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Periodontal pocket treatment with diode laser 940 nm

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***Abstract*---**Introduction: Many adjunctive treatment have been introduced to enhance the therapeutic outcome of periodontal treatment. Diode laser 940 nm has the potential to act as antibacterial and enhances wound healing. Material and methods: 114 periodontal pockets of 5 chronic periodontitis patients having 3 mm≤IPD≤8 mm, who had been treated in the private clinic, Baghdad, Iraq were subjected to the current study. The treatment was done by using 940 nm wavelength diode lasers for three months with twice weekly recall. Results: There was a highly significant improvement in the pocket depth at the end of the 12th week in which the depth of patient's pockets was reduced to half their depth at the initial visit that run in parrelel with a significant increase in the lenghths of the alveolar bone that measured by OPG after six weeks of treatment which persist to increase significantly till the 12th week of treatment which is accompanied by bone biostimulation that improved after the exposure to the diode laser. Conclusion: diode laser 940nm can be considered as a promising periodontitis treatment as it causes a rapid reduction in probing depth with an increase in the bone bio-stimulation when it used in an appropriate protocol.

***Keywords*---**diode laser 940 nm, bone regeneration, periodontitis, probing depth.

Introduction

Periodontal disease (PD) is a disease with multiple factors that consists of hard and soft dental supporting tissues, microbial colonization, and host immune/inflammatory responses (Ali, 2015). Periodontitis is a complex interplay of bacterial infection and host response, modified by behavioral and systemic risk factors, resulting in inflammation of the supporting tissues of the teeth with progressive attachment and bone loss (Silva et al., 2015). The formation of a space between the pathologically detached gingiva and the tooth is called the "periodontal pocket" (Bosshardt, 2018).

The present study suggests the application of diode laser 940 nm in the periodontal pocket. Authors reported that diode lasers have several advantages in soft tissue surgery with benefit of less bleeding, pain, infection and scar formation. Diode laser was effective in the reduction of microbial population and it is safe to use near the hard tissue as it is absorbed by pigments in soft tissue only (Musaa et al., 2019). One of the main variables used to evaluate clinical success of periodontal therapy is periodontal pocket depth reduction. Periodontal pocket with a depth > 6 mm is considered 'critical' and presents a risk factor for both the progression of periodontal disease and tooth loss (Nammour et al., 2021).

Furthermore, the laser irradiation provokes a release of fibrin and collagen inside the lased tissues after 6 hours of irradiation (Marques et al., 2004). This release of fibrins inside the pocket may increase the quality of the natural filling material (blood and fibrins) and the bonding of the pocket soft tissue to the cleaned root surface (Nammour et al., 2021). Various studies have demonstrated that Low Level Laser Irradiation (LLLI) can increase cell proliferation, differentiation, and migration in tissues through its stimulation of growth factor and cytokine synthesis, thereby enhancing their regenerative capacity (Hendudari et al., 2016). The growth and differentiation of osteoblasts, responsible for bone formation and regeneration, are known to be enhanced by 940 nm diode laser treatment, and this effect has been attributed to the release of autocrine factors (e.g., TGFβ1 or BMP-2) by osteoblasts in response to the irradiation (Manzano-Moreno et al., 2015; Illescas-Montes et al., 2017). Therefore, our study aims to evaluate the efficacy of a new nonsurgical approach with diode laser (940 nm) as adjunctive to an existing conventional procedure for the treatment of periodontitis.

Material and Methods

Subjects and Methods

The protocol of this prospective study was approved by The Clinical Research Ethics Committee of Institute of Laser for Postgraduate Studies, Iraq. Research was conducted according to the principles outlined in the Declaration of Helsinki on experimentation involving human subjects. The duration of the study was 12 weeks.

