International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page:www.iscientific.org/Journal.html

Evaluation of High-Level Laser Therapy for Peri-implantitis from a Clinical and Microbiological Perspective

Sugandha Gupta[1], Muthukumaraswamy A[2], Minal Vaibhav Awinashe[3], Sudipta Sahu[4], Prajwal Shetty[5], Prajakta Ganesh Chougule[6]

[1]*Assistant Professor, Department of Prosthodontics, Dental College, Azamgarh, UP, India.*
[2]*Department of Periodontics, Tamilnadu Government Dental College, Chennai-3, Tamil Nadu, India.*
[3]*Department of Oral Surgery and Diagnostic Sciences, College of Dentistry, Qassim University, Buraidah, Kingdom of Saudi Arabia.*
[4]*Department of Public Health Dentistry, Institute of Dental Sciences, Shiksha O Anusandhan University, Bhubaneswar, Odisha, India.*
[5]*Department of Orthodontics and Dentofacial Orthopedics, AB Shetty Memorial Institute of Dental Sciences, NITTE (Deemed to be University), Derlakatte, Karnataka, India.*
[6]*Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Sangli, Maharashtra, India.*

Abstract

Because of the Surface characteristics of the implant surface, it is particularly difficult to remove all bacterial deposits from contaminated surfaces. The purpose of this work was to assess the bactericidal potential of photodynamic treatment in peri-implantitis utilizing a novel high-level laser irradiation technique in conjunction with hydrogen peroxide. For this investigation, 12 individuals with peri-implantitis were chosen. Every participant's medical and dental history was gathered at baseline and six months following surgery. Real-time PCR was used for microbiological analysis. In accordance with the High Level Laser care protocol, each patient received nonsurgical periodontal care as well as surgery in addition to photodynamic therapy. Every peri-implant pocket was successfully treated, with no complications. Plaque Index (average drop of 60%, range 20–82%) and probing depth (average decrease of 1.4 mm, range 0,38–2.1 mm) were among the clinical metrics that demonstrated improvement overall. Six months following surgery, periapical radiographs revealed a full radiographic filling of the peri-implant defect surrounding the treated implants. Six months following surgery, the overall number of bacteria and every species of bacteria, with the exception of Eikenella corrodens, decreased, according to the results.In addition to surgery, photodynamic therapy with HLLT seems to be a useful treatment for peri-implantitis.

Keywords: Assessment, high level laser therapy, microbiological, peri implantitis, radiographic

Full-length article **Corresponding Author*, e-mail:drmkswamy@gmail.com

1. Introduction

For the replacement of lost teeth, endosseous implants are now a commonly used treatment option [1]. A bacterially-induced inflammatory response known as "peri-implantitis" causes the surrounding bone around an implant to gradually disappear, potentially leading to implant failure and the loss of the implant fixture. A reversible inflammatory response in the soft tissues around a functional implant is called peri-implant mucositis [2, 3]. Peri-implant disease development is largely dependent on the existence of bacteria [4].In both health and illness, the periimplant microbiome is very different from the periodontal population. Less complex than periodontitis, peri-implantitis is an infection caused by a variety of microorganisms, primarily Gram-negative [1]. The majority of the current suggested therapies for treating peri-implantitis are founded on scientific data from the management of periodontal disease. The main objective of treating peri-implant illness is to remove biofilm from implant surfaces [1, 5,6, 7].

Research from published works reveals that regenerative surgical treatment for peri-implantitis raises some contentious questions, including whether it is actually possible to achieve implant surface cleaning, bone tissue regeneration, and Osseointegration [8, 9]. Additional therapeutic alternatives for the nonsurgical treatment of mucositis and peri-implantitis include the use of antibiotics, antiseptics, and laser treatments [7].Since its introduction to medicine in 1964, lasers have been successfully used in dentistry to treat a variety of diseases. The term "photodynamic therapy" (PDT) refers to the destruction of target cells using reactive oxygen species generated by a photosensitizing agent and wavelength-appropriate light. It might offer an alternate strategy to directly target bacteria at the infection site. The three elements of PDT are light, oxygen, and photosensitizer. A photosensitizer changes from a low energy ground state to an excited singlet state when exposed to light of a certain wavelength. PDT causes molecules and subcellular organelles to become cytotoxic. Cell membranes, lysosomes, and mitochondria are the targets of its effects [1]. Because the CO2 laser absorbs very little at the implant surface, its application in implant dentistry is growing [10].The purpose of this work was to assess the bactericidal potential of photodynamic treatment in peri-implantitis utilising a novel high-level laser irradiation technique in conjunction with hydrogen peroxide.

