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Comparative evaluation of Indocyanine Green and 810nm Diode Laser Assisted Antimicrobial Photodynamic Therapy with 810nm Diode Laser Assisted New Attachment Procedure as adjuncts to Scaling and Root Planning in Supportive Periodontal Therapy: A Randomized Controlled Split-Mouth Clinical Trial

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Abstract

BACKGROUND: Minimally invasive nonsurgical management of recurrent periodontal pockets remains the most viable option during supportive periodontal therapy (SPT), but with inconclusive results. The purpose of this study is to evaluate and compare the adjunctive use of Indocyanine green (ICG) and 810nm Diode laser assisted photodynamic therapy (IG-PDT) with 810nm Diode laser assisted new attachment procedure (LANAP) in the management of persistent pockets in SPT.

MATERIALS AND METHODS: This single blinded randomized controlled split mouth clinical trial included 20 participants with at least two adjacent teeth with PPD ≥5mm and Clinical attachment level (CAL) ≥3mm in the contralateral quadrants. IG-PDT group received application of 5mg/ml solution of ICG for one minute followed by 810±10nm diode laser with 1W power density. LANAP group received 810±10nm diode laser application at 3W power density with 100ms and 650ms pulse duration at two consecutive passes. Clinical parameters i.e., Plaque index (PI), Gingival index (GI), PPD, CAL gain were recorded at baseline, 3 and 6 months. Landry's Healing index was assessed on the 7th day and 1 month postoperatively. Patient comfort was assessed using Visual Analog Scale (VAS) immediate post-operatively.

RESULTS: Student t test and repeated measures of ANOVA were used for statistical analysis. Both site level and patient level assessments of clinical parameters showed improvement in clinical parameters in both groups. However, IG-PDT group showed significantly greater improvements in PPD (<0.001) and CAL (<0.001) at 3 and 6 months evaluation. IG-PDT showed better healing (P-0.03) at 7th post-operative day. However, LANAP showed less discomfort (2.40±0.50) compared to IG-PDT group (3.20±0.61).

CONCLUSION: IG-PDT is shown to provide better clinical outcomes compared to LANAP in management of patients under SPT.

KEYWORDS: Indocyanine Green; Laser; Photodynamic therapy; Periodontitis; Periodontal attachment loss

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Introduction

Periodontitis is the most common and prevalent oral chronic inflammatory disease caused by a dysbiosis of the host response and oral microorganisms, resulting in periodontal attachment and bone loss [1]. Comprehensive periodontal therapy, which combines non-surgical and surgical periodontal therapy, has been shown to be effective in achieving adequate attachment gain [2]. Periodontal maintenance, also known as supportive periodontal therapy (SPT), is a phase of periodontal therapy in which the periodontal condition is monitored and etiological factors are reduced or eliminated following periodontal treatment [3,4,5]. Following active periodontal therapy, maintenance consists of three components: patient personal care, preventive procedures performed by dental health care professionals, and supportive periodontal therapy interventions addressing disease recurrence due to re-emergence of subgingival biofilm and pocket formation [6].

Scaling and root planning (SRP) with disruption of bacterial biofilm, as well as adjunctive use of various nonsurgical treatment procedures, such as systemic and local delivery of antimicrobial agents, have been tried for pocket reduction during SPT [7-11]. However, there are inconsistent results and insufficient evidence to determine the superiority of different protocols or adjunctive strategies to improve tooth maintenance during SPT when performed alone or in combination with SRP [11].