Study participants

The sample of this study consisted of 114 periodontal pockets of 5 chronic periodontitis patients having 3 mm≤IPD≤8 mm, who had been treated in the private clinic, Baghdad, Iraq. To be included in this study, participants had to be systemically healthy, non-smoker, between 23 to 69 years of age, had not been received any periodontal treatment within the last 3 months, have horizontal bone loss in radiograps, have at least 10 teeth except third molars in the oral cavity and consent to participate in the study. periodontitis was diagnosed according to Armitage (Armitage, 1999). The exclusion criteria were as follows: any systemic alteration that might interfere with the prognosis of periodontal diseases (i.e, diabetes mellitus, HIV infection), smoking, usage of antibiotics and anti-inflammatory drugs or any other medication taken within the previous 6 months that might affect the outcome of the study, any physical limitations or restrictions that might impede normal oral hygiene procedures. Written informed consent was obtained from all subjects.

All patients suffered from a bleeding on probing with pain in the molar area of the upper jaw in one patient and pain in the molar area in the lower jaw in another patient. All patients showed a good oral hygiene when examined clinically as shown in figure (I) before receiving treatment. The measurement of pocket was performed by using WHO periodontal probe as shown in Figure (II). All cases were diagnosed as localized periodontitis. At the initial visit, Orthopantamogram **(**OPG) were performed as illustrated in figure (III) in an addition to a routine blood analysis. All cases were subjected to general scaling as a result of calculus presence in addition to root planning (SRP) at the pocket region with instructions regarding to oral hygiene for the two patients.

Patient condition assessed weekly by using WHO periodontal probe to measure the depth of pockets in addition of Orthopantomogram X-ray (OPG) investigation that is scheduled to performed at the initial visit and after six and twelve weeks to assess the treatment outcome and after three months for a follow-up. Using my OPG software, the lenght of alveolar bone was measured and recorded for each measurement. Every week patients' oral hygiene maintenance was assessed and patients subjected to a treatment with diode laser for each affected pocket. All patients signed an informed consent in addition to the agreement of patient to receive 940 nm laser as a treatment according to the form as shown in Figure (IV).

Figure (I): periodontitis and periodontal bleeding before treatment

Figure (II). Pocket measuring probe to measure pocket depth in mm

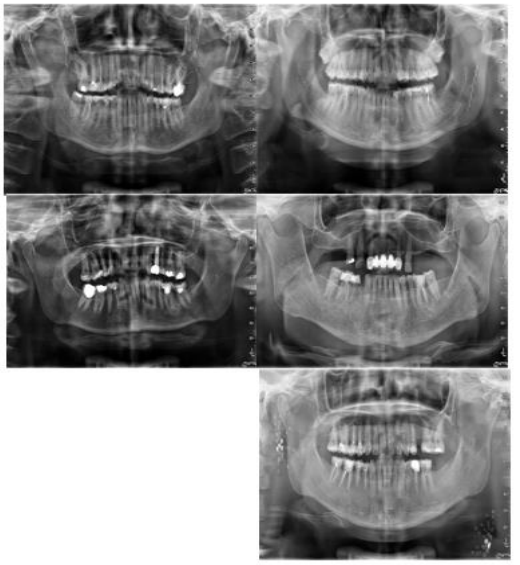

Figure (III). Orthopantamogram for the all patients at the first visit

Name of person described in the article and/or shown in the photograph/video/multimedia/etc:_____

