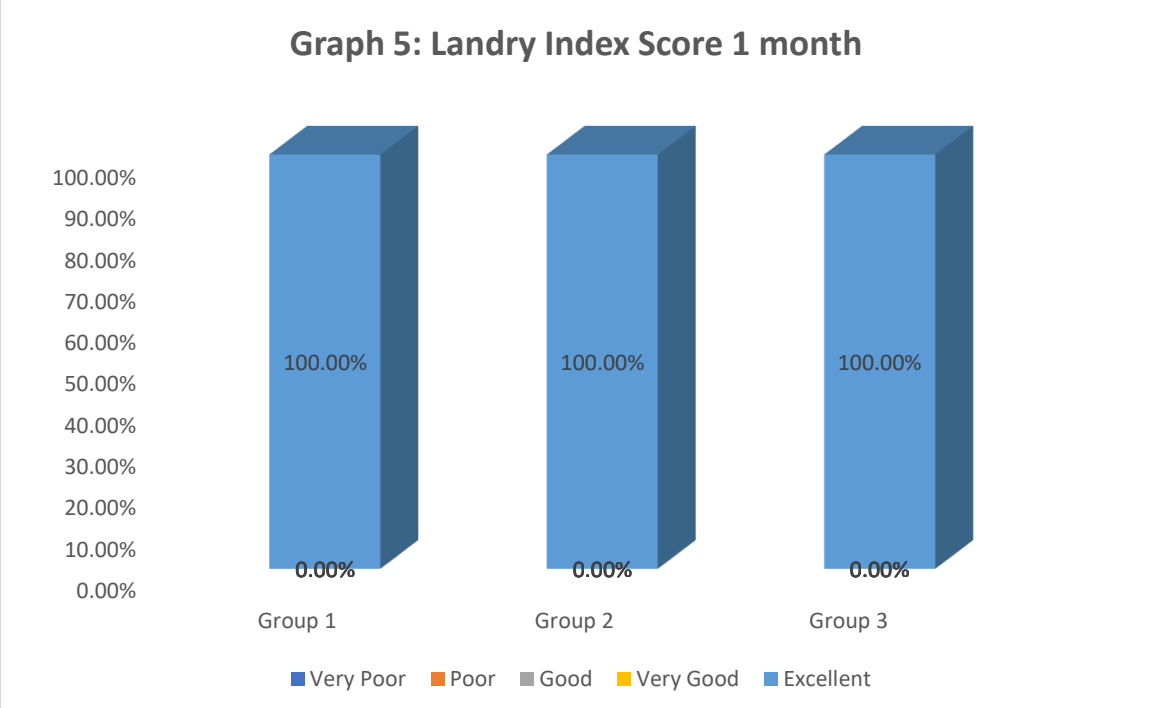
GRAPHS



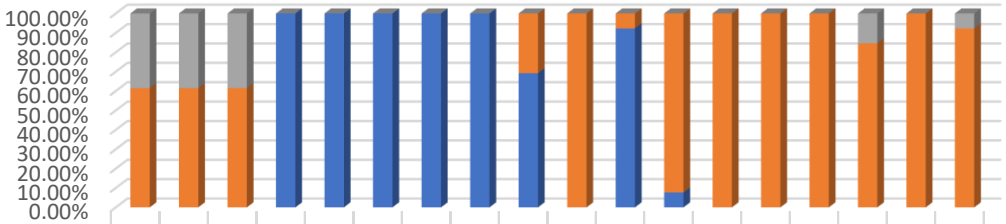



Graph 3: Mean Distribution of the VAS Score in Group 1, 2 and 3 at 24 hours
5
4
3
2
1
0
2.54
2.54
4.31
Group 1
Group 2
Group 3


Graph 4: Landry Index Score 2 week
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
100.00%
100.00%
69.20%
30.80%
0.00%
0.00%
0.00%
Group 1
Group 2
Group 3
Very Poor
Poor
Good
Very Good
Excellent

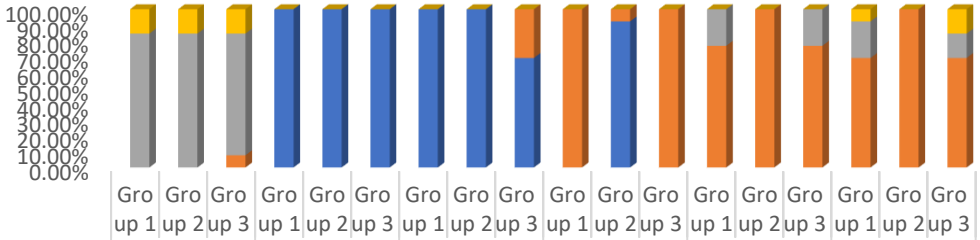

Graph 5: Landry Index Score 1 month
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
100.00%
100.00%
100.00%
0.00%
0.00%
0.00%
Group 1
Group 2
Group 3
Very Poor
Poor
Good
Very Good
Excellent

Graph 6: Comparison of the Takashi Score in Group 1, Group 2 and Group 3



	Takashi Baseline			Takashi 2 week			Takashi 1 month			Takashi 3 months			Takashi 6 months			Takashi 9 months		
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
Score 2	38.5	38.5	38.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.4	0.00	7.70
Score 1	61.5	61.5	61.5	0.00	0.00	0.00	0.00	0.00	30.8	100.	7.70	92.3	100.	100.	100.	84.6	100.	92.3
Score 0	0.00	0.00	0.00	100.	100.	100.	100.	100.	69.2	0.00	92.3	7.70	0.00	0.00	0.00	0.00	0.00	0.00

Graph 7: Within Group and between group Comparison of the Dummet Score in Group 1, Group 2 and Group 3



