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The Effect of Photodynamic Therapy on the Early Outcome of Implants Placed on Patients with Periodontitis

Pabbati Krishna Vardhan [1], Rashmi Paramashivaiah [1], Munivenkatappa Laxmaiah Venkatesh Prabhuji [1], Shaeesta Khaleelahmed Bhavikatti [2,3], Sakeenabi Basha [4], Suraj Arora [5], Syed Nahid Basheer [6], Syed Wali Peeran [7], Omir Aldowah [8,*] and Artak Heboyan [9]

1 Department of Periodontology, Krishnadevaraya College of Dental Sciences, Rajiv Gandhi University of Health Sciences, Bangalore 562157, India; krishna.vardhan89@gmail.com (P.K.V.); drrashmip.perio@kcdsh.org (R.P.); prabhujimlv@gmail.com (M.L.V.P.)
2 Department of Periodontics, Health Campus, Universiti Sains Malaysia, Kota Bharu 16150, Malaysia; drshaeesta@gmail.com
3 Center for Transdisciplinary Research (CFTR), Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences University, Chennai 600077, India
4 Department of Community Dentistry, Faculty of Dentistry, Taif University, P.O. Box 11099, Taif 21944, Saudi Arabia; sakeena@tudent.edu.sa
5 Department of Restorative Dental Sciences, College of Dentistry, King Khalid University, P.O. Box 960, Abha 61421, Saudi Arabia; surajarorasgrd@yahoo.co.in
6 Department of Restorative Dental Sciences, College of Dentistry, Jazan University, Jazan 45142, Saudi Arabia; syednahidbasheer@gmail.com
7 Department of Periodontics, Armed Forces Hospital, Jazan 82722, Saudi Arabia; peeransyedwali@gmail.com
8 Prosthetic Dental Science Department, Faculty of Dentistry, Najran University, P.O. Box 1988, Najran 11001, Saudi Arabia
9 Department of Prosthodontics, Faculty of Stomatology, Yerevan State Medical University after Mkhitar Heratsi, Str. Koryun 2, Yerevan 0025, Armenia; artak.heboyan@ysmu.am
* Correspondence: aldowah@gmail.com

Abstract: Background: Immediate implant is a subtype of implant that is placed following tooth extraction within the socket without further delay. These implants are known to preserve the alveolar bone and minimize the total number of surgical interventions in a patient. [4] Photodynamic therapy (PDT) augments nonsurgical periodontal therapy using antibacterial mechanisms. PTD can be more effective in conjunction with scaling and root planing (SRP). The aim of this study is to assess the effects of PDT on the early outcomes of implants placed on patients with periodontitis with and without SRP at 9 months of follow-up. Materials and methods: A total of 23 implants were placed in 14 patients, with 11 in the test group and 12 in the control group. SRP was carried out prior to immediate implant placement in control sites, and PDT adjunctive to SRP (SRP + PDT) was performed in test sites before immediate implant placement. Plaque index, gingival index, probing pocket depth, clinical attachment level, and radiovisiographs were procured at baseline, 3 months, 6 months, and 9 months. Primary stability was examined at the time of implant placement, and the healing index was recorded a week later. Results: At the end of the 9 months of the study period, (SRP + PDT) group had a mean marginal bone loss of 0.95 mm, and the control group had 1.08 mm. Clinical parameters such as plaque index, gingival index, clinical attachment level, and probing depth showed definitive improvement after 9 months, compared with the baseline, but when the test and control groups were compared, the difference was statistically significant for plaque index and probing depth. The implants in both groups were followed up for a period of 9 months. There was an improvement in marginal bone loss but was not statistically significant. The survival of immediate implants in the PDT group was not different from those in the scaling and root planing group. Conclusion: The effect of PTD can be beneficially used as an adjunct to SRP. However, the effects were not significant. Photodynamic therapy can be effectively used as an adjunct to SRP owing to the better outcomes using PDT.

Keywords: chronic periodontitis; immediate implant; photosensitizer; photodynamic therapy; randomized clinical trial; scaling and root planing

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1. Introduction

The main etiological factor of periodontal diseases is the bacterial biofilm [1]. Accordingly, periodontal therapy aims to reduce the accumulation of microbes by mechanically disrupting the subgingival biofilm [2,3]. Mechanical debridement (scaling and root planing (SRP)) by hand and/or using ultrasonic instruments can predictably achieve this goal in the majority of cases [4,5]. However, in some cases associated with the presence of *A. actinomycetemcomitans* [6] and/or *P. gingivalis* [7], SRP alone is often insufficient. This is due to the ability of these pathogens to penetrate the surrounding soft tissues. Additionally, Rabbani et al. [8] stated that SRP is bound to have some amount of residual plaque and calculus. In such clinical situations, topical or systemic antibiotics are frequently used [9–13].

