Comparative Evaluation of Treatment Outcome of Gingival Depigmentation by Surgical Scalpel, Laser and Cryosurgery Techniques for the Management of Gingival Hyperpigmentation – A Randomized Clinical Trial Conducted in the Institute of Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Hingna

Saurabh Lingala[1], Deepti Gattani[2], Jigyasa Sahu[3], Nupur Kar[4]

[1, 2, 3, 4] Department of Periodontology, Swargiya Dadasaheb Kalmegh Dental College & Hospital, Nagpur, Maharashtra, India.

ABSTRACT

BACKGROUND

Aesthetic concerns have plagued humans for ages, but now modern technology and science have presented us with various options to treat these concerns. One such aspect is gingival depigmentation which as a dentist, we often come across. A randomized controlled clinical trial was conducted to compare and evaluate the techniques of gingival depigmentation for the management of gingival hyperpigmentation.

METHODS

A total of 45 patients with gingival pigmentation were randomly allocated into 3 groups: Surgical scalpel (N = 15), Cryosurgery (N = 15) and 810nm Diode Laser (N = 15). Melanin pigmentation index (MPI), visual analogue scale (VAS), wound healing index (WHI) and colour intensity index were evaluated for all the groups at baseline, immediate postoperative, 1 week, 1 and 3 months postoperatively. Statistical analysis was done for the data obtained to test the significance between the variables. P value < 0.05 was considered significant.

RESULTS

MPI scores from baseline to the postoperative intervals were effective in the management of gingival hyperpigmentation without any statistically significant difference. Faster healing was noted with surgical scalpel than cryosurgery. VAS scores were higher for the surgical scalpel group and lower for the other groups. The colour intensity index, an increase in the red colour value and decrease in the blue colour value was indicative of effectiveness of all the three techniques in the management of gingival hyperpigmentation.

CONCLUSIONS

It can be concluded that all the three techniques are effective in the management of gingival hyperpigmentation.

KEY WORDS

Gingival Hyperpigmentation, Aesthetic, Cryosurgery, Surgical Scalpel, Laser

Corresponding Author:
Dr. Nupur Kar,
Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital,
Hingna, Nagpur, Maharashtra, India.
E-mail: nupurkar37@gmail.com

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BACKGROUND

Aesthetic concerns have directed the management of dental maladies to varying extent for many years. The awareness and expectations of the patients from a dental treatment have increased recently to the point that less-than-optimal aesthetics are no longer an acceptable outcome.[1] The most common components of mouth that play an essential role in building an attractive face, personal satisfaction and affects confidence are lips, teeth and gingival tissue that are seen when a person smiles or speaks. Therefore, gingival pigmentation affects the beauty of smile.[2,3] With the growing aesthetic concern, gingival hyperpigmentation although not a medical problem, but may present as a black gum in patients with high smile line. The most common cause of gingival pigmentation is the overproduction of melanin, a brown pigment produced by the melanoblasts.[4,5] The oldest text by Ginwalla et al. 1966 documented about the unpleasant dark gingival colour and suggested removal of these pigmented areas.[6]

Gingival hyperpigmentation can be treated with various methods which include surgical methods such as gingivectomy,[7] gingivectomy with free gingival autograft,[8] gingival abrasion technique,[9] split thickness epithelial excision,[10] combination technique (gingival abrasion and split thickness epithelial excision) electrosurgery,[11] chemical methods using phenol, alcohol, ascorbic acid and recent methodologies like lasers,[12,13] cryosurgery,[14] and radiosurgery.[15] Every technique has its own advantages and disadvantages. Therefore, clinical experience, patient's affordability and individual's preferences should dictate the selection of technique. Surgical scalpel technique being the most ancient technique is a recommended method in areas with equipment constraint which may not be readily available at dental clinics. Although the surgical wound created due to scalpel heals rapidly than the other techniques, the unpleasant bleeding during and after the procedure has made the technique less acceptable.