Lasers have been proposed in the treatment of periodontal disease as a more efficient and atraumatic technique that improves periodontal healing. Various dental laser wavelengths have been used by clinicians in the treatment of periodontitis over the last decade, most notably diode lasers (809-980 nm), Nd:YAG (1064 nm), Er:YAG and Er,Cr:YSGG (2940 nm and 2780 nm, respectively), and CO2 (10,600 nm) [12]. Lasers are thought to improve decontamination during treatment, provide antiseptic action on non-vascularized tissues, overcome antibiotic resistance in subgingival biofilms, and stimulate fibroblast and osteoblast activity [13-15]. Gregg and McCarthy pioneered the use of the LANAP protocol, claiming it could regenerate bone growth and stimulate new attachment [16]. The laser-assisted new attachment procedure (LANAP) aims to reduce pocket depth by promoting the growth of new bone, cementum, and periodontal ligament on previously damaged root surfaces [17-19]. The Nd:YAG laser with a shorter wavelength of 1,064nm was initially considered for use in LANAP protocols due to its affinity for melanin or dark pigmentation, as opposed to longer wavelengths that are highly absorbed in water and would have a shallow depth of penetration [20]. Diode lasers are also known for this specific ingestion in pigmented tissues and deeper penetration into biological tissues, as well as producing a relatively thick coagulation layer on the lased soft-tissue surface [20].

The shortcomings of conventional treatments for the management of SPT patients have led to the proposal of adjunctive antimicrobial photodynamic therapy (PDT) as an alternative treatment [21,22]. When a non-toxic photosensitizing chemical is stimulated by light of a specific wavelength, reactive oxygen species (ROS) are produced. ROS can cause DNA and cell membrane damage, which can lead to microbial killing [23]. PDT works by activating photosensitizers in the presence of oxygen when they are exposed to light. One consideration in periodontal disease is the lack of oxygen in the subgingival area, which may render the antimicrobial PDT ineffective when combined with traditional photosensitizers. Indocyanine Green (ICG), a commonly used photosensitizer, has been widely used in clinical settings in recent years for diagnostic procedures such as angiography in ophthalmology, monitoring liver function and splanchnic perfusion, perfusion-related examination of tissues and organs, sentinel lymph node biopsy, and rheumatic disorder diagnosis [23-25]. ICG is used in PDT in addition to

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diagnostic applications because of its ability to absorb light at a wavelength of 810 nm, which is closer to the absorption wavelength of diode lasers [26]. Because anaerobic subgingival PDT does not require oxygen, free radicals and singlet oxygen are known to be produced during the activation process of ICG-mediated PDT(IG-PDT). Given the benefits listed above, it was hypothesised that IG-PDT, like the well-established LANAP protocol, could be a promising tool for periodontal disease management. As a result, the current split mouth randomised controlled clinical trial sought to evaluate and compare the efficacy of ICG-mediated PDT and LANAP as adjuvants to SRP in the management of recurrent periodontal pockets during SPT.

Material and Methods

Study design

The present study was a single blinded randomized controlled split-mouth clinical trial to evaluate the efficacy of IG-PDT over LANAP as an adjunct to scaling and root planning in the treatment of periodontitis. A single calibrated (with intra-examiner correlation coefficient k-0.82) and blinded examiner performed the clinical assessments throughout the study period. The study was conducted in the Department of Periodontology at Vishnu Dental College, Bhimavaram from March 2021 to June 2022.

Ethical aspects

Institutional Ethical Committee provided the ethical clearance (IEC VDC/2021/PG01/PI/IVV/49) and the study was registered under clinical trials registry of India (CTRI/2021/08/035658). In accordance with the 2003 revision of the Declaration of Helsinki, the patients signed a written statement of informed consent.

Sample size

Using G*Power software (version3.1.9.4), the required sample size was calculated to be 18 patients in both groups with a statistical power of 0.80, an alpha of 0.05, and effect sizes of 0.32 (ANOVA repeated measures within-between interactions). The sample size calculation was done for patient level assessment and was rounded to 20 patients considering 10% loss of follow-up.

Selection criteria

Inclusion criteria were participants in the age range of 30-55 years, previous surgical treatment of periodontitis stage II and Stage III, Grade A and B (according to 2017 classification of periodontal diseases by world workshop of periodontal and peri-implant diseases) at least 6 months to 3 years earlier, systemically healthy individuals and participants not being administered antibiotics or not having undergone periodontal care in the past six months [27].