Photodynamic therapy (PDT), which uses red light, infrared light, and diode lasers with a certain wavelength, is one way to reduce the number of microorganisms in the body [14,15]. The transfer of energy leads to the release of free oxygen radicals, which destroy bacteria and their by-products [16–18]. Several studies show statistically significant declines in the numbers of *A. actinomycetemcomitans*, *P. gingivalis*, and *T. forsythia* following the use of PDT [19–23]. On the other hand, it should be pointed out that conflicting results have been raised regarding the clinical and microbiological effects of PDT. Several studies [24–28] concluded that PDT can be effective when used in conjunction with mechanical debridement [19,23,27,29–39]. Moreover, PDT has been claimed to be efficient in preventing the recolonization of periodontal pathogenic microorganisms subgingivally [40].

Many studies and systematic reviews with meta-analyses show evidence that a history of periodontitis is a major risk factor for implant failure [41–45]. Nevertheless, studies conducted in periodontally compromised patients provided encouraging results [46–49]. These studies reported survival rates of more than 90% over 5 to 10 years. However, it is important to note that these findings were based on different definitions of the presence or severity of periodontal disease, as well as the success and survival parameters.

In their meta-analysis, Chen et al. concluded that immediate implant placement into infected sites and noninfected sites in the aesthetic zone resulted in comparable survival rates, bone level, and gingiva level [50]. Similarly, another systematic review and meta-analysis stated that placing the immediate implants in compromised sites appeared not to decrease survival and success rates [51]. Randomized clinical trials on a large scale should be carried out, however, to determine with certainty whether this treatment protocol is safe and effective for damaged sockets.

The aim of this study is to assess the effects of photodynamic therapy on the early outcomes of implants placed on patients with periodontitis with and without SRP at 9 months of follow-up.

2. Materials and Methods

2.1. Ethics and Patient Consent

The study was approved by Krishnadevaraya College of Dental Sciences and the Hospital Ethical Committee, registered to CDSCO, India, and it was conducted in full accordance with the declared ethical principles (World Medical Association, Declaration of Helsinki, version VI, 2002). Informed consent was obtained from individual subjects after a detailed explanation of the procedure.

2.2. Patient Selection

A total of 14 subjects (8 males and 6 females) with 23 sites were included in this clinical research after satisfying the inclusion and exclusion criteria. Inclusion criteria were patients falling in class 1 or 2 of the American Society of Anesthesiology's physical status classification, at least one maxillary or mandibular single-rooted tooth indicated for extraction due to chronic periodontitis, and patients with good oral hygiene maintenance. Exclusion criteria were patients below 20 years (owing to lack of complete skeletal maturity), aggressive periodontitis cases, teeth with inadequate supporting bones of less than 2 mm after extraction, Smokers, sites showing bony fenestrations and dehiscence, presence of any

signs of active infections (abscess, draining fistula, etc.), teeth with close root proximity and near to anatomical structure, and any systemic disorders such as osteoporosis and uncontrolled diabetes mellitus.

2.3. Groups

After randomization, using a toss of coin method, participants were allocated to group A or group B.

Group A (test group): in this group, 8 subjects with 11 sites underwent photodynamic therapy along with nonsurgical periodontal therapy before immediate implant placement;

Group B (control group): in this group, 6 subjects with 12 sites underwent nonsurgical periodontal therapy in the form of SRP before immediate implant placement.

All participants were diagnosed with chronic periodontitis based on the levels of Clinical Attachment Loss (CAL) and probing pocket depth (PPD) according to the Armitage 1999 classification [13]. Most of the subjects included in this study were in the category of severe generalized chronic periodontitis.

2.4. Treatment Protocol

All subjects in the control group underwent thorough SRP using manual and ultrasonic instruments. For participants in the test group, a photosensitive dye, indocyanine green (EmunDo), was placed in the gingival sulcus for 1 min and then rinsed out. The EmunDo solution was prepared according to the manufacturer's instructions at a concentration of 1 mg/mL and stored in the dark. Then, it was photoactivated with a laser (A.R.C LASER) beam (810 nm, 100 mw, and in continuous noncontact wave mode) by passing it both mesiodistally and apicocoronally in the pockets for 1 min (Figure 1A), after which the solution was thoroughly rinsed out. After rendering customized oral hygiene instructions, the individuals were sent with the instructions to report back after a period of 3 weeks. Before commencement of the clinical trial, basic parameters including plaque index (PI), gingival index (GI), clinical attachment level (CAL), and probing depth (PD) were recorded as baseline values.