In recent years, lasers have emerged as the most effective, compatible, valid method and choice of treatment among clinicians. Another relatively newer technique of gingival depigmentation that has emerged is cryosurgery which is based on the principle of cryonecrosis of tissues. The use of cryogen tetrafluoroethane (TFE) is easy, practical, and inexpensive as compared to lasers and other conventional methods such as scalpel or chemical methods. The ultra - low temperature of TFE causes controlled cryonecrosis of gingival epithelium and effectively eliminates gingival pigmentation without any significant side effects and aesthetically pleasing results.[16] There is limited availability of higher level of evidence; the present study has been conducted to compare and evaluate the efficacy of the gingival depigmentation by surgical scalpel, laser, and cryosurgery with TFE.

METHODS

A randomized comparative clinical trial was conducted after the study protocol was approved by the Institutional Ethics Committee and the approval document had been sent. This study was conducted in the Institute of Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Hingna, Nagpur from November 2017 to April 2019. Sample size estimation was done by using G Power software (version 3.0) and a total of 45 patients in the age group of 18 – 45 years irrespective of gender were included in this study by estimating the difference between two dependent means in the previous study by Mani A et al. and calculated by the formula $P = 65\%$, for 5 % level of significance $Z_{2\alpha/2} = 1.96$. wherein an alpha of 0.05, power of 95 %, 1.16 as an effect size was taken into consideration. The individuals were selected from the outpatient department of Periodontics, who requested cosmetic therapy for hampered aesthetics' due to "black gums". Patients with systemically and periodontally healthy condition, with hyperpigmentation extending from the marginal gingiva to mucogingival junction in the maxillary and mandibular arches on the facial aspect from first premolar of left side to the first premolar of opposite side and MPI score equal to 2 were included in the study. Patients with habit of smoking or chewing tobacco in any form, pregnant or lactating females, patients with a previous history of periodontal surgery or taking any medications which causes hyperpigmentation were excluded from the study. Patients were randomly allotted to the treatment group by the lottery method as: Group A – Surgical scalpel (N = 15), Group B – Diode Laser (N = 15), Group C – Cryosurgery (N = 15). A detailed case history was recorded; patients were duly explained about the intervention and signed a written informed consent before participation in the study.

666 Standardization of Photographs

The patients were made to sit upright in the dental chair with head straight. A Nikon D3200 camera, 24.2 mega pixel digital camera was used for the study. The photos were taken using the golden ratio grid while keeping the central square focused onto the area of pigmentation and keeping the camera stabilized. The images were captured at a resolution of 4032 x 3024, shutter speed at 1 / 125 and ISO of 130.

Calculation with the Software

An Adobe Photoshop Software CC (Adobe System, United States) was used to measure the colour intensity (RGB value). The images were cropped and equal size digital grid lines at every 1 cm were drawn for all images (at baseline, immediately postoperative, 1 week, 1 month and 3 months postoperatively). The pigmented area segments were selected and calculated with regard to the individual red, green and blue values (RGB values) at different intervals of time to calculate the colour intensity.

Detailed Procedure

All the patients before undergoing any depigmentation procedure underwent phase I periodontal therapy and oral hygiene instructions were given. The patients were then recalled after 7 days and following indices and clinical photographs were taken at baseline and at the follow up intervals:

1. Melanin pigmentation index for gingival pigmentation[17]
2. Wound healing index for wound healing[18]
3. Visual analogue scale for assessment of pain[19]

4. Colour intensity using image analysis software (Adobe Photoshop CC)

Surgical Scalpel Procedure

Following local anaesthesia**,** hyperpigmented areas were treated by using either 15 no. or 11 no. scalpel blades by scraping over the pigmented tissues till there was complete removal of the epithelium along with a small amount of connective tissue. While doing so precautions were taken not to expose the underlying bone. The interdental pigmented tissue was removed using Castro Viejo scissor. The raw surface was irrigated with saline solution. Following haemostasis, the exposed depigmented gingival surface was covered with a periodontal dressing for one week.