2. Materials and Methods

2.1. Study Population

Twelve peri-implantitis patients were chosen. Exact inclusion and exclusion criteria were used to guide the selection of patients.Periodontal charting was done for every patient, and the Plaque Index and probing depth were evaluated. Gingival fluid was removed from periimplant pockets both before and after therapy using paper tips in order to conduct microbiological analysis using Real Time PCR. Every patient received nonsurgical periodontal therapy together with photodynamic therapy in accordance with the High Level Laser Therapy protocol one week prior to surgery. All periodontal and periimplant pockets were scaled and their Surfaces planed using Titanium curettes, titanium ultrasonic tips, irrigation with betadine (5:1), and an air powder abrasive device with powdered sodium bicarbonate.Using Oxylaser solution (hydrogen peroxide stabilized with glycerophosphoric complex) and a high power diode laser set to the following parameters, photodynamic treatment was administered: (i) 2.5W of power; (ii) 10.0 kHz of frequency; (iii) 20 μs of on and 80 μs of off; (iv) 60 seconds per site, (v) with an average power of 0.5W. 400 microns of fibre.Every pocket around implants and in the periodontal area was irrigated with oxylaser solution. The laser fibre was inserted into the pocket, travelling back and forth for 50 seconds for each pocket before reaching the bottom and radiating subgingival tissues.

2.2. Surgical Procedures

Local anaesthesia was used for surgical procedures. To expose the labial and palatal components of the periimplant defect, full thickness mucoperiosteal flap was raised after intrasulcular incisions were made. Titaium Gracey curettes, Titanium Ultrasonic tips, irrigation with betadine (5:1), and an air powder abrasive device with sodium bicarbonate powder were used to eliminate the granulation tissue. The implant surface was exposed to 50 seconds of high-level laser irradiation for every individual pocket. The debridement process was then repeated until the implant surface was thoroughly cleaned. Following debridement bone graft was placed and the flaps were sutured. To relieve flap tensions, an internal mattress suture was placed initially. Fifteen days following the procedure, the sutures were removed, and High Level Laser Therapy was used to enable additional purification. For three months, patients had HLLT every fifteen days. Clinical, radiological, and microbiological data were gathered six months following surgery.

3. Results

Twelve patients in all, seven men and five females, with an average age of 42.3 years and a range of 30 to 55 years, consented to have high-level laser therapy and surgery. i) Four Nobel implants with TiUnite surfaces; ii) three Straumann implants with SLA surfaces (three of which were included in the case study); iii) one Straumann implant with SL Active surface; and iv) two Zimmer implants with MTX surfaces were the implants treated in this investigation. Every peri-implant pocket was successfully treated, with no complications. Plaque Index (average drop of 60%, range 20–82%) and probing depth (average decrease of 1.4 mm, range 0,38–2.1 mm) were among the clinical metrics that demonstrated improvement overall.

Six months following surgery, periapical radiographs revealed a radiographic bone fill of the peri-implant defect surrounding the treated implants.Numerous bacterial species, such as Porphyromonasgingivalis (Pg), Aggregatibacteractinomycetemcomitans (Aa), Tannerella forsythia (Tf), Fusobacterium nucleatum (Fn), Eikenellacorrodens (Ec), and Campylobacter rectus (Cr), as well as the total number of bacteria, were subjected to microbiological analysis.Six months following surgery, the overall number of bacteria and all species of bacteria (except Ec) decreased, with a medium decrease of 94,72% for Aa.

