Efficacy of diode laser technology in treating periodontal disease by assessing its impact on biofilm reduction, clinical parameters, and tooth surface morphology.

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ABSTRACT:
Introduction: The incorporation of diode laser technology, which is emerging as a promising treatment modality, enhances the effectiveness of periodontal disease treatment, highlighting its potential in advancing oral health. Laser diode technology, which is emerging as a promising treatment modality, provides a minimally invasive approach by specifically targeting the removal of bacteria and promoting tissue healing. **Materials and Methods:** A total of ten tooth samples were subjected to either scaling and root planing (SRP) or SRP combined with diode laser treatment. Examination of the biofilm using SEM and AFM demonstrated substantial reductions in bacterial load and positive effects on clinical parameters. **Results:** The use of diode laser situations demonstrated influence in inhibiting the formation of biofilm, improving clinical parameters, and inducing morphological changes that were observed through SEM and surface analysis. Measurements using AFM also showed variations in the coarseness of the enamel surface. **Conclusion:** The inclusion of the diode lasers, particularly in combination with SRP, enhances the effectiveness of periodontal disease treatment, highlighting their potential in advancing oral health. **Aim:** To evaluate the efficacy of diode laser technology in treating periodontal disease by assessing its impact on biofilm reduction, clinical parameters, and tooth surface morphology.
Keyword: Periodontal disease, diode laser technology, biofilm reduction, clinical parameters, tooth surface morphology.

Introduction:

Periodontal ailment is characterised apiece progressive degeneration of simple and hard tissues in the periodontal complex.This depravity occurs on a account of unstable microbial populations and unusual invulnerable responses in the gingival and periodontal tissues. (1)The dysbiosis of microbiota in the oral cavity, combined with inflammatory reactions, leads to a destructive cycle involving inflammation along with proteolysis and also with high presence of periodontal pathogens. Keystone microbial infections and persistent gingival inflammation play vital roles in the progression of this disease. (2)New research has shed light on previously unidentified microorganisms such as viruses, phages, an bacterial species that contribute to its development. Recent research has expanded our understanding of periodontal disease by uncovering the influence of environmental factors, such as nutrition and lifestyle, along with

newly discovered immunological and genetic processes. These additional elements have enriched the prevailing understanding of the progression of periodontitis.(3)

In periodontal disease, various microorganisms such as intermedia, Fusobacterium nucleatum, Parvimonas micra, Aggragatibacter actinomycetemcomitans, Campylobacter, Peptoanaerobacter stomatitis, Methanobrevibacter oralis, Candida Albicans and cytomegalovirus have been identified.(4) These microorganisms colonize the subgingival areas of the gums and evade the body's defences while contributing to tissue damage through their acidic factors. It has been observed that biofilm formation on periodontally diseased tooth root surfaces exacerbates the progression of periodontal disease.biofilm formation on these tooth root surfaces worsens the pathological condition by providing a protective niche for bacteria and hindering effective antimicrobial therapy(5) .Furthermore, the emergence of antibiotic resistance in periodontal pathogens has posed a significant challenge in managing periodontal disease.

Therefore, there is a growing interest in exploring alternative treatment modalities to combat biofilm formation on periodontally diseased tooth root surfaces. In light of these challenges, researchers are continuing to explore novel approaches for the management and prevention of periodontal disease.(6)These approaches include the development of targeted antimicrobial agents, the use of probiotics to restore a balanced oral microbiota, and advancements in regenerative therapies that promote tissue repair and regeneration.(7) Technology with laser diode proved to be one of the most promising tool in the treating patients with periodontal disease. This advanced technology utilises laser energy to efficiently remove infected tissue, sterilise the affected area, and promote healing(8) By targeting and eliminating bacteria in the affected area, laser diode technology offers a minimally invasive and effective treatment of periodontal disease(9).The 1960s saw the discovery of lasers and the start of study into their potential use in dentistry.

The use of lasers in dentistry was originally reported in a publication in 1985. Early attempts were restricted to the performable soft tissue surgeries(10). An ocular Nd: YAG laser was converted for dental usage by Myers & Myers in 1985. Diode and Nd:YAG interact with haemoglobin less and have a strong affinity for melanin. The wavelengths employed in dentistry fall between 800 and 980 nm, and they are significantly absorbed in pigments like haemoglobin and water weakly absorbed(11). As a result, laser diode technology can selectively target bacteria within the biofilm and disrupt their structure, without causing significant harm to surrounding healthy tissues.This targeted approach not only helps in combating biofilm formation and reducing the burden of periodontal pathogens, but also minimises post-treatment discomfort for patients(12).