Diode Laser

Diode laser (Picasso, AMD Laser Technologies, USA; wavelength 810 nm) set at a power of 0.8 W, 400µm fibre, in a continuous irradiation mode was used for de-epithelialization procedure. Following application of topical anaesthesia and abiding all the laser safety protocols, the laser tip held in contact with the gingiva and ablation was performed using light paint brush strokes in an apico-coronal direction and on the papillary edges. After the removal of the overlying epithelial tissue, power setting was increased to 1.2 W so as to ablate remaining pigments present deep beneath the basement membrane with respect to the interdental papillary areas and also to minimize the intraoperative haemorrhage from the connective tissue. After every 3 - 5 min. the surgical field was wiped with sterile gauze soaked in cold saline so as to remove any remnants left out by laser ablation. Ventilation with suction was maintained throughout the procedure. No periodontal pack was given.

Cryosurgery Technique

Following application of topical anaesthesia, after drying and isolation of the hyperpigmented area, the tetrafluoroethane gas was dispensed using the valve and nozzle over dry cotton swabs and then immediately gently rolled over the hyperpigmented tissue including the gingival papillae. A freezing zone was maintained continuously for 30 - 40 seconds in each area till thawing of the tissues was visible which faded after 10 - 15 seconds. No periodontal dressing was given.

Figure 1. Patient Undergoing Cryosurgery Technique of Depigmentation

Postoperative Instructions

- Patients were advised not to eat acidic, salty, hot and spicy foods for the first few days after operation.
- They were instructed to maintain good oral hygiene and avoiding trauma to the surgical site.
- They were prescribed with analgesics only to be taken in case of pain and 0.2 % chlorhexidine gluconate mouthwash to be rinsed twice daily for two weeks.

The periodontal dressing was removed at the end of one week for Group A. The patients were recalled after 1 week, 1 month and 3 months post-operatively for follow-up to revaluate and record the parameters and reinforce oral hygiene.

Statistical Analysis

The data analysis was done using GraphPad Prism version 8.0. Descriptive statistics like mean, median & standard deviation were used to summarize categorical variables in all the groups. Differences in the mean across the groups were tested by Mann Whitney Signed Rank test while the differences in percentages were tested by Kruskal Wallis test. The P value < 0.05 was considered statistically significant. Evaluation and comparison of the groups were titled as intergroup changes. The CI values were analysed using One Way ANOVA test.

RESULTS

Melanin Pigmentation Index (MPI)

Intergroup Changes

Table 1 shows comparison of changes in MPI scores at baseline, immediate postoperative, 1 week, 1month and 3 months. The intergroup comparison showed statistically significant difference (P = 0.001) at immediate postoperative for group C with score 2 for 100 % of patients. However, no statistically significant difference was observed at 1 week (P = 0.85), 1 month (P = 0.95) and 3 months (P = 0.90) postoperatively.

	Melanin Pigmentation Index	Pre - Operative	Immediate Post - Operative	One Week	One Month	Three Months
Scalpel Group	0	0(0 %)	15(100 %)	13(86.7 %)	12(80 %)	12(80 %)
	1	0(0 %)	0(0 %)	2(13.3 %)	3(20 %)	3(20 %)
	2	15(100 %)	0(0 %)	0(0 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
Diode Laser Group	0	0(0 %)	15(100 %)	13(86.7 %)	13(86.7 %)	13(86.7 %)
	1	0(0 %)	0(0 %)	2(13.3 %)	2(13.3 %)	2(13.3 %)
	2	15(100 %)	0(0 %)	0(0 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
Cryo-surgery Group	0	0(0 %)	0(0 %)	13(86.7 %)	13(86.7 %)	12(80 %)
	1	0(0 %)	0(0 %)	2(13.3 %)	2(13.3 %)	3(20 %)
	2	15(100 %)	15(100 %)	0(0 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
χ2 - value		-	45	0.00	0.33	0.30
p - value		-	0.0001,S	1.00,NS	0.84,NS	0.85,NS