4. Discussion

Thorough removal of bacterial biofilm is necessary to achieve reosseointegration of a rough implant surface exposed by bone loss. Because of the shape and roughness of the implant, mechanical therapy is insufficient to completely eliminate the biofilm. A modified and stabilised H2O2 solution is combined with a penetrating laser to provide the therapy known as HLLT technology [1]. Probing reveals bleeding in the peri-implant tissues afflicted by peri-implantitis, which are clinically indicative of inflammation [10]. Numerous in vitro investigations demonstrated the bactericidal effects of laser irradiation and hydrogen peroxide on a variety of bacterial species [11–13]. According to Alshehri et al., laser therapy can be utilised to treat PI in an efficient manner as an addition to traditional mechanical debridement treatments [14]. According to Altindal et al., the peri-implant tissue's clinical characteristics improved thanks to the diode laser [15]. When compared to mechanical instrumentation alone, Roccuzzo et al.'s conclusion from their repeated adjunctive application of diode laser in the non-surgical management of PI [16] did not yield statistically significant advantages.According to Li et al., Er:YAG lasers can successfully lower PD and GR and provide health advantages to patients with peri-implantitis [17]. According to Máximo et al., treating peri-implantitis with open debridement has shown improvements in clinical and microbiological aspect [18]. Galofré et al. discovered that the clinical characteristics of implants with mucositis or peri-implantitis were improved by giving a daily lozenge of L. reuteri for 30 days together with mechanical debridement of the entire mouth [19]. Similar to our results, Abduljabbar et al. concluded that non-surgical MD with Nd:YAG laser assistance is more successful than MD alone in the short term, but not in the long term, at reducing periimplant soft tissue inflammatory parameters [20]. Following surgical treatment for peri-implantitis, Luengo et al. showed a statistically significant improvement in microbiological and biochemical parameters [10].

Table1. Plaque Index at baseline and six months after procedure

Plaque score	**At baseline**	**After 6 months**	***p***
Group 1	435.76+-21	124+-34	0.001
Group II	465.87+_46	132+-35	0.001

Table 2. Depth of probing at baseline and six months post-treatment

Probing depth	**At baseline in mm**	**After 6 months in mm**	***p***
Group 1	5.8	2.6	0.001
Group II	5.6	2.7	0.001

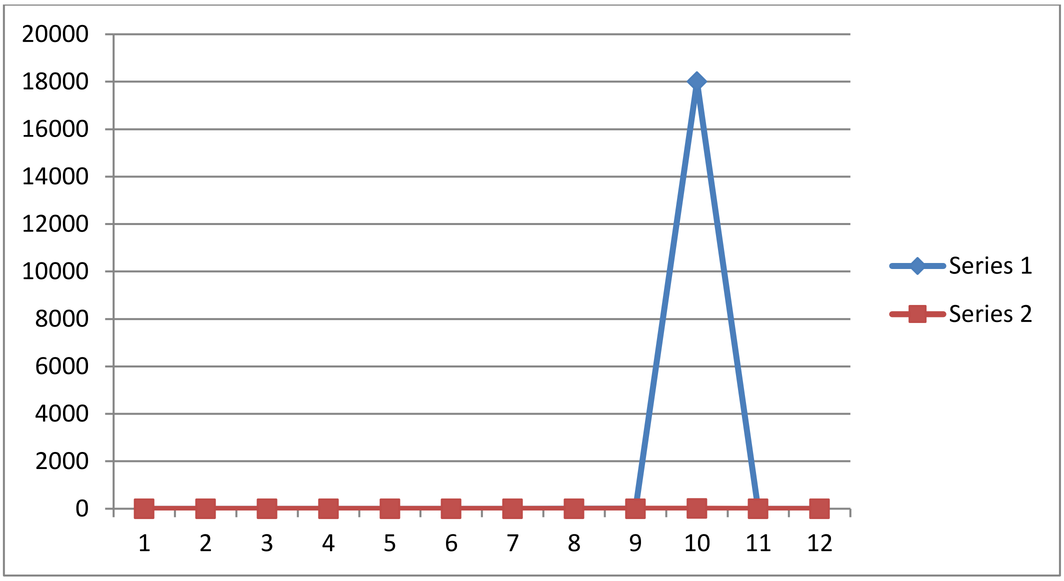

Figure 1. Aa: microbiological examination at the beginning and six months following surgery