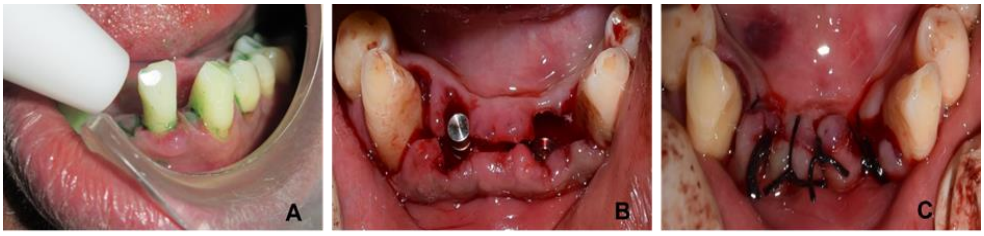


Figure 1. (**A**) Photodynamic therapy; (**B**) implants placed after extraction; (**C**) sutures placed.

2.5. Surgical Procedure

A preoperative radiovisiograph (RVG) was obtained at the planned site. Local anesthetic 2% lignocaine hydrochloride 1:80,000 epinephrine was administered, and atraumatic extraction of the tooth was performed. All of the infected granulation tissue in the extraction socket was curetted out, and the socket was rinsed with irrigation containing p povidone–iodine. The socket measurements (i.e., diameter and length) were procured with the help of a graduated UNC-15 probe, which aided in the selection of the size of the implant (Norris tuff TT, Endosseous implant).

A large precision drill was used initially to penetrate the base of the extraction socket, which acted as a guide for sequential drilling. Following sequential drilling, Lance Pilot Drills were used until a diameter of 3.2 mm. The drills were used at a speed ranging from 800 to 1200 rpm [14] with adequate cooling. Osteotomy improves the primary stability of the implant when it is placed into an extraction socket. Using a hand wrench, the implant was fixed, torque was measured, and the wrench was removed only after the torque if the

desired level (>20 N/cm^2) was reached. The implant was flushed with the marginal bone level (Figure 1B).

An RVG was taken to ascertain the proper implant placement, and only thereafter was the cover screw fixed. Primary closure of the flap was obtained via simple interrupted sutures (Figure 1C) and with the application of an ice pack for 3–5 h externally to the operated location, as instructed in the immediate postsurgical time. Postoperative medications comprising amoxicillin 500 mg TID, analgesic diclofenac potassium, and serratiopeptidase TID were prescribed for 5 days. In addition, 0.2% chlorhexidine mouth rinse was also prescribed twice daily for two weeks. The clinical parameters and the radiographic data were obtained at baseline (Figure 2A), 3 months (Figure 2B), 6 months (Figure 2C), and 9 months (Figure 2D).

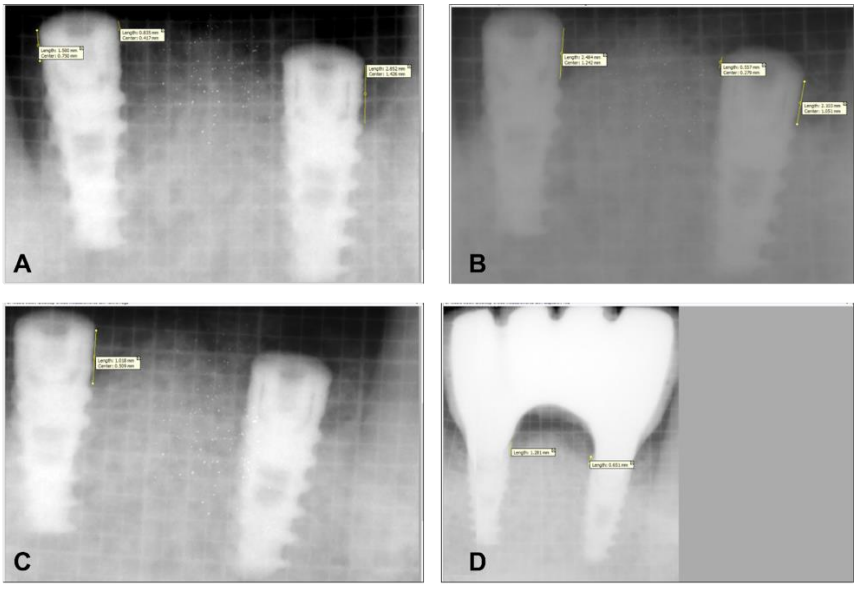


Figure 2. (**A**) Radiovisiograph of test site baseline; (**B**) radiovisiograph of test site at 3 months; (**C**) radiovisiograph of test site at 6 months; (**D**) radiovisiograph of test site at 9 months.