Exclusion criteria were participants with systemic diseases that would influence the periodontium and effect healing, pregnant and lactating women, smokers, and usage of other kinds of tobacco products, allergy history known to exist to any type of pigmented chemical use, teeth with persistent angular defects and bony deformities requiring osseous surgery, Grade II and Grade III mobility, non-compliant patients, poor oral hygiene maintenance, presence of occlusal discrepancies and mal-aligned teeth.

Patient selection

The patients who satisfied all the inclusion and exclusion criteria were enrolled in the study CONSORT guidelines were followed (Figure 1).

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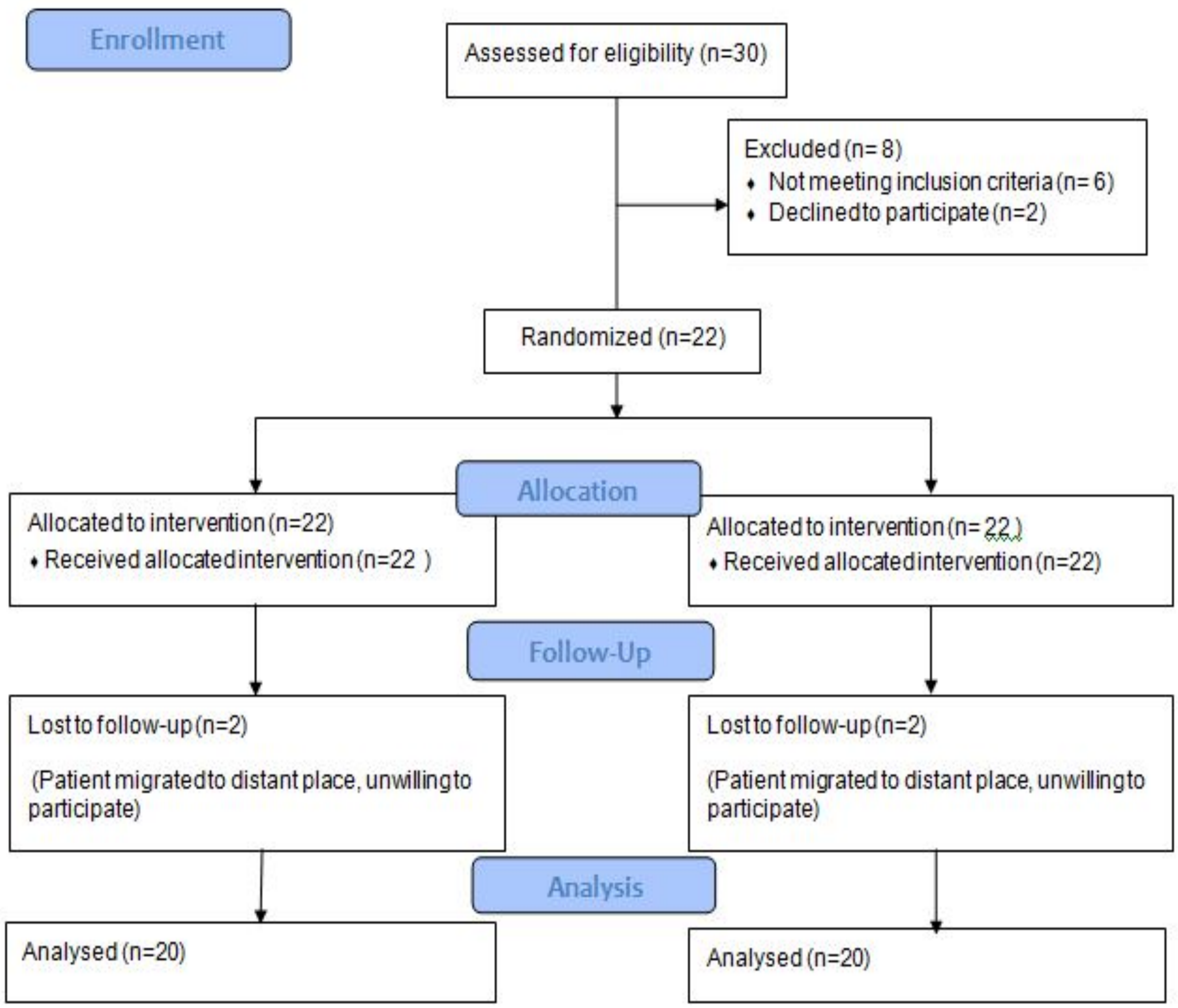