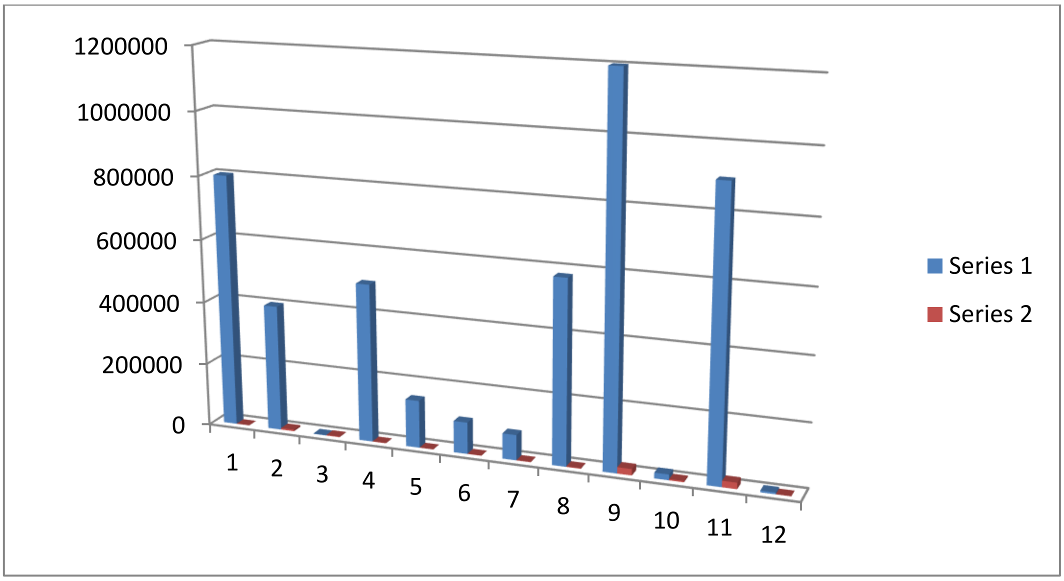

Figure 2. Pg: microbiological examination at the beginning and six months following surgery

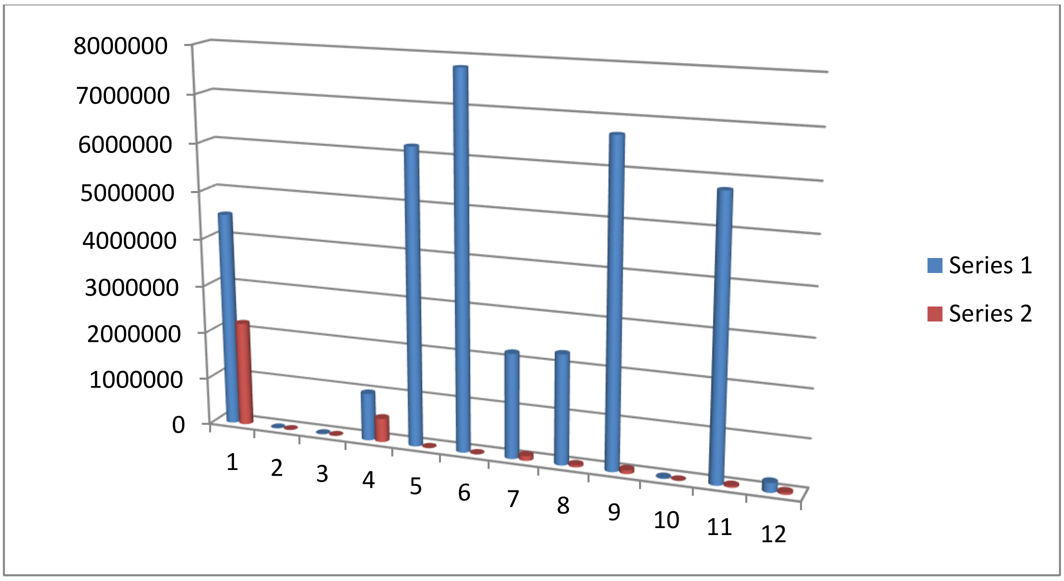

Figure 3. Total microbial count: microbiological examination at the beginning and six months following surgery