Table 1. Representing Intergroup Comparison (Group A, B and C) of Melanin Pigmentation Index (MPI) Scores at Follow Up Intervals

Wound Healing Index (WHI)

Intergroup Changes

Table 2 shows comparison of changes in WHI scores at baseline, immediate postoperative, 1 week, 1 month and 3

months. Immediate postoperative score was statistically significant for all the groups (Score C for Group A and B and Score A for Group C, (P = 0.0001). Also, the score after 1 week was statistically significant for all the groups (P = 0.0001), but the score at 1 month (P = 0.25) and 3 months was not statistically significant between the three groups.

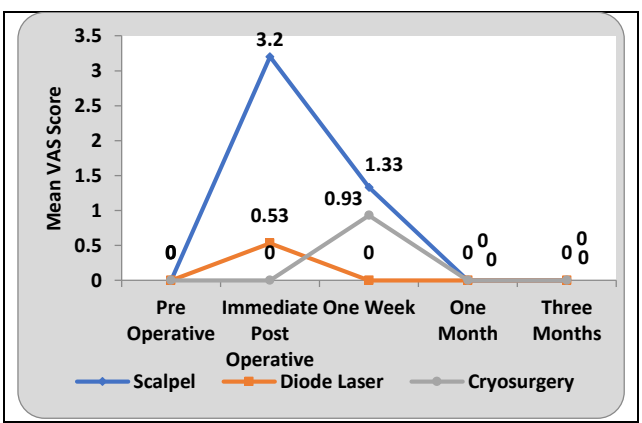
	Wound Healing Index	Pre - Operative	Immediate Post - Operative	One Week	One Month	Three Months
Scalpel Group	A	15(100 %)	0(0 %)	12(80 %)	15(100 %)	15(100 %)
	B	0(0 %)	0(0 %)	3(20 %)	0(0 %)	0(0 %)
	C	0(0 %)	15(100 %)	0(0 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
Diode Laser Group	A	15(100 %)	0(0 %)	8(53.33 %)	15(100 %)	15(100 %)
	B	0(0 %)	0(0 %)	5(33.33 %)	0(0 %)	0(0 %)
	C	0(0 %)	15(100 %)	2(13.33 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
Cryo-surgery Group	A	15(100 %)	15(100 %)	0(0 %)	14(93.33 %)	15(100 %)
	B	0(0 %)	0(0 %)	7(46.67 %)	1(6.67 %)	0(0 %)
	C	0(0 %)	0(100 %)	8(53.33.67 %)	0(0 %)	0(0 %)
	Total	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**	**15(100 %)**
$\chi 2$ - value		-	30	45	2.04	-
p - value		-	0.0001,S	0.0001,S	0.35,NS	-

Table 2. Representing Intergroup Comparison (Group A, B and C) of Wound healing Index Scores at Follow Up Intervals

Visual Analog Scale

Intergroup Changes

Graph 1 depicts the intergroup comparison of VAS scores. Immediate postoperatively, statistically significant variation was observed across the group (P = 0.0001) and also in between group A and B (P = 0.0001), group A and C (P = 0.0001) and between group B and C (P = 0.029). At 1 week postoperative, statistically significant variation was observed across the group (P = 0.0001) and also between group A and B (P = 0.0001), group A and C (P = 0.201) and group B and C (P = 0.0001). However, no statistically significant difference was observed at 1 month and 3 months postoperatively between the groups.