Figure 1. *CONSORT flow diagram*

Randomization, allocation, and blinding

A total of 26 participants (16 females and 10 males) with previous history of surgical periodontal therapy at least 6 months to 3 years before inclusion in the study were selected. All the participants received a complete periodontal, clinical, and radiographic examination and oral prophylaxis. Participants were recalled after 3 weeks of root planning and sites with persistent probing pocket depths (PPD) of ≥5mm in contralateral sites with minimum of 2 teeth in each quadrant were selected for the study. The PPD and Clinical attachment loss (CAL) were calculated using UNC-15 probe (Hu-Friedy®). The sites were randomly allocated into both the groups i.e., IG-PDT and LANAP. Allocation concealment was done by using computer generated random numbering system which is sealed in opaque envelopes.

Clinical parameters

Clinical parameters assessed in the study were evaluated at baseline, 3 months and 6 months after the treatment in both the groups. The parameters recorded include full mouth plaque index (PI), full mouth Gingival index (GI), bleeding index (BI), PPD, and CAL gain at baseline, 3

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months and 6 months [28]. Healing was assessed on the 7-post operative day and 1 month postoperatively by using Landry et al healing index [29, 30]. Healing was assessed as an ordinal value on a scale of 1-5, where score 1 indicates very poor and score 5 excellent healing. The healing is based on tissue colour, response to palpation, presence or absence of bleeding epithelisation of gingival margin and presence or absence of suppuration [29, 30]. Patient comfort was assessed immediate postoperatively using VAS scale. The VAS scale is a numeric scale assessed as an ordinal value from 0 to 10 with 0 indicating 'No discomfort' and 10 indicating 'greatest discomfort' [31].

Preparation of Indocyanine green solution

ICG aqueous solutions should be used within 24 hours in sterile circumstances due to their instability. Therefore, a fresh 5 mg/ml solution was created as needed as follows: To create a 5 mg/ml ICG solution, ICG (Aurogreen, Aurolabs®, Madurai, India) was dissolved in 5 ml of sterile water and gently shaken for 1 min according to manufacturer instructions, resulting in a concentration of 0.1 mg/ml ICG [32].

Treatment procedure

IG-PDT group

The ICG photosensitizer system was combined with a calibrated class 4 laser device developed for dental use with multi-functional soft tissue applications (Denlase®, Pune, Maharashtra) at the IG-PDT sites. The laser light is transmitted via an optical fibre connected to a hand piece to photosensitize ICG dye within a wavelength of 810±10 nm. The active solution of prepared ICG was then transferred via disposable 2ml syringe to the test sites and injected with a thin canula to the deep periodontal pockets until excess fluid was visible around the teeth, followed by resting for 1 to 2 min (Figure 2a, 2b, 2c). Irradiation of ICG-loaded sites was performed using a 400 µm LASER fibre tip in a pulsed wave mode and a pulse repetition rate of 2 kHz with a mean output power of 100 mW, and a power density of 1 W yielding an applied radiation energy of 1414 J/cm2 per site for 60s(Figure 2d) [32].