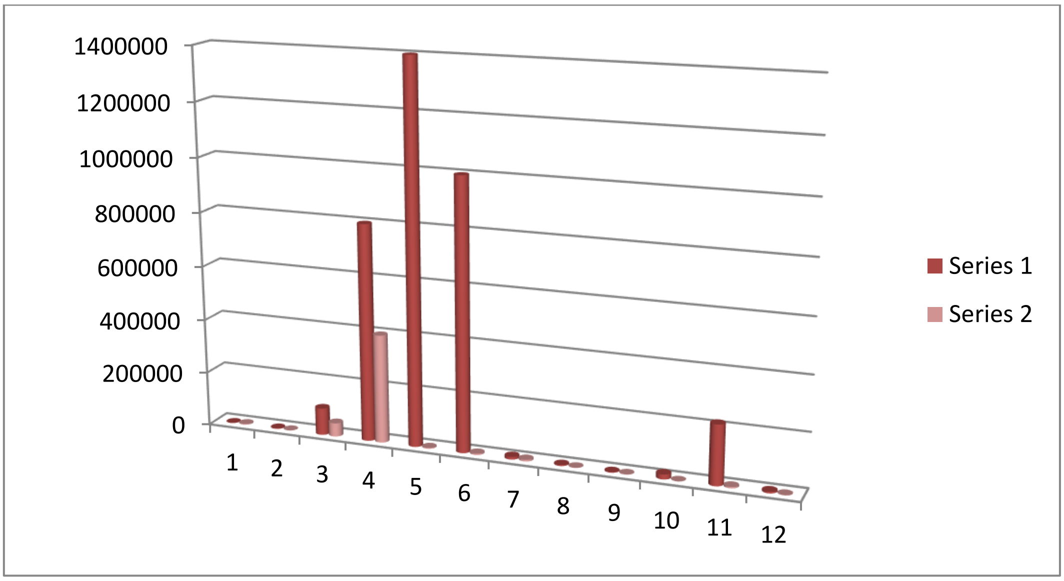

Figure 4. Ec: microbiological examination at the beginning and six months following surgery

The modified H_2O_2 solution is activated by laser radiation, which also releases singlet oxygen and free radicals that have antibacterial effects on both Gram-positive and Gram-negative periodontal infections. Bacterial cells die due to denaturation of DNA molecules, modification of mitochondrial function, bacterial membrane disintegration, and lysosomal membrane degradation caused by the oxygen free radical singlet oxygen. This laser operates at very high frequency, with low average power (less than 0.8 watts), and high power peaks (to kill germs). The HLLT laser is adjusted to prevent noticeable heat effects, which keeps the implant surface unaltered [1]. Additional research is required to verify the findings.

5. Conclusions

The preliminary findings of this study and a biological justification for photodynamic therapy using HLLT suggest that this treatment may be a useful addition to surgical management of peri-implantitis. The effectiveness of the suggested protocol emphasises the necessity of treating the site as minimally traumatically as possible while still achieving the desired results in terms of bacterial and inflammatory reduction.

References

[1] G. Caccianiga, G. Rey, M. Baldoni, and A. Paiusco. (2016). Clinical, radiographic and microbiological evaluation of high level laser therapy, a new photodynamic therapy protocol, in peri-implantitis treatment; a pilot experience. BioMed Research International. Article ID 6321906.

[2] T. Albrektsson, and F. Isidor. (1994). Consensus report of session IV, in Proceedings of the 1st European Workshop on Periodontology. N.P. Lang and T. Karring, Eds. 365–369.

[3] N.P. Lang, and T. Berglundh. (2011). Periimplant diseases: where are we now?consensus of the Seventh European Workshop on Periodontology. Journal of Clinical Periodontology. 11: 178–181.

[4] A. Mombelli, M.A.V. Oosten, E. Schurch Jr, and N.P. Land. (1987). The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiology and Immunology. 2(4): 145–151.

[5] I.K. Karoussis, G.E. Salvi, L.J.A. Heitz-Mayfield, U. Br¨agger., C.H.F. H¨ammerle., N.P. Lang. (2003). Long-termimplant prognosis in patients with and without a history of chronic periodontitis: a 10-year prospective cohort study of the ITIÝ Dental Implant System. Clinical Oral Implants Research. 14(3): 329–339.

[6] N.P. Lang, T. Berglundh, L.J. Heitz-Mayfield, B.E. Pjetursson, G.E. Salvi, and M. Sanz. (2004). Consensus statements and recommended clinical procedures regarding implant survival and complications. The International Journal of Oral & Maxillofacial Implants. 19: 150–154.