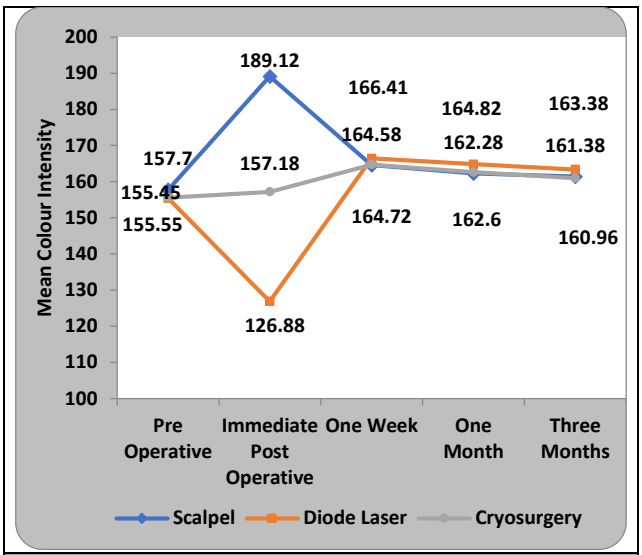


Graph 1. Line Graph Showing Intergroup Comparison (Group A, B and C) of VAS Scores at Various Intervals

Colour Intensity Index

Intergroup Changes (Red Colour)

Graph 2 depicts intergroup comparison of colour intensity index for red colour. For immediate postoperative scores, a statistically significant difference was recorded across the group (F = 1304.84, P = 0.0001) and in between the groups [Group A and B (P = 0.0001), Group A and C (P = 0.0001) and between Group B and C (P = 0.029)]. No significant difference was recorded at 1 week, 1 month and at 3 months across the group and in between the groups.



Graph 2. Multiple Line Graphs Showing Intergroup Comparison (Group A, B and C) of Colour Intensity – Red Colour

Intergroup Changes (Green Colour)

No significant difference was observed preoperatively and immediate postoperatively across the group and in between the groups. However, at one week (F = 0.20, P = 0.81) no significant difference was observed across the group and in between the groups. At one month postoperatively, significant difference was observed across the group (F = 5.34, P = 0.009) and no significant difference was recorded between group A and B (P = 1.000), but significant differences were seen between group A and C (P = 0.048) and also between group B and C (P = 0.011).

Intergroup Changes (Blue Colour)

A statistically significant difference was observed at immediate postoperative between group A and C (0.0001) and between group B and C (P = 0.0001). No significant difference was seen at 1 week, 1 month and 3 months postoperatively.

DISCUSSION

Hyperpigmentation may be observed in all races and at all ages with no gender predilection[20] and interferes with an individual's smile window. With the increasing awareness among the patient for the aesthetics', there has been a surge in the treatment modalities for hyperpigmentation. To the best of the author's knowledge, no study has been conducted previously comparing the efficacies of three treatment modalities - Surgical scalpel, diode laser and cryosurgery technique. In the present study, no significant difference was observed in between the groups for any of the investigated parameters indicative of appropriate patient selection and devoid of bias. Also, during the course of study wound healing was uneventful for every patient in all the groups without any sign of infection or complications.