Subject matter of photograph or article:_____

Title of article:_____

Corresponding author:_____

I agree to be treated using 940nm diode laser according to the protocol mentioned in the article and I give my consent for this information about MYSELF/MY CHILD OR MY RELATIVE relating to the subject matter above ("the Information") to appear in the journal, associated publications or translations or those to whom the journal licenses its content. I have/have not seen the material to be submitted to the journal. I understand the following:
(1). Use of this consent form does not waive your right to privacy. The Information will be published without your name attached and the publishing partners will make every attempt to ensure your anonymity. You should understand, however, that complete anonymity cannot be guaranteed. It is possible that somebody somewhere - perhaps, for example, somebody who looked after you or a relative - may identify you.
(2). The text of the article will be edited for style, grammar, consistency, and length.
(3). The Information may be published in the journal, which is online and freely accessible worldwide to both health professionals, journalists, the public and others. The material may subsequently be used in Microsoft PowerPoint or other presentations at saminars or coferences.
(4). Patients and their family should note, they cannot normally expect to derive any financial benefit from the publication of the case. If there is any financial or material benefit, this should be stated here:
(5). An original of the signed form will be held at the treating institution and the authors may be required to prove that consent was obtained.
(6). The author attests that an informed consent process was followed when this form was completed, with the patient/relative given sufficient time to consider its implications and the permanency of publication.

Signed (patient/relative): _____ Date:_____

Name: _____

Signed by author taking consent:_____Date:_____

Name: _____

Figure (IV). The form that each patient should write for his agreement to be treated by 940 nm diode laser.

Patients did not receive a local anesthesia and antimicrobial agent and also no periodontal dressing was used. The treatment scheduled to take three months with a laser treatment performed weekly beside the pocket depth measurement, Night guard was not used through treatment period.

Laser parameters

Laser biolase epic 940 nm wavelengths were used with an output power of 80 mW. In pulsed mode of 50% duty cycle the delivery system was an optical fiber of 300 μm diameter, each surface of the pocket was irradiated for 20 second exposure time at each pocket. The treatment was repeated twice a week.

Results

According to results illustrated in table (I) and figure (V) there was a highly significant improvement in the pocket depth at the end of the 12th week as obviated by the results of the 24th visit in which the depth of patient's pockets was reduced to half their depth at the initial visit. Additionally, results illustrated in table (II) demonstrated that the depth of periodontal pockets showed a significant improvement in the third visit (after one week of treatment) as appear in the significant reduction of the pocket depths which in turn further improved in the

5th visit (after two weeks of treatment). After the rapid improvement that appear in the first two weeks, the significant reduction in the continuity of the improvement had been slowed down and become significantly improved at the 9th visit (after four weeks of treatment). The improvement persists after two weeks and become reduced significantly in the 13th visit and reach nearly constant periodontal depth at 19th visit after which the depth reduced non-significantly till the 24th visit.

Table I: Comparison between the mean of pockets' depth in all visits

Visit No.	N	Mean (mm)	Std. Deviation	Std. Error
1.00	114	5.7456	1.30222	0.12196
3.00	114	5.0263	1.32010	0.12364
5.00	114	4.5614	1.20497	0.11286
7.00	114	4.2281	1.06460	0.09971
9.00	114	3.8860	.97544	0.09136
11.00	114	3.6579	.86043	0.08059
13.00	114	3.3684	.64167	0.06010
15.00	114	3.1667	.66408	0.06220
17.00	114	3.0526	.66309	0.06210
19.00	114	2.8070	.65008	0.06089
21.00	114	2.6316	.53651	0.05025
23.00	114	2.4912	.50213	0.04703
24.00	114	2.4474	.49942	0.04677
P-value	<0.001			

The lenghths of the alveolar bone that measured by OPG that illustrated in table (III) and figure (VI) showed a highly significant increase in there values after six weeks of treatment which persist to increase significantly till the 12th week of treatment.