Figure 2. *IG-PDT Group; a. Presence of persistent probing pocket depth; b. Intrapocket delivery of ICG solution; c. ICG dye injected into the sulcus; d. diode LASER tip inserted into the sulcus.*

LANAP group

The first pass with an 810±10 nm diode laser and a 400µm fibre diameter, laser settings of 3.0 W and energy density of 1,965 mJ/mm2, 100-ms pulse duration, and 20 Hz were applied from the gingival margin to the base of the pocket parallel to the root surface and moved laterally and apically to remove the diseased pocket epithelium. With piezo ultrasonic instrumentation, the teeth were then completely scaled and root planed. A second pass was performed from the apical extent of the bone defect to the gingival margin using a 400µm fibre diameter, laser settings of 3.0 W and energy density of 1,965 mJ/mm2, 650ms pulse duration, and 20 Hz (Figure 3a, 3b) [19, 33].

Figure 3. *LANAP Group; a. Presence of persistent probing pocket depth; b. Diode LASER tip inserted into the sulcus and moved circumferentially*

Statistical analysis

A sample size of 20 participants each having two contralateral sites was included under 5% alpha error and 80% of power of the test to detect the significant difference. All data collected were entered into Microsoft Excel (MS Office version 2010) and tabulated. Statistical analysis of the results was done using SPSS 26.0 (IBM Inc. Chicago, IL, USA). The intergroup comparison of the data was done using the student t test and

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the intra group comparisons were performed using repeated measures of ANOVA. Non para-metric test Mann- Whitney U test was performed.

Results

A total of 22 participants were allocated to the intervention. However, two were lost to follow up which led to inclusion of 20 participants (including 12 females and 8 males) in the final analysis. Both patient level and site level analysis was done for both the groups. The mean age of the participants was 42.20±5.90. In both the treatment groups healing took place uneventfully. A total of 240 sites were treated and evaluated in the IG-PDT and 234 sites in the LANAP group. The clinical parameters like PPD, CAL, PI, GI and BI were assessed in all the sites at 3 and 6 month postoperatively. The patient level analysis was also done for all the parameters. The mean baseline PI, GI and BI scores were 1.66±.07, 1.61±.09 and 2.40±0.14 respectively which reduced significantly (p=<0.001) to 0.42±0.07, 0.41±0.06 and 0.19±0.02 at 6 months.

PPD and CAL reduction

The baseline site level mean PPD were 5.19±0.78 and 5.22±0.73 in IG-PDT and LANAP groups respectively with no statistically significant difference (p=0.64). A significant reduction in PPD was observed from baseline to 3 and 6 months in both the groups (p=<.001). However, intergroup analysis at both 3- and 6-months interval showed highly significant reduction of PPD in both groups (p- <0.001) with IG-PDT showing less PPD (3.21±0.46) compared to LANAP (3.52±0.50) (Table 1).

The baseline site level mean CAL values were 5.15±0.61, 5.22± 0.62 in IG-PDT and LANAP groups respectively showing no significant difference (p-0.67). At 3 and 6 months postoperatively a significant difference (p<0.001) in the mean CAL were observed between the two groups with IG-PDT group showing greater CAL gain. The site level mean CAL values at 6 months were 2.03±0.54 and 3.22±0.62 in IG-PDT and LANAP groups respectively (Table 1). The intergroup patient level assessment of CAL values also showed similar reduction at 6 months i.e., 2.01±0.64 in IG-PDT and

Table 1: Intra and Intergroup Site Level Assessment of Clinical Parameters

	TIME INTERVAL	IG-PDT		LANAP		IG-PDT Vs LANAP
		MEAN ±SD	P-VALUE	MEAN±SD	P-VALUE	
PPD	BASELINE	5.19±0.78	<0.001**	5.22±0.73	<0.001**	0.641
	3MONTHS	3.97±0.65		4.24±0.69		<0.001**
	6MONTHS	3.21±0.46		3.52±0.50		<0.001**
CAL	BASELINE	5.15±0.61	<0.001**	5.22± 0.62	<0.001**	0.20
	3MONTHS	4.02± 0.54		4.22±0.62		<0.001**
	6MONTHS	2.03±0.54		3.22±0.62		<0.001**

**- P<0.001- Highly statistically significant
PPD- Probing pocket depth; CAL- Clinical attachment loss

The patient level analysis also showed similar PPD reduction scores with lesser PPD in IG-PDT group (3.21±0.10) compared to LANAP group (3.50±0.50) at 6 months (Table 2) (Figure 4).