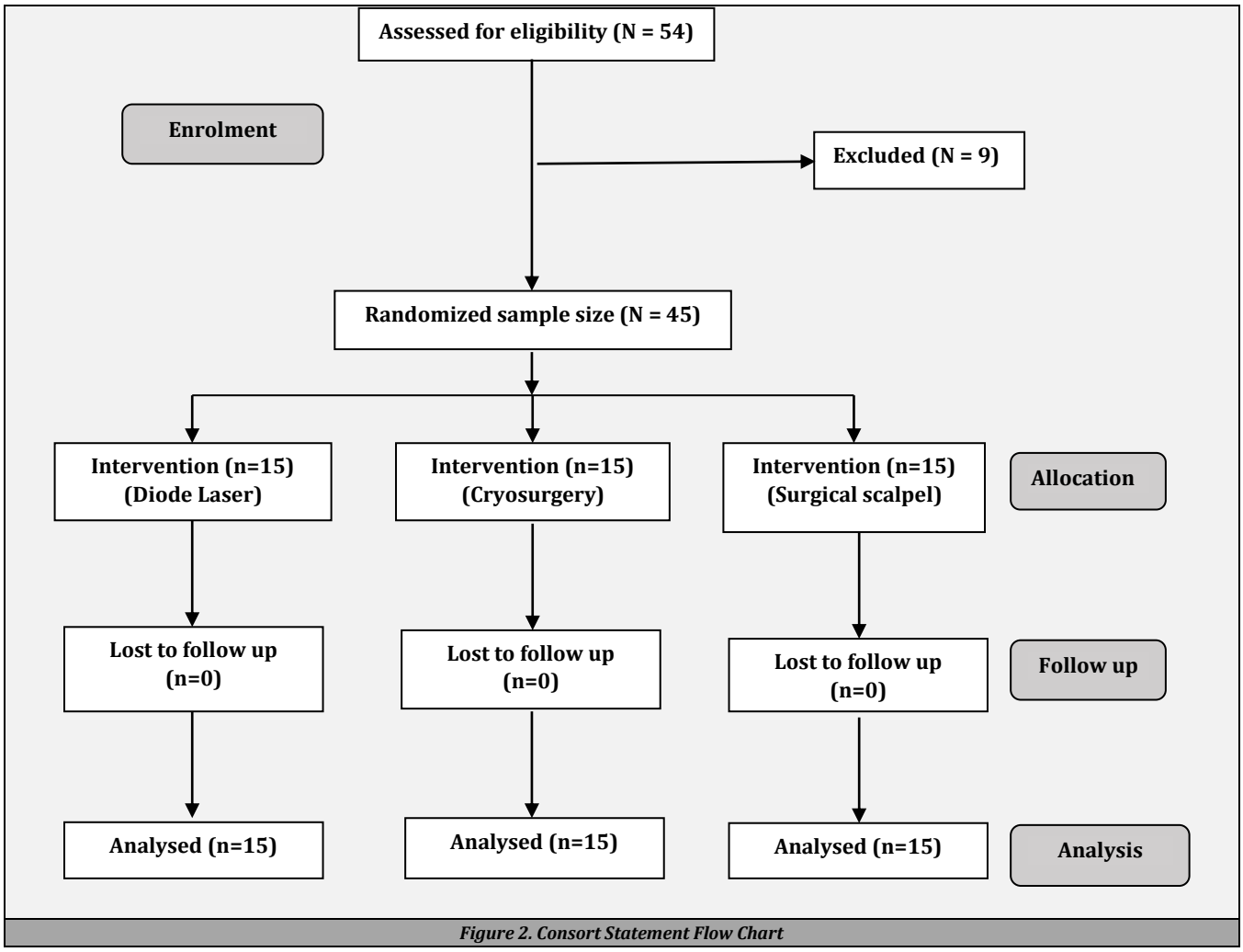


Figure 2. Consort Statement Flow Chart

Pigmentation Index

The present study showed a significant reduction in MPI score at immediate postoperative for group A and B owing to the complete removal of the epithelium along with a thin layer of connective tissue and melanin pigments. These findings were in accordance with the studies conducted by the Ambika Bharadwaj et al. (2014)[21,22,23]

Repigmentation

It has been a critical concern in the treatment of hyperpigmentation. Although, duration of repigmentation differs from one technique to another it has remained controversial, various factors such as smoking, sun exposure, and genetic determination of skin colour, influence the duration of relapse. Repigmentation may be attributed to the migration of the melanocytes which are left during the surgery as stated by the Ginwalla et al.[24] or due to the migration of the active melanocytes from the adjacent pigmented tissue to the treated site as stated by the migration theory.[25] The present study reported, no significant difference between the three techniques yet group A had a higher rate of recurrence.