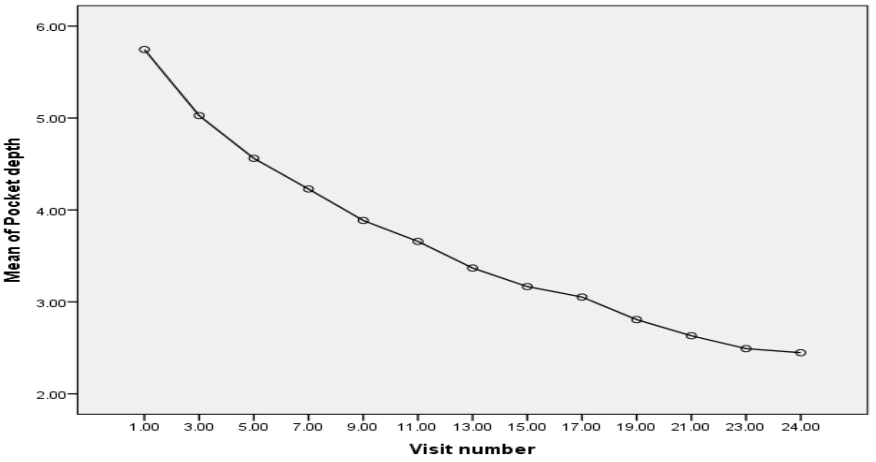

Figure (V): Mean of pocket depth in a subsequent visits

Table II: The significancy of the reduction in the pocket depth among all visits

Visit number	Visit number	Sig.	Visit number	Visit number	Sig.
1	3.00	.000	7	23.00	.000
	5.00	.000		24.00	.000
	7.00	.000	9	11.00	.770
	9.00	.000		13.00	.001
	11.00	.000		15.00	.000
	13.00	.000		17.00	.000
	15.00	.000		19.00	.000
	17.00	.000		21.00	.000
	19.00	.000		23.00	.000
	21.00	.000		24.00	.000
	23.00	.000	11	13.00	.399
	24.00	.000		15.00	.002
3	5.00	.005		17.00	.000
	7.00	.000		19.00	.000
	9.00	.000		21.00	.000
	11.00	.000		23.00	.000
	13.00	.000		24.00	.000
	15.00	.000	13	15.00	.887
	17.00	.000		17.00	.260
	19.00	.000		19.00	.000
	21.00	.000		21.00	.000
	23.00	.000		23.00	.000
	24.00	.000		24.00	.000
5	7.00	.186	15	17.00	.999
	9.00	.000		19.00	.105
	11.00	.000		21.00	.000
	13.00	.000		23.00	.000
	15.00	.000		24.00	.000
	17.00	.000	17	19.00	.670
	19.00	.000		21.00	.021
	21.00	.000		23.00	.000
	23.00	.000		24.00	.000
	24.00	.000	19	21.00	.958
7	9.00	.155		23.00	.260
	11.00	.000		24.00	.105
	13.00	.000	21	23.00	.993
	15.00	.000		24.00	.939
	17.00	.000	23	24.00	1.000
	19.00	.000			
	21.00	.000			

Table III: The comparison between the mean lenghths of the alveolar bone (mm) after six and twelve weeks of treatment with the initial lenghths

Group	mean± SD (mm)	P^1-value	P^2-value	P^3-value	P^4-value
Initial OPG	12.14±2.11	<0.001	<0.001	0.001	<0.001
2nd OPG	13.25±2.06				
3rd OPG	14.24±1.98				

P^1 value between initial and second OPG; P^2 value between initial and third; P^3 second and second OPG; P^4 value among all groups by ANOVA test.

Results illustrated in table (IV) showed that there was highly significant negative correlation between the depth of the periodontal pocket and the results of OPG and also a highly negative correlation between the pocket depth and the visit number. In addition to the numirical results that presented above, the clinical observation of the complications revealed that the improvement in the pocket depth run in parrelel with the other clinical signs such as pain and BOP that also reduced dramatically from the first to the third week of treatment as illustrated in figure (VII). Furthermore, OPG image obtained after the end of the treatment for 12 weeks support the statistical results that presented above and showed that the bone biostimulation become improved after the exposure to the diode laser 940 nm as demonstrated in figure (VIII).