2.6. Statistical Analysis

SPSS software for Windows, Version 16.0. (Chicago, IL, USA, SPSS Inc.), was used to analyze the data. Statistical analysis was performed by using tools of descriptive statistics, such as mean and SD, for representing quantitative data (angular measurement recorded in degrees). An independent *t*-test between two samples was used to compare the means of measurements of both experimental and control groups, respectively, at each interval (intergroup mean comparison at each interval). A one-way ANOVA test was applied to compare measurements of an experimental group recorded at three or more different time intervals. Similarly, the one-way ANONA test was applied to compare measurements of the control group recorded at three or more different time intervals. The probability of $p < 0.05$ was considered significant, and the alpha error was set at 5%, with a confidence interval of 95%. The post hoc data analysis, which followed one-way ANOVA, was performed by using Bonferroni's multiple comparison test. A post hoc test was used to analyze multiple pairwise individual comparisons at two different time intervals each.

3. Results

A total of 23 implants were placed in 14 patients. Group A comprised 8 subjects with a total of 11 implants placed after NSPT in the form of SRP with adjunctive PDT, while Group B comprised 6 subjects with a total of 12 implants after SRP.

3.1. Age and Gender Distribution

For this study, 14 patients with a mean age of 47.18 years in the test group and 44 years in the control group were selected. In terms of the age distribution of the subjects, 47.82% were in the age group of 41–50 years, 26.1% were in the age group of 51–60 years, 21.73% were in the age group of 31–40 years, and 4.35% were in the age group of 21–30 years. As regards the gender distribution of the participants, 63.3% of the test group were males, and 36.7% were females; in the control group, 50% were males, and 50% were females.

3.2. Clinical Examination Data

None of the implants failed based on the parameters established by Buser et al. [52].

The intragroup comparison of the clinical parameters of the test group is depicted in Table 1. The repeated measurements of ANOVA, followed by Bonferroni's post hoc test for PI, GI, PD, CAL, and marginal bone loss (MBL), are presented in Table 2 for the test group The intragroup comparison of the clinical parameters of the control group is shown in Table 3. The repeated measurements of ANOVA, followed by Bonferroni's post hoc test for PI, GI, PD, CAL, and marginal bone loss (MBL), are presented in the Table 4 for the control group.

Table 1. Intragroup comparison of clinical parameters of test group.

	Baseline	3 Month	6 Months	9 Months	ANOVA F Value	*p* Value (Significance)
	Mean (S.D)	Mean (S.D)	Mean (S.D)	Mean (S.D)		
Plaque index score (PI)	2.51 (0.28)	1.43 (0.27)	1.53 (0.34)	1.70 (0.25)	<0.001 **	$p < 0.001$
Gingival index score (GI)	2.45 (0.18)	1.34 (0.18)	1.43 (0.34)	1.6 (0.36)	<0.001 **	$p < 0.001$
Pocket depth (PD)	5.55 (0.89)	4.6 (1.02)	4.2 (0.88)	4.12 (0.84)	<0.001 **	$p = 0.002$
Clinical attachment loss (CAL)	8.82 (0.99)	7.88 (0.85)	7.19 (1.07)	6.9 (1.21)	<0.001 **	$p = 0.001$
MBL	0.0 (0.0)	0.41 (0.37)	0.69 (0.36)	0.95 (0.41)	<0.001 **	$p < 0.001$

** highly significant.

Table 2. Repeated measurements of ANOVA followed by Bonferroni's Post-hoc test (Plaque index, Gingival index, Probing depth, Clinical attachment level, Marginal bone loss) for test group.