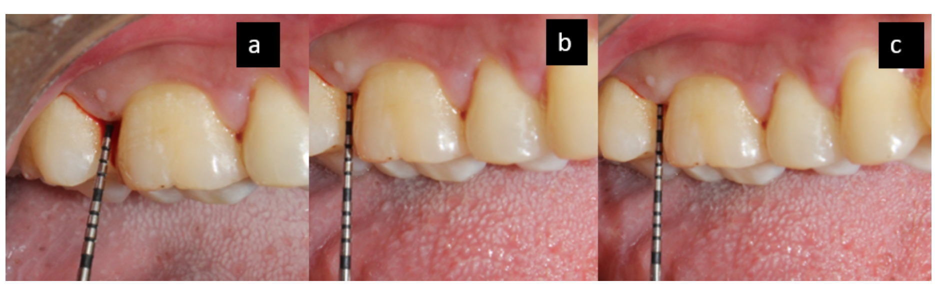

Figure 4. *IG-PDT Group; a. Baseline PPD of 5mm; b. 3mm PPD at 3-month PPD re-evaluation; c. 3mm PPD at 6-month re-evaluation*

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3.02±0.72 in LANAP groups (Table 2, Figure 5).

Figure 5. LANAP Group; a. Baseline PPD of 6mm; b. 5mm PPD at 3-month re-evaluation; c. 5mm PPD at 6 month re-evaluation.

Table 2: Intra and Intergroup Patient Level Analysis of Clinical Parameters

	TIME INTERVAL	IG-PDT		LANAP		IG-PDT Vs LANAP
		MEAN ±SD	P-VALUE	MEAN±SD	P-VALUE	
PPD	BASELINE	5.17±0.27	<0.001**	5.22±0.73	<0.001**	0.641
	3MONTHS	4.12±0.25		4.21±0.29		0.143
	6MONTHS	3.21±0.46		3.52±0.50		<0.001**
CAL	BASELINE	5.25±0.24	<0.001**	5.38± 0.25	<0.001**	0.20
	3MONTHS	1.05± 0.12		0.95±0.16		<0.001**
	6MONTHS	1.80±0.54		1.63±0.62		<0.001**

**- P<0.001- Highly statistically significant
PPD- Probing pocket depth; CAL- Clinical attachment loss

Healing index and patient discomfort (VAS)

The Landry et al., healing index was used to assess the healing at 7 days and 1 month postoperatively. The mean healing index score at 7 days in IG-PDT and LANAP group were 4.95±0.22 and 4.70±0.47 respectively and the difference in healing index scores was statistically significant (p=0.03). At 1month postoperatively mean healing index scores were 4.95±0.22 and 4.55±0.51 for IG-PDT and LANAP groups respectively and the difference was highly significant (p-value =0.00) (Table 3).

Patient discomfort was assessed immediately after surgery by using VAS scale. The mean VAS scores post-operatively were 3.20±0.61 and 2.40±0.50 in IG-PDT and LANAP groups respectively with IG-PDT group showing greater discomfort(p=<0.001) (Table 3).

Table 3: Intra and Intergroup Analysis of Healing index and Patient Discomfort (VAS)

PARAMETER	TIME INTERVAL	GROUPS	MEAN ±SD	P-VALUE
HEALING INDEX	7 DAYS	IG-PDT	4.95±0.22	0.03*
		LANAP	4.70±0 .47	
	1 MONTH	IG-PDT	4.85± 0.36	0.68
		LANAP	4.80± 0.41	
PATIENT DISCOMFORT(VAS)	AFTER THE PROCEDURE	IG-PDT	3.20±0.61	<0.001**
		LANAP	2.40±0.50	