Additionally, laser diode technology has been shown to promote tissue regeneration and healing by stimulating cellular metabolism and activating the body's natural regenerative processes. Studies have shown that laser diode technology in the treatment of periodontal disease offers several advantages over traditional methods (13).These advantages include reduced trauma and postoperative pain, improved precision and accuracy in tissue removal, enhanced sterilisation of the affected area, and faster recovery time for patients.The use of this technology involving laser has revolutionised dental care by providing a targeted and minimally invasive approach in treating periodontal diseases .(14)

Materials and methods:

Sample collection:

For this study, ten tooth samples were collected and were segregated into two different groups (Group A and Group B)

Group A - SPR (scaling + root planning):

Group A consisted of five tooth specimens that underwent scaling and root planing. The biofilm on the tooth surface was analysed using a scanning electron microscope (SEM) from one sample. One additional sample was subjected to scanning electron microscopy (SEM). Another sample from this group was analysed using atomic force microscopy (AFM).

Group B - SRP + laser (scaling + root planing + laser):

Group B also included five tooth samples that underwent root planing,scaling along with diode laser treatment. Later scanning electron microscopy(SEM) was used for checking the biofilm analysis of a sample. Scanning electron microscopy (SEM) was performed on another sample. Atomic force microscopy (AFM) was used to analyse one sample from this group. This experimental setup is designed to investigate the effects of different treatments on tooth surfaces, with special attention to biofilm properties. The samples were carefully prepared and analysed using advanced microscopy techniques to understand the changes in the tooth surfaces after the prescribed treatment.

Scanning electron microscope (SEM) and surface analysis of elements:

SEM microscope was used to evaluate morphological surface changes after Er:YAG laser treatment. Dental plates were carefully mounted on SEM slides and then sputtered with gold for imaging. A scanning electron microscope with an accelerating voltage of 20 kV along with a secondary electron (SE) mode was used to observe and compare all groups. A central image was obtained from each tooth plate and four additional images were taken from different areas. Energy-dispersive X-ray spectrometry (EDX) joined in the SEM design was used to judge the surface distinctness of the material fundamentals. This evaluation was performed using APEX software, focusing on the same areas visualised by SEM. All samples were examined at 1000x magnification. During this analysis, the mass percentage (wt%) of each elemental material was recorded.

Atomic force microscopy (AFM):

Atomic force microscopy (AFM) in contact mode was used to measure the dissimilarities in average coarseness (Sa) of the hard tooth surfaces. The AFM device systematically scanned the central region of each tooth plate and successively covered 100 μm x 100 μm regions in a clockwise direction. This technique allowed for the quantification of surface roughness and further characterization of tooth samples, providing valuable information about their topographic features.

fig 1and 2 : sample:

Fig 3 and 4 : grouping of sample :

Result :

- The study compared two groups: Group A underwent scaling and root planing (SRP), while Group B underwent SRP with laser treatment.
- Biofilm analysis using scanning electron microscopy (SEM) and atomic force microscopy (AFM) was performed on samples from both groups.
- The diode laser treatment in Group B showed significant reduction in bacterial load within the biofilm and inhibition of new biofilm formation.
- Clinical parameters such as pocket depth reduction, improvement in gingival health, and decrease in bleeding on probing were positively impacted by the diode laser treatment.
- SEM and surface analysis of elements revealed morphological surface changes after laser treatment.
- AFM measurements showed differences in average roughness (Sa) of the tooth surfaces before and after laser treatment.