	Baseline vs. 3 Months	Baseline vs. 6 Months	Baseline vs. 9 Months	3 Months vs. 6 Months	3 Months vs. 9 Months	6 Months vs. 9 Months
			Plaque index			
Mean Difference	1.08	0.98	0.80	0.1	0.27	0.17
***p* value**	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.854	0.146	0.518
			GI score			
Mean Difference	1.109	1.018	0.854	0.09	0.25	0.16
***p* value**	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.871	0.161	0.525
			PD score			
Mean Difference	0.91	1.35	1.42	0.43	0.50	0.07
***p* value**	$p = 0.103$	$p = 0.007$	$p = 0.004$	0.680	0.565	0.998
			CAL score			
Mean Difference	0.94	1.63	1.9	0.69	0.95	0.26
***p* value**	$p = 0.163$	$p = 0.004$	$p = 0.001$	0.416	0.156	0.934
			MBL score			
Mean Difference	0.41	0.69	0.95	0.27	0.53	0.26
***p* value**	$p = 0.028$	$p < 0.001$	$p < 0.001$	0.220	0.03	0.274

Table 3. Intragroup comparison of clinical parameters in control group.

	Baseline	3 Months	6 Months	9 Months	ANOVA F Value	*p* Value (Significance)
	Mean (S.D)	Mean (S.D)	Mean (S.D)	Mean (S.D)		
Plaque index score (PI)	2.68 (0.24)	1.73 (0.34)	1.87 (0.32)	1.95 (0.26)	24.644	$p < 0.001$
Gingival index score (GI)	2.53 (0.28)	1.36 (0.28)	1.53 (0.32)	1.79 (0.38)	30.818	$p < 0.001$
Pocket depth (PD)	4.82 (0.79)	4.12 (0.73)	3.8 (0.94)	3.3 (0.80)	6.697	$p = 0.001$
Clinical attachment loss (CAL)	7.9 (0.81)	7.21 (0.71)	6.9 (0.88)	6.3 (0.54)	9.438	$p < 0.001$
MBL	0.0 (0.0)	0.40 (0.21)	0.74 (0.32)	1.08 (0.44)	29.341	$p < 0.001$

Table 4. Results of repeated-measures ANOVA, followed by Bonferroni's post hoc test (plaque index, gingival index, pocket depth (PD), clinical attachment level, and marginal bone loss) for control group.

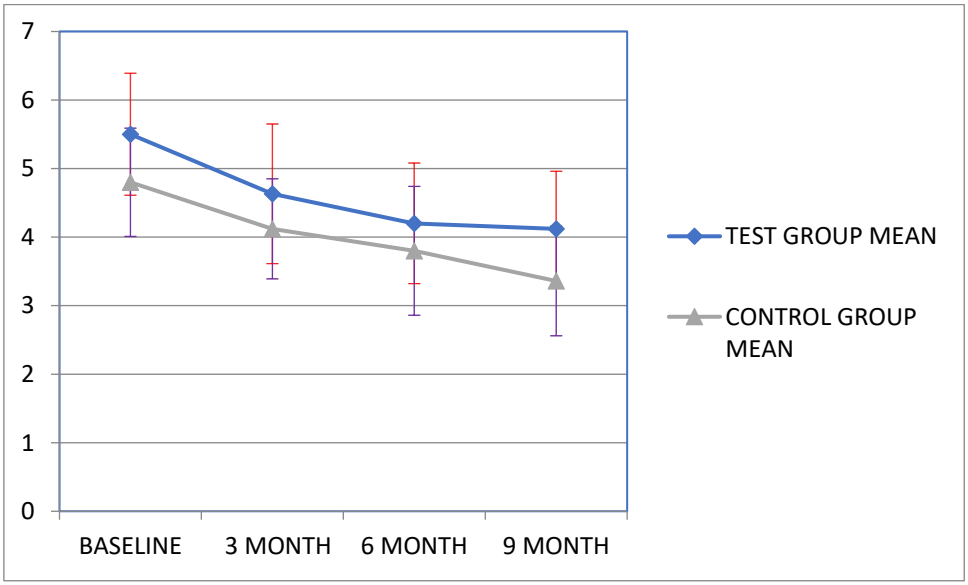
	Baseline vs. 3 Months	Baseline vs. 6 Months	Baseline vs. 9 Months	3 Months vs. 6 Months	3 Months vs. 9 Months	6 Months vs. 9 Months
Plaque index						
Mean Difference	0.95	0.80	0.72	0.14	0.22	0.083
***p* value**	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.647	0.259	0.901
GI score						
Mean Difference	1.16	1.0	0.741	0.16	0.425	0.25
***p* value**	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.587	0.012	0.216
PD score						
Mean Difference	0.70	1.01	1.45	0.31	0.75	0.07
***p* value**	$p = 0.173$	$p = 0.020$	$p < 0.001$	0.781	0.123	0.557
CAL score						
Mean Difference	0.68	1.0	1.6	0.31	0.91	0.60
***p* value**	$p = 0.132$	$p = 0.011$	$p < 0.001$	0.732	0.023	0.220
MBL score						
Mean Difference	0.40	0.74	1.08	0.335	0.684	0.348
***p* value**	$p = 0.009$	$p < 0.001$	$p < 0.001$	0.04	0.03	0.031

The intergroup comparison of the mean PI, GI, PD, CAL, and MBL in the test and control groups at baseline, 3 months, 6 months, and 9 months follow-up are presented in Table 5.