**- P<0.001- Highly statistically significant
*- P<0.05- Statistically significant

Discussion

Amongst the various adjunctive nonsurgical treatment procedures LANAP has been widely accepted for routine clinical care. However, there is a lack of evidence to support the use of LANAP in supportive periodontal care, and no previous trials compared the effects of PDT with a well-established LANAP protocol in recurrent periodontal pockets during supportive periodontal care. As a result, the purpose of this in vivo study was to examine the effect of IG-PDT and LANAP as adjuncts to SRP in the treatment of periodontal pockets in supportive periodontal therapy. The current study's methodology for treating periodontal pockets in both groups is well established. To our knowledge, no study has compared the efficacy of PDT and LANAP in supportive periodontal therapy. Furthermore, ICG has been shown to be a potential alternative to the conventional photosensitizers used in

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the majority of the studies [32, 34-39].

In the current study no detrimental/ adverse effects were reported in either of the groups showing good tissue acceptability of both the procedures which is in accordance with earlier studies [40,41]. The shorter wavelengths of deep-tissue penetrating diode lasers do not interact with the periodontal tissues within the pocket or tooth crown, and should not cause any thermal changes within the gingival tissues and root surfaces, or destruction of the intact attachment apparatus at the base of pockets [42,43].

To avoid confounders, the full mouth PI, GI and BI scores were assessed at specific time intervals to assess the patient's overall oral hygiene status throughout the study period. The full mouth plaque and bleeding scores reduced significantly after both the treatments. Reduction in the plaque scores dictates the adequate maintenance of oral hygiene and good patient compliance. Also, the full mouth bleeding scores reduced significantly and maintained throughout the study period. This is in accordance with study done by Christodoulides N et al who reported a significantly higher reduction in bleeding scores in PDT group compared to scaling and root planning alone [34]. The lower bleeding scores can be attributed to the use of LASER light in both groups, which has been shown to reduce the formation of abnormal blood vessels and bleeding, thereby preserving gingival health.

The results of the present study illustrated statistically significant positive treatment outcomes in terms of CAL gain and reduction in PPD at 3 and 6 months follow up in both the groups however significantly greater reduction in PPD and CAL were observed in the IG-PDT group. Recent studies reported a significant improvement in periodontal parameters using IG-PDT compared to scaling and root planning [32,35,39,44]. IG-PDT may convey anti-inflammatory properties and is effective in eliminating periodontal pathogens. The enhanced treatment outcomes shown with adjunctive IG-PDT may be explained by the toxic effect on the microbial organisms responsible for the disease, along with anti-inflammatory abilities [26]. IG-PDT downregulates inflammatory mediators such as tumor necrosis factor-α, nitric oxide, and 5-lipoxygenase which play a significant role in the pathogenesis of periodontal disease. McCawley et al., conducted a clinical trial on the immediate effects of LANAP procedure on human periodontal microbiota, and reported that 85% of the patients treated with LANAP showed negative culture tests immediately for the red and orange complex microbes [36]. Marc Nevins et al conducted a study to evaluate the clinical response to the LANAP in a 9-month re-evaluation and the results demonstrated a statistically significant improvement in majority of the sites treated showing clinical improvement in terms of decreased PPD and increased CAL which is in accordance with our study [45].

Two histologic studies on humans have been done so far using LANAP technique. Yukna et al examined healing in teeth extracted three months following treatment in the first study and reported that laser-assisted new attachment procedure showed the formation of new cementum and connective tissue attachment, as well as new bone in four of the six specimens. In contrast, five of the six teeth that underwent the control procedure healed by a long junctional epithelium [18]. A similar histological study by Nevins et al. also reported similar results with greater new attachment gain in laser-assisted new attachment procedure treated teeth [17]. Till date no clinical trial compared the outcomes of PDT with LANAP procedure.