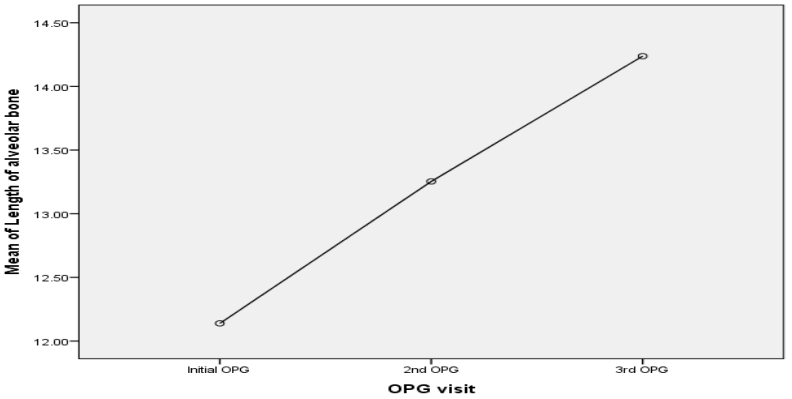

Figure (VI): the mean of OPG in all visits

Table (IV): The correlations between pocket depth, visit number and length of alveolar bone

		Visit number	Alveolar bone length (mm)
Pocket depth (mm)	Pearson Correlation	-0.725	-0.342
	Sig. (2-tailed)	<0.001	<0.001
Visit number	Pearson Correlation	1	0.387
	Sig. (2-tailed)		<0.001

Discussion

Periodontitis is the most frequently observed periodontal disease worldwide and it is still one of the two foremost causes of tooth loss. It is an infectious and inflammatory disease that needs to be treated for maintain both periodontal and systemic health (Meseli et al., 2017). The 'gold standard' therapy for periodontitis is the non-surgical periodontal treatment that consists of conventional mechanical debridement.4 The mechanical debridement is based on a professional scaling and root planing to remove supra and subgingival biofilms and calculus from colonized root surfaces in order to arrest and control inflammatory processes (Drisko et al., 2014).

Figure (VII): periodontitis and periodontal bleeding after treatment for 12 weeks.

In addition to mechanical debridement, different adjunctive methods and treatment protocol are being proposed such as antimicrobial photodynamic therapy or systemic antibiotics5, the use of antibiotics for aggressive periodontitis (Jepsen and Jepsen, 2016), the application of botanical compositions (Yimam et al, 2019), and the introduction of a multiplex-targeted proteomics (Mertens et al., 2018). In addition, several laser-assisted methods and treatment protocols have been described. The irradiation with laser aims to enhance the efficacy of disinfection of the colonized root surface and to delay the epithelial migration to the bottom of the pocket by de-epithelization of gingival pocket, which will result in delaying the re-attachment of junctional epithelium (Nammour et al., 2021).
In addition, the diode laser irradiation will be used to coagulate the blood inside the pocket, which may trigger pocket wound healing (Al-Wardi et al., 2018).

Fibroblasts are an essential cell component of soft tissue and are the main cells involved in wound healing, contributing to the restoration of tissue physiology by providing growth factors and extracellular matrix proteins (Desmoulière et al., 2005). Study conducted by llescas-Monte et al. in 2017 demonstrated that fibroblast growth can be stimulated by application of the 940 nm diode laser under specific treatment conditions (mode, power, and energy density) which is in agreement with the results obtained by the current work.

In the current work, patients subjected to treatment showed a significant outcome that presented as a notable reduction in pain and bleeding after the first two weeks with a highly significant reduction in the depth of all pockets of more than 6mm depth even in elderly patient (69 years old). The reduction in the depth of pockets ranged from 2-4mm (mean= 2.9mm) after about one month of treatment with a diode laser. It was also demonstrated that a significant reduction in PD was obtained in every subsequent week of treatment that prove the cumulative effect of treatment with diode laser with a lowest depth was obtained at the 24th visit.