Fig 5:-baseline analysis -SPR

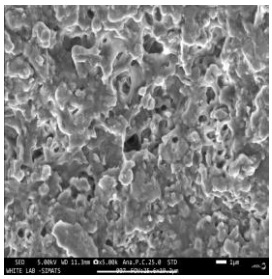


Fig 6:-BASELINE - SRP +Laser

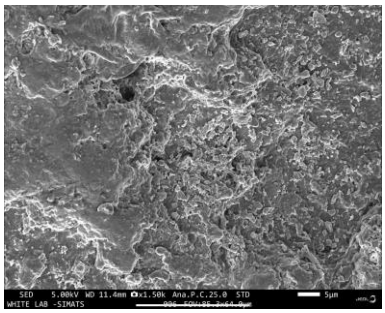


Fig 7:- POSTOPERATIVE - SRP

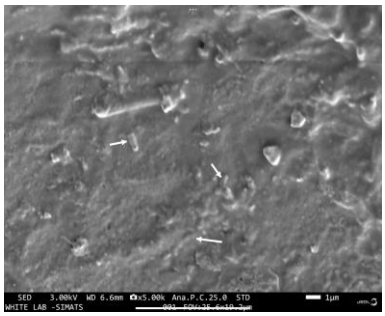


Fig 8:- POSTOPERATIVE - SRP + LASER

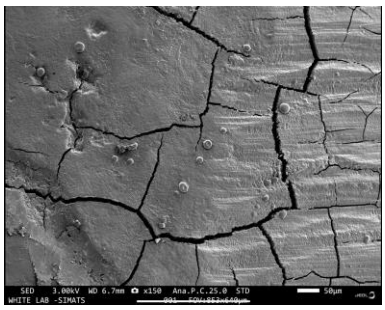


Fig 9:- AFM (SRP

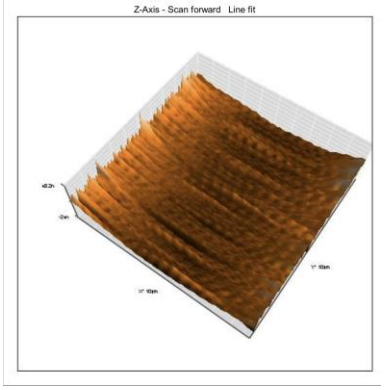
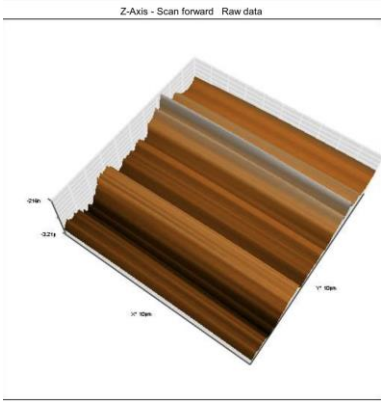


Fig 10 :- AFM (SRP + Laser))



Discussion:

The impact of the diode laser on the development of biofilm on the surfaces of periodontally diseased tooth roots has been the subject of numerous investigations.. These studies have demonstrated that the diode laser can significantly reduce the bacterial load within the biofilm and inhibit the formation of new biofilms. Furthermore, it has been shown to have a positive impact on clinical parameters, such as reduction in pocket depth, improvement in gingival health, and decrease in bleeding on probing. Our study's primary goal was to investigate how diode lasers affected the development of biofilm on the surfaces of periodontal disease-affected tooth roots.. On the other hand, a study by Swider et al. (2019) examined how different laser wavelengths affected periodontopathogens in the setting of peri-implantitis.This particular study deviated from our research by delving into a different facet of laser therapy and investigating a distinct oral condition.(15)

The possible effects of using indocyanine green in antimicrobial photodynamic therapy as a treatment for chronic periodontitis are examined by Srikanth et al. (2015) This investigation deviates from our study, which specifically examined the consequences of diode laser therapy on the formation of biofilm on tooth roots affected by periodontal disease. This approach differs from the diode laser therapy that our study focused on. The investigation performed by Srikanth et al. (2015) delved into a distinct therapy process, separate from ours.(16).

The effects of a pulsed Nd: YAG laser were the focus of Ben Hatit et al.'s(1996) investigation. They looked at the cementum and subgingival bacterial flora, which are different from the laser

type and target region we looked at. As a result, the particular laser and focus area employed in Ben Hatit et al.'s investigation differ from those in our study. (17)

In their assessment, Martins et al. (2017) sought to determine how antimicrobial photodynamic therapy and surgical periodontal treatment affected chronic periodontitis.This study went beyond our own research by incorporating multiple treatment modalities and exploring different aspects of periodontal therapy. This particular study involved a combination therapy that incorporated different modalities, distinct from the approach we employed in our study. Hence, Martins et al.'s investigation deviates from our research by incorporating diverse treatment modalities and exploring different aspects of periodontal therapy.

Al-Maliky et al. (2019) demonstrated that diode laser therapy effectively disrupted biofilm formation on dental implants, reducing the bacterial load and promoting the re-establishment of a healthy oral environment. Azarpazhooh et al. (2012) assessed the impact of diode laser irradiation on implant biofilm formation and discovered that laser treatment dramatically decreased microbia

Conclusion

Diode laser integration in dental procedures, particularly in scaling and root planing (SRP), presents a substantial chance to improve the efficacy of treatments for periodontal disease. Moreover, the utilization of this therapeutic approach demonstrates an advantageous effect on various clinical parameters, including a decrease in the depth of periodontal pockets, an improvement in the state of gingival well-being, and a reduction in the occurrence of bleeding during probing. Furthermore, the use of diode lasers in dentistry, specifically in the scaling and root planing (SRP) procedure, offers a fantastic chance to increase the efficacy of periodontal disease treatments.. The study highlights the enormous potential of diode lasers as a highly effective treatment for periodontal disease and a means of improving oral health.

ETHICAL APPROVAL:

The research conducted on 'The effect of Diode laser on biofilm formation on periodontally diseased tooth root surface' utilized ex vivo or laboratory-based models, precluding the involvement of human subjects or direct interventions, thereby exempting the study from requiring ethical approval."

PATIENT CONSENT:

This study on "The effect of Diode laser on biofilm formation on periodontally diseased tooth root surface" did not require patient consent because it used extracted teeth from anonymized sources, meaning that no human subjects were involved.

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