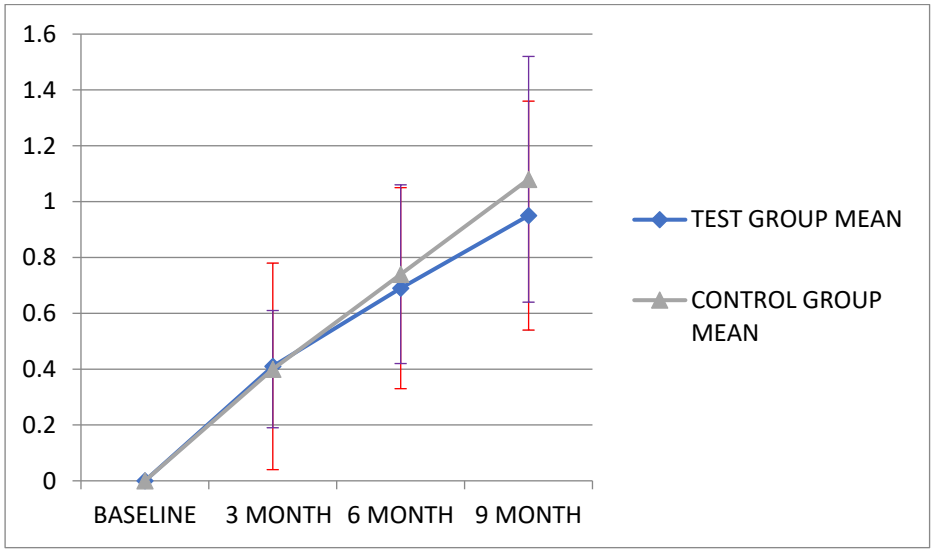
The mean probing depth reduction is elucidated in Scheme 1. The mean CAL and MBL (inter- and intragroup comparison) are reported in Schemes 2 and 3, respectively. The intergroup comparison of the mean primary stability values of the implants for the test and control groups is shown in Table 6.

Table 5. Intergroup comparison of mean PI, GI, PD, CAL, and MBL in test and control groups at different time intervals (baseline, 3 months, 6 months, and 9 months, respectively).