[7] A. Mombelli, and N.P. Lang. (1992). Antimicrobial treatment of periimplant infections. Clinical Oral Implants Research. 3(4): 162–168.

[8] F.H. Nociti Jr, M.A.N. Machado, C.M. Stefani, E.A. Sallum, and A.W. Sallum. (2001). Absorbable versus nonabsorbable membranes and bone grafts in the treatment of ligatureinduced peri-implantitis defects in dogs. Clinical Oral Implants Research. 12(2): 115–120.

[9] F.H. Nociti Jr, R.G. Caffesse, E.A. Sallum, M.A. Machado, C.M. Stefani, and A.W. Sallum. (2001). Clinical study of guided bone regeneration and/or bone grafts in the treatment of ligatureinduced peri-implantitis defects in dogs. Brazilian Dental Journal. 12(2): 127–131.

[10] F. Luengo, M. Solonko, J. Sanz-Esporrín, I. Sanz-Sánchez, D. Herrera, and M. Sanz. (2022). Clinical, Microbiological, and Biochemical Impact of the Surgical Treatment of Peri-Implantitis—A Prospective Case Series. Journal of Clinical Medicine. 11(4699):1-15

[11] G. Caccianiga, G. Rey, T. Fumagalli, A. Cambini, G. Denotti, and M.S. Giacomello. (2012). Photodynamic therapy (association diode laser/hydrogen peroxide): evaluation of bactericidal effects on periodontopathy bacteria: an in vitro study. European Journal of Inflammation. 10(2): 101–106.

[12] G. Caccianiga, A. Baldini, A. Baldoni, and G. Tredici. (2004). Application of laser in periodontology: microbiological evaluation with PCR-real time," inMediterranean Dental Implant Congress. P.N. Bochlogyros, Ed., Medimond International Proceedings.

[13] G. Caccianiga, A. Cambini, G. Rey, A. Paiusco, T. Fumagalli, and M.S. Giacomello. (2012). The use of laser diodes superpulses in implantology. European Journal of Inflammation. 10(2): 97–100.

[14] F.A. Alshehri. (2016). The role of lasers in the treatment of peri-implant diseases: A review. The Saudi Dental Journal. 2: 103–108

[15] D. Altindal**,** E.A. Alkan**.**, and M. Calisir. (2023).Evaluation of the effectiveness of diode laser therapy in conjunction with nonsurgical treatment of peri-implantitis. Journal *of* Periodontal *&* Implant Science. 53(5):376-387.

[16] A. Roccuzzo,S. Klossner,A. Stähli., J.C. Imber, S. Eick,A. Sculean, and G.E. Salvi. (2022). Non-surgical mechanical therapy of peri-implantitis with or without repeated adjunctive diode laser application. A 6-month double-blinded randomized clinical trial. Clinical Oral Implants Research.1–13.

[17] L. Li, J. Deng, and S. Ren. (2021). The clinical efficacy of Er:YAG lasers in the treatment of peri-implantitis: a systematic review and meta-analysis. Annals of Palliative Medicine. 10(8): 9002-9014

[18] M.B.Máximo, A.C.D. Mendonça, V.R.Santos, L.C.Figueiredo, M.Feres, a nd P.M. Duarte. (2009). Short-term clinical and microbiological evaluations of peri-implant diseases before and after mechanical anti-infective therapies. Clinical Oral Implants Research. 20(1):99-108.

[19] M. Galofré, D. Palao, M. Vicario, J. Nart, and D. Violant. (2018). Clinical and microbiological evaluation of the effect of Lactobacillus reuteri in the treatment of mucositis and peri-implantitis: A

triple-blind randomized clinical trial. Journal of Periodontal Research. 53(3):378-390.

[20] T.Abduljabbar, F.Javed, S.V. Kellesarian, F. Vohra, and G.E. Romanos. (2017).Effect of Nd:YAG laser-assisted non-surgical mechanical debridement on clinical and radiographic peri-implant inflammatory parameters in patients with peri-implant disease. Journal of Photochemistry and Photobiology B: Biology. 168: 16-19.