This result is compatible with a previously presented work which demonstrated that the group of patients who received a combination of SRP with 940 nm diode laser for four months showed a reduction in the probing depth for about 76% (Crispino et al., 2015) given that in the present work a reduction of about 38.5% were obtained after only one month of treatment which become 57.4% at the end of the 3 months of treatment. Additionally, more recent study demonstrated that the probing depth were reduced significantly by about 43% after one month of SRP with 810 nm diode laser that become about 49% after three months of treatment (Al Shbool et al., 2021) in a consistent with results obtain in the present work after the end of the first and third month of treatment. Results obtained from the treatment used in the present study revealed that diode laser considered as very promising way of treatment and this finding is in consistent with several published work (Mirdan, 2012; Mahmood and Hammoodi, 2015; Stavropoulos and Sculean, 2017).

It was also demonstrated that OPG images and the length of alveolar bone obtained revealed that the treatment with 940 nm diode laser cause an improvement in bone bio-stimulation as it indicated by the highly significant increment in the length of alveolar bone and supported by images illustrated that showed the significant differences in the bony socket length in the final visit in a comparison with the initial visit which is also consistent with previous studies which demonstrated that the use of LLLT may play an important role in stimulating osteoblast cells that lead to an improvement in bone formation (Jawad et al., 2013) which is attributed to the release of autocrine factors (e.g., TGFβ1 or BMP-2) by osteoblasts in response to the irradiation (Illescas-Montes et al., 2017)

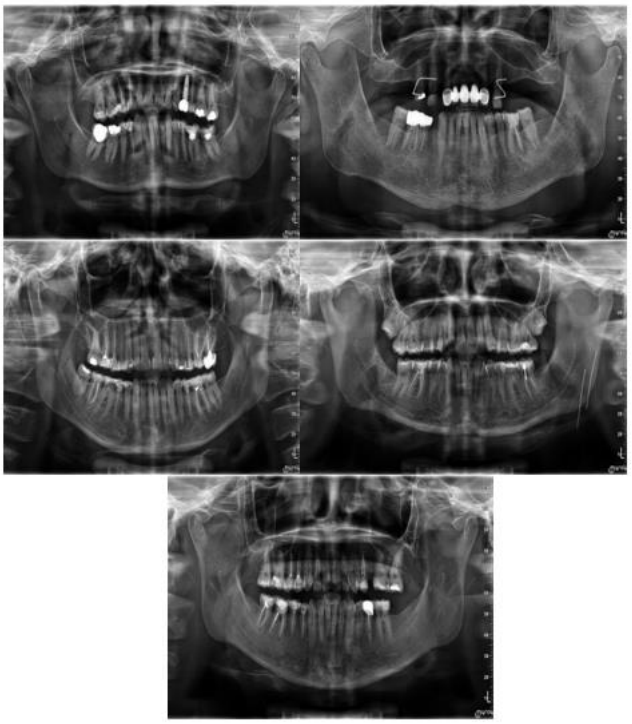

Figure (VIII). Orthopantamogram for the all patients at the end of treatment

Moreover, the results obtained in the current research revealed that the increment in the length of alveolar bone which represent the rate of bone bio-stimulation were accompanied by the reduction the depth of probing pocket which may indicate the cause of rapid healing that occur after about one month of treatment which is expressed as a reduction in the pain and bleeding that encouraged patients to continue the treatment sessions and improve their compliance.

In conclusion, results obtained in this study demonstrated that the treatment with 940nm diode laser can be considered as a promising treatment of periodontitis as it causes a rapid healing and reduction in probing depth with an increase in the bone bio-stimulation when it used in an appropriate protocol that is indicated by the significant increase in the length of alveolar bone. Further research is necessary to define a therapeutic protocol, as suggested by other authors and to elucidate the mechanisms underlying the bio-stimulating action of a 940 nm diode laser irradiation on fibroblasts and to investigate possible clinical applications.

Disclosure

Authors have no conflict of interests and the work was not supported or funded by any drug company. No part of this article was presented in any conference or published before

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