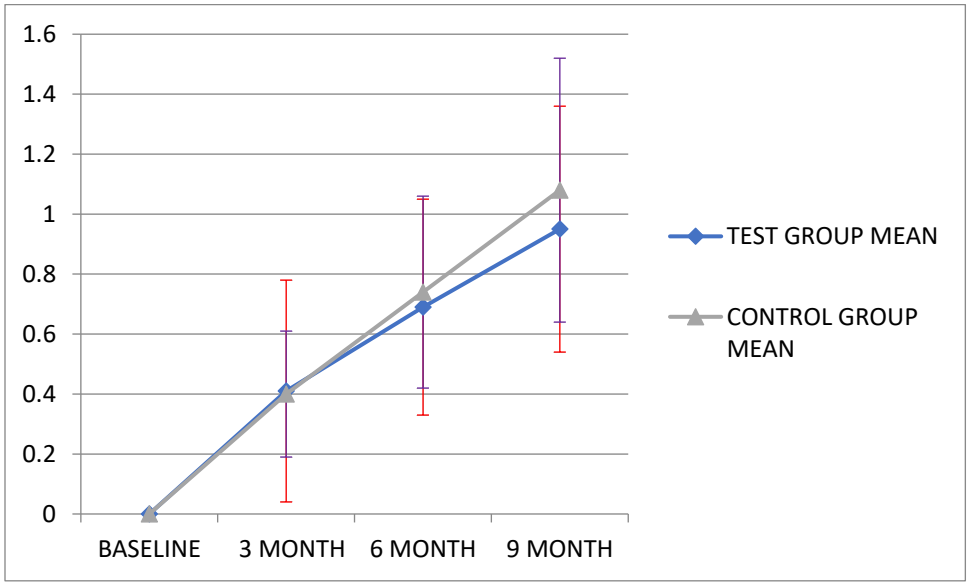
		Baseline	3 Month	6 Month	9 Month
Plaque Index					
Test group (*n* = 11)	**Mean (SD)**	2.51 (0.28)	1.43 (0.27)	1.53 (0.34)	1.79 (0.25)
Control group (*n* = 12)	**Mean (SD)**	2.68 (0.24)	1.73 (0.34)	1.87 (0.32)	1.95 (0.26)
Independent *t* test	***p* value**	0.15	0.034	0.024	0.032
Gingival Index					
Test group (*n* = 11)	**Mean (SD)**	2.45 (0.18)	1.34 (0.18)	1.43 (0.34)	1.6 (0.36)
Control group (*n* = 12)	**Mean (SD)**	2.53 (0.28)	1.36 (0.28)	1.53 (0.32)	1.79 (0.38)
Independent *t* test	***p* value**	0.437	0.835	0.493	0.234
Pocket Depth					
Test group (*n* = 11)	**Mean (SD)**	5.5 (0.89)	4.63 (1.02)	4.2 (0.88)	4.12 (0.84)
Control group (*n* = 12)	**Mean (SD)**	4.8 (0.79)	4.12 (0.73)	3.8 (0.94)	3.36 (0.80)
Independent *t* test	***p* value**	0.051	0.181	0.317	0.038
Clinical Attachment Level					
Test group (*n* = 11)	**Mean (SD)**	8.8 (0.99)	7.88 (0.85)	7.19 (1.07)	6.92 (1.21)
Control group (*n* = 12)	**Mean (SD)**	7.9 (0.81)	7.21 (0.71)	6.9 (0.88)	6.3 (0.54)
Independent *t* test	***p* value**	0.023	0.049	0.485	0.119
Marginal Bone Loss					
Test group (*n* = 11)	**Mean (SD)**	0.0 (0.0)	0.41 (0.37)	0.69 (0.36)	0.95 (0.41)
Control group (*n* = 12)	**Mean (SD)**	0.0 (0.0)	0.40 (0.21)	0.74 (0.32)	1.08 (0.44)
Independent *t* test	***p* value**	——-	0.930	0.750	0.462



Scheme 1. Intergroup comparison of mean pocket depth (in millimeters).



Scheme 2. Intergroup comparison of mean clinical attachment level.



Scheme 3. Intergroup comparison of marginal bone loss.

Table 6. Intergroup comparison of mean primary stability in test and control groups.

Groups	Baseline
Test Group (*n* = 11) Mean (SD)	31.81 (7.83)
Control Group (*n* = 12) Mean (SD)	37.08 (6.55)
Independent *t* test *p* value	0.094

The results revealed that conventional clinical parameters such as plaque index, gingival index, clinical attachment level, and probing depth showed definitive improvement after 9 months, compared with the baseline, but when the test and control groups were compared, the difference was not significant except for plaque index and probing depth. The implants in both groups were followed up for a period of 9 months. The difference in the marginal bone loss was not statistically significant (Table 5).

The survival of immediate implants in the PDT group was not different from that in the SRP group. The peri-implant soft and hard tissue conditions were healthy. All of the implants in both the test and control group survived, and the healing index measured by using the Lein Huin Hang index was found to be satisfactory in general.

4. Discussion

The aim of this study is to assess the effects of photodynamic therapy on the early outcomes of implants placed on patients with periodontitis with and without SRP at 9 months of follow-up. The morbidity or loss of teeth is one of the most alarming complications for a patient. Periodontal disease is among the primary causes of tooth loss. Periodontal disease is multifactorial, chronic, destructive, and inflammatory. It manifests as increased pocket depth as a result of alveolar bone loss, which may ultimately lead to tooth mobility and loss [53].

There is controversy surrounding the survival of implants placed in patients with a history of chronic periodontitis. Implants placed in periodontitis-affected sites frequently fail due to recolonization by pathogenic bacteria, according to the results of a number of clinical trials conducted in the past. Contrary to this finding, accumulating evidence suggests that the fate of implants placed in periodontitis sites is not significantly different from those placed in healthy sites [54]. In periodontitis patients, a variety of surgical and nonsurgical treatment methods are utilized. SRP is a common form of nonsurgical therapy, and various adjunctive therapies, such as systemic and local antimicrobials, have been tried to improve the efficacy of nonsurgical therapy. In the form of photodynamic therapy, the combination of laser light and photosensitizer dye has recently demonstrated promising results. The principle of photodynamic therapy is the activation of a photosensitizer dye placed in a periodontal pocket via irradiation with a laser emitting the appropriate wavelength. PDT has a number of advantages, including modulation of cytokines and MMPs and deeper oxygen penetration [55].