The probable cause of repigmentation in group A may be attributed to incomplete removal of melanocytes from the deeper layers of the gingival tissue and also the difficulty to visualize the complete removal of melanocytes due to bleeding. With regards to group B, the near proximity of papillary and marginal gingiva to the tooth surface restricts the application of diode laser so as to avoid damage to the tooth structure. For group C, repigmentation could be attributed to difficulty in controlling the depth of penetration, optimal duration of freezing is not known and also no immediate changes were observed that this technique could leave behind residual pigments.

Wound Healing Index

The present study revealed statistically significant difference in the wound healing index at 1 week postoperatively with better healing potential in group A than group B and C. The findings are consistent with the findings of Lagdive et al. (2009)[26] and D'Arcangelo et al. (2007)[27] who reported delayed healing in diode laser treated sites. Luomanen et al. (1987)[28] connoted that with lasers, there is retarded proliferation of capillaries and slower infiltration of inflammatory cells due to thermal coagulation and denaturation of vasculogenic polypeptides.

On the contrary, Fisher et al. (1983),[29] Gnana Sagar (2016),[30] LT Hariati et al. (2018),[31] reported rapid healing with lasers as compared to the surgical counterpart due to the photobiostimulatory effect or low-level laser therapy effect which increases the proliferation of fibroblasts,

increased synthesis of proteins and reduced bacteraemia due to reactive oxygen species.

Visual Analog Scale

The present study revealed significantly increased pain perception by the patients of group A, slight or negligible pain for group B whereas no patients in group C reported any pain (P = 0.0001). Increased pain perception in group A was due to increased depth of penetration into the connective tissue which exposes lamina propria leaving behind raw wound surface with open nerve ending and healing by secondary intention.[25,32,33,34,35]

In group B, lesser pain perception was due to the disruption of sodium – potassium pump in the cell membrane resulting in impaired nerve conduction due to ablation of nerve endings by protein coagulation which also acts as biological dressing thus sealing off free nerve endings. Also, due to photobiostimulation, there is increase in anti-inflammatory effects due to neuro hormonal response by serotonin and norepinephrine.[29,36,37,21,22,23,37,38,39]

In group C, the level of pain associated was less than surgical scalpel, however some amount of pain was experienced due to the cellular destruction by rapid freezing and slow thawing of cells. Also, there was slight burning or discomfort after 24 - 72 hours due to immediate blockage of neural transmission in treatment area.[25,40]

Colour Intensity Index

Colour intensity index measures the RGB (Red, Green, Blue) components in digital images. Red colour represents the haemoglobin while green and blue colour represent cytoplasm and the melanin pigment respectively. There was no significant difference between the RGB values in the intergroup comparison groups but within individual groups there was a significant difference noted in the red, green and blue colour values when compared with the baseline values.

Group A measured increase in red colour due to the extravasation of haematopoietic cells at immediate post-operative while a decrease in red colour was seen in group B which may be due to ablation of capillaries and blood vessels less than 0.5 mm which gives a dry field due to the effect of diode laser and no changes were observed in group C as no immediate changes were observed after cryosurgery. Also, the blue colour values reduced significantly when compared with the baseline indicating that all the three techniques, were effective in management of gingival pigmentation.

CONCLUSIONS

With an increasing aesthetic concern, there is a surge in the demand for depigmentation therapy in patients with excessive gingival display. Although many techniques have been developed till date but a novel technique that has been widely accepted and can wisely treat the smile window of the patient is yet to be evidenced in the literature. In the present study all the three techniques have been shown to be effective in the treatment of hyperpigmentation, but pain perception and recurrence were lesser for both laser and cryosurgery groups. The authors recommend conduct of more prospective randomized controlled longitudinal studies to evaluate the effectiveness of the available techniques with histological evaluation to assess the alteration in the melanin pigment at the molecular level and a longer follow up of 18 – 36 months to determine the recurrence amongst the techniques.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.
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