AlSarhan MA et al reported a significant greater reduction in probing pocket depth and bleeding on probing in IG-PDT compared to the control group where only scaling and root planning were performed in a three-month clinical trial [32]. The above study reported a reduction in mean probing pocket depths in the IG-PDT group from 5.22± 0.924mm to

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2.27± 0.749mm. In the current study, the mean PPD decreased from 5.17±0.27 to 3.21±0.46mm in the IG-PDT group. This difference in residual PPD at the end of study period could be attributed to Al Sarhan MA et al's protocol of multiple applications of PDT at 3 intervals one week apart [32]. In contrary, another split mouth trial by Muller Campanile VS et al evaluating the multiple application protocol of PDT did not show any significant difference in PPD reduction in single (2.8±1.1 mm) or twice (2.9±1.1 mm) application protocols. However, no sites in twice application and two sites in single application protocol had persistent PPD >4mm [37]. A recent systematic review and meta-analysis by Bashir et al., aimed to evaluate the efficacy of IG-PDT as an adjunct to NSPT in the management of chronic periodontitis. The results of the RCTs included showed positive treatment outcomes in terms of reduced PPD and increase in CAL gain at 3 and 6 months postoperatively and hence concluded that IG-PDT can be used as an adjunct to NSPT [38].

Post operative healing was assessed at 7th day and one month post operatively to assess early healing of the sites after both the protocols [30]. The current study showed a significant improvement in healing in both the groups from one week to one month post-operatively with IG-PDT group showing significantly better healing at one week. There are hardly any clinical trials evaluating the healing after PDT. However, laser biostimulation is shown to increase the healing in various clinical trials suggesting that low level lasers increases the motility of epithelial cells and proliferation of fibroblasts suggesting an enhanced wound healing [46]. Also LASER biostimulation is thought to increase the revascularization process [47]. The results show a significant (p=0.03) difference with better healing in the IG-PDT group at the seventh post-operative day, with no difference at the one-month interval, indicating faster healing in the IG-PDT group, which can be attributed to the photosensitizer used in the IG-PDT group in conjunction with laser irradiation. Laser irradiation with deep penetrating lasers such as diode laser was shown to produce a thicker coagulation layer due to greater tissue denaturation compared to superficially absorbed lasers resulting in slower healing. Photobiomodualtion with use of ICG causes biostimulation thus promoting cell proliferation and differentiation, as well as anti-inflammatory effects, which may positively modulate wound healing [48,49].

The findings of the current study are at odds with previous reviews that indicated PDT to be only marginally clinically effective in the management of periodontitis [50]. But this can be accounted for by the fact that the systematic reviews were conducted before ICG was approved as a photosensitizer for periodontitis, and as a result, their conclusions were based on the outcomes seen with less-than-ideal photosensitizers such toluidine blue and methylene blue. There is currently very little evidence for the use of PDT in supportive periodontal care. Previously published clinical trials showed contradictory results for the use of PDT as adjuncts in supportive periodontal care [23,51,52]. A single episode of PDT as an adjunct to scaling and root planning did not result in an additional improvement in terms of PPD reduction and CAL gain, but it did result in a significantly higher reduction in bleeding scores than scaling and root planning alone [50]. Repeated (five times) application of PDT as adjunct to debridement yielded improved clinical outcomes in residual pockets in maintenance patients [51]. Mongardinii et al. reported that adjunctive photodynamic treatment with light-emitting diode (LED) may improve short-term clinical and microbiological outcomes in periodontitis patients undergoing SPT [53].

Limitations and future research

The current study, like most previous studies, is a short-term (6-month) clinical trial with a small cohort (n=20). A single concentration of ICG was also used, along with specific laser properties and protocols based

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on previous research. Despite having similar properties, using a Diode laser instead of the well-established ND:YAG laser assisted LANAP protocol may be a limitation. Further research with larger sample size, different protocols and multiple applications at different time intervals could provide more insight into developing a defined protocol for routine management of patients receiving supportive periodontal care.

Conclusion

IG-PDT outperformed LANAP in terms of probing depth reduction, clinical attachment gain, and faster healing within the limitations of the current study. The promising impact of IG-PDT as an additional therapeutic procedure necessitates additional research, including long-term clinical trials, to validate its clinical use as a treatment strategy in supportive periodontal therapy.

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