In the present study, an indocyanine green dye that belongs to the tricarbocyanine group and has an absorption band between 600 and 900 nanometers was utilized. It is claimed that the indocyanine green dye has a deeper tissue penetration, as it reduces the viable bacterial load significantly within the first week of use.

The success criteria for immediate implants were both radiographic and clinical. The primary implant stability, healing index, probing pocket depth, clinical attachment level, plaque index, and gingival index were meticulously documented. The most important radiographic parameter was the marginal alveolar bone level, the values of which were 0.95 0.41 mm and 1.08 0.44 mm in the test and control groups, respectively. Similarly, in a study by Adell et al. [56], Branemark osseointegrated implants were implanted, and the findings revealed that marginal bone loss was 1.5 mm in the first year, followed by a mean bone loss of 0.1 mm per year. Comparable to the findings of De Almeida et al. [57], the marginal bone loss was marginally lower in the test groups. Both the primary and secondary stability values of the implant were evaluated. The primary stability values of the implant in the present study, as measured with a torque wrench at the time of implant placement, were 31.81 ± 7.83 N/cm^2 in the test group and 37.08 ± 6.55 N/cm^2 in the control group. These values fell within the clinically acceptable range of grades 3 and 4 minimum insertion torque. The results were comparable to those of Kotsakis GA et al. [58]. However, the difference between the groups was not statistically significant.

All implants placed in the current study demonstrated a high level of osseointegration. Mean PI decreased from 2.51 ± 0.28 and 2.68 ± 0.24 at baseline to 1.70 ± 0.25 and 1.95 ± 0.26 at 9 months in the test group and control group, respectively, representing a statistically significant decrease in plaque when comparing intra and inter groups. Mean GI values were 2.45 ± 0.18 and 2.53 ± 0.28 at baseline in the test and control groups, respectively. These values decreased to 1.6 ± 0.36 and 1.79 ± 0.38 at 9 months in the test and control groups, respectively, which was statistically significant within each group from baseline to follow-up but not between groups. At baseline, the mean PD values for the test and control

groups were 5.5 ± 0.89 mm and 4.8 ± 0.79 mm, respectively. These values decreased to 4.12 ± 0.84 mm and 3.36 ± 0.8 mm at 9 months in the test and control groups, respectively, which was statistically significant within the groups, and the intergroup comparison was also significant at 9 months. At baseline, the mean CAL values for the test and control groups were 8.8 ± 0.99 mm and 7.8 ± 0.81 mm, respectively. After 9 months, these values decreased to 6.92 ± 1.21 mm and 6.3 ± 0.54 mm, respectively. The differences in scores from baseline to nine months were statistically significant within the individual groups but were not statistically significant when compared across groups. All of the aforementioned clinical parameters and changes during the study period were consistent with the findings of Srikanth et al. [59] and Karimi et al. [60]. Photodisinfection is considered to be contributing to superior healing, but there was no difference in healing between the test group and control groups.

This randomized, controlled study compared the survival of immediate implants placed in periodontally compromised sites with and without adjunctive photodynamic therapy to nonsurgical periodontal therapy at 9 months of follow-up. Upon sequential examination using radiovisiography, the MBL was found to be less than 1.5 mm in both groups; however, after 9 months of follow-up, the test group had a statistically insignificant advantage over the control group with less bone loss. In general, primary stability values in the range of 30 to 45 N/cm^2 were obtained, indicating complete osseointegration. There were no adverse complications related to implant healing.

In light of the positive results of this clinical trial, it can be concluded that a history of severe periodontal disease does not necessarily preclude the placement of immediate implants, so long as local accretions are meticulously removed. Photodynamic therapy might have increased the efficacy of conventional treatment but not to a measurable degree.

5. Conclusions

At the conclusion of this randomized, controlled clinical trial on the effect of photodynamic therapy prior to immediate implant placement in chronic periodontitis subjects, it is possible to infer that PDT may be beneficial as an adjunct to SRP. Additionally, the immediate implant placement in patients with a history of periodontitis is a very good treatment option, contrary to previous evidence. Within the given time frame, immediate implants seemed to have a good survival rate (100%). The adjunctive benefits of PDT are likely attributable to their inherent photooxidative mechanisms. An extended period of follow-up and a larger sample size could have given a clearer picture, but due to lack of feasibility, it was not possible. Periodontal disease does not necessarily result in implant failure if comprehensive nonsurgical treatment is administered, and PDT can improve the overall prognosis.

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Data Availability Statement: The dataset used in the current study is available upon reasonable request.

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