	Dummet Baseline			Dummet 2 week			Dummet 1 month			Dummet 3 months			Dummet 6 months			Dummet 9 months		
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
Score 3	15.4	15.4	15.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.70	0.00	15.4
Score 2	84.6	84.6	76.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.1	0.00	23.1	23.1	0.00	15.4
Score 1	0.00	0.00	7.70	0.00	0.00	0.00	0.00	0.00	30.8	100.	7.70	100.	76.9	100.	76.9	69.2	100.	69.2
Score 0	0.00	0.00	0.00	100.	100.	100.	100.	100.	69.2	0.00	92.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DISCUSSION

This study assessed the efficacy of three gingival depigmentation methods—scalpel, ceramic bur, and diode laser—in 13 participants, mostly young males. The Bubble Test showed higher tissue exposure in scalpel and ceramic bur groups (100% positivity) compared to the laser group (69.2%), with a statistically significant difference ($p = 0.012$). Pain scores were lower in the scalpel and ceramic bur groups at 24 hours, and all groups reported no pain by two weeks. Healing was "Excellent" in all patients treated with scalpel or ceramic bur, while only 69.2% in the laser group achieved this outcome. Complete depigmentation was initially achieved in Groups 1 and 2, but repigmentation occurred over time, significantly by three months ($p = 0.001$), likely due to differences in gingival phenotype. The scalpel technique was cost-effective but required postoperative dressing due to bleeding. The ceramic bur was also affordable and efficient, while the diode laser, though effective and patient-friendly, had limitations due to high equipment costs. Overall, the study highlights significant differences in clinical outcomes among the three methods.

The current investigation's findings support Govila et al. (2011) [5] regarding the effectiveness of a 940-nm diode laser for gingival depigmentation. However, they contrast with Suragimah et al. (2016), [6]

which found no significant difference in healing between scalpel and laser treatments. The study highlights the role of reactive oxygen species (ROS) in laser treatment and suggests that Photobiomodulation (PBM) can enhance healing. [7] Additionally, combining low-level laser treatment (LLLT) with high-intensity laser therapy shows improved outcomes in depigmentation and healing. With respect to repigmentation of the Gingiva a study conducted by Chandra GB et al reported that no statistically significant difference was observed for both treatment techniques in terms of wound healing, reappearance of gingival pigmentation, and intensity of the same at the end of 6 and 9 months postsurgical we found that our study is in alignment with the literature. In study published by Kaur H et al it was found that in repigmentation duration is primarily attributed to the employed technique and the patient's ethnicity.[8] Alhabashneh et al. conducted a study comparing the 6-month clinical efficacy of laser and scalpel techniques in Jordanian patients. The recurrence of pigmentation was detected at both sites at approximately 3 and 6 months, respectively.[9] In our study we found that the pigmentation was recurring at 6,9 months.

Although the precise mechanism of clinical repigmentation remains ambiguous, it is thought to result from the migration of active melanocytes from neighbouring pigmented tissues to surgically treated regions, facilitating repigmentation.[10] Conversely, Ginwalla et al. attributed repigmentation to residual melanocytes.[11]
In the case series by Perlmutter and Tal, repigmentation was absent in some instances up to 431 days post-surgery, and in one instance, it did not occur over the initial 2 years. They hypothesised that the delay in occurrence was either owing to the non-migration of melanocytes or the inactivity of migrated melanocytes.[10] In a follow-up conducted three years later for four patients who were assessed as having "no repigmentation" after nine months, modest gingival repigmentation was observed in both groups. Furthermore, individuals classified as mild exhibited pigmentation in the form of tiny patches, bands, or streaks. All re-examined patients express high satisfaction, as the degree of repigmentation is moderate in comparison to preoperative pigmentation. We found that our study was in alignment with the literature published.
With limited sample size of this study further studies with larger sample size and different study designs comparing the techniques mentioned in this study with a longer follow up period. Standardized digital photographs of pigmented areas can be recorded by doing red, green, and blue (RGB) image statistics using Adobe Photoshop software study can be conducted to evaluate how helpful the technique is for the gingival depigmentation procedure and to assess it by use of RGB—a digital photographic analysis method. They key strength of the study was usage of 3 techniques to observe the dominance of the technique.
Another strength of the study was usage of recent identification and gold standard index. Along with this the most important strength of this study was while the study was conducted as a split mouth it was observed that patient was his own control as well hence less deviation of the results could occur. The limitation of the study was since the study was conducted in a unicenter generalization of the results was difficult. To generalize our results a greater sample size and multicentric approach will be required which is our future prospective. Growth factor administration at the healing site or parentally to enhance healing and limit recurrence of gingival pigmentation could provide a scope of future advancements.

CONCLUSION

The study compared diode laser, ceramic bur, and scalpel techniques for gingival depigmentation. The diode laser and ceramic bur groups showed better clinical outcomes, including complete pain resolution, faster wound healing, and effective depigmentation, while the scalpel group had higher pain and slower healing. Statistically significant differences were noted in pain and pigmentation levels at various intervals, with all groups achieving complete healing by one month. However, pigmentation recurrence was more pronounced in the scalpel and diode laser groups by nine months. The ceramic bur emerged as a cost-effective alternative to diode laser therapy, despite both being effective.

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COLOUR PLATES

PRE-OPERATIVE

DEPIGMENTATION USING DIODE LASER IN GROUP 1

DEPIGMENTATION USING CERAMIC BUR

DEPIGMENTATION USING SCALPEL IN

FOLLOW UP AT 2 WEEKS

FOLLOW UP AT 1 MONTH

FOLLOW UP AT 3 MONTHS

FOLLOW UP AT 6 MONTHS

FOLLOW UP AT 9 MONTHS

ARMAMENTARIUM

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