Use of Diode Laser for Volume reduction of edematous gingival tissue treated with causal therapy: evaluation of clinical efficacy

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Abstract

Aim
The purpose of this study is to evaluate and compare the effectiveness of two different techniques for the treatment of plaque-induced gingivitis, specifically investigating whether laser-assisted causal therapy resolves gingival edema more quickly than traditional causal therapy alone.

Materials and Methods
This study involved 34 patients aged between 20 and 60 years. Initially, all patients underwent a PSR to exclude those with periodontitis. Clinical parameters were recorded, and a baseline scan was performed. Patients rinsed with 0.20% CHX before receiving a professional oral hygiene session. A split-mouth protocol was used, with each patient receiving both experimental therapy (causal therapy plus diode laser) and control therapy (traditional causal therapy) on different hemi-arches, determined by randomization. Patients were instructed on proper oral hygiene techniques to perform at home. Follow-up scans and clinical assessments were conducted at 7- and 14-days post-treatment. The data were analyzed in a double-blind manner.

Results
Analysis of gingival-periodontal health parameters and the volumetric values of treated areas revealed no statistically significant differences between the regions treated with diode laser adjunctive therapy and those treated with traditional causal therapy alone.

Conclusion
Within the limitations of this study, diode laser therapy does not appear to facilitate a faster resolution of gingival edema caused by gingivitis compared to traditional therapy. Both treatment methods effectively reduced inflammation, but the addition of diode laser did not significantly enhance outcomes.

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Keywords

Gingivitis, Periodontal Debridement, Laser Therapy, Periodontal Diseases, Inflammation, Edema.

INTRODUCTION

The primary objective of a dentist is the prevention and, when necessary, the early treatment of oral pathologies, whether they pertain to the oral mucosa, natural teeth, or implant-prosthetic rehabilitations. This necessity is growing, particularly as the increase in average age coincides with the development of various systemic diseases and an increased demand from patients for the functionality and aesthetics of dental elements and their restoration in cases of absence (1-7).
As the population ages, maintaining oral health becomes increasingly critical to ensure overall well-being and quality of life.
Given these circumstances, especially considering the COVID-19 pandemic period, the prevention of dental and implant diseases involving periodontal support tissues through constant patient monitoring is essential to prevent inflammation and infection of periodontal and peri-implant tissues (8-9).
The pandemic has underscored the importance of preventive measures and regular check-ups to maintain oral health and avoid complications.
Gingivitis is generally regarded as a site-specific inflammatory condition resulting from the accumulation of dental biofilm. It is characterized by gingival redness, edema, and the absence of periodontal attachment loss. Gingivitis is typically painless, rarely causes spontaneous bleeding, and is often marked by subtle clinical changes, rendering most patients unaware of the disease or unable to recognize it (10-15).
This underscores the necessity of regular dental visits for early detection and treatment.
A critical feature of gingivitis is its complete reversibility following the removal of dental biofilm. However, gingivitis is of clinical significance as it is considered the precursor to periodontitis, a condition characterized by gingival inflammation combined with connective tissue attachment loss and bone loss (16).
If untreated, gingivitis can progress to periodontitis, leading to more severe oral health issues and potential tooth loss.
The primary cause of this disease is insufficient oral hygiene; however, other potential factors such as smoking, genetic alterations, systemic bacterial diseases, viral or fungal infections, autoimmune or endocrine-based diseases, and traumatic lesions can promote inflammation of periodontal and peri-implant supporting tissues (17). This highlights the importance of comprehensive oral hygiene practices and awareness of risk factors.
Protocols for the treatment of gingivitis include debridement to remove plaque and/or tartar deposits, followed by the reduction and/or elimination of risk factors, and the education and motivation of patients in proper oral hygiene techniques at home. This combination of treatments constitutes causal therapy, so named because it aims to eliminate the cause of gingival inflammation (18).
Effective oral hygiene education is essential for patients to maintain their oral health between dental visits.
Debridement can be performed using manual scalers and/or ultrasonic instruments. Both manual and ultrasonic instrumentation are effective in removing supragingival plaque and tartar and altering the microbiota (19).
The choice of method depends on the patient's specific needs and the clinician's expertise.
Laser treatment has been proposed as a possible therapeutic alternative or adjunct to conventional therapy. The use of diode lasers appears to be an excellent addition to causal therapy, as the specific wavelength of the laser targets bacteria, particularly gram-negative anaerobic bacteria, which are primarily responsible for periodontitis (20).
Laser therapy can reduce pathogenic bacteria, offering an additional tool for managing periodontal disease.
Furthermore, lasers have been observed to stimulate cell proliferation, reduce inflammation, and increase fibroblast production, consequently improving periodontal tissue health (21-28).
This regenerative capability positions laser therapy as a promising adjunctive treatment for enhancing the healing and maintenance of periodontal health.
The purpose of this study is to evaluate and compare two different techniques for the treatment of plaque-induced gingivitis, demonstrating whether laser-assisted causal therapy may allow a resolution of edema, caused by gingivitis, in less time than traditional single causal therapy.

MATERIALS AND METHODS

Sample Selection

This study was conducted on a sample of 34 patients aged between twenty and sixty years, all recruited from the CLID Oral Hygiene and Prevention Centre at San Raffaele Hospital, Milan, Italy. The sample comprised individuals specifically diagnosed with gingivitis (PSR code 1-2). The study protocol received approval from the Local Ethics Committee in Milan (n. PR246), and informed written consent was obtained from all participants in accordance with the Helsinki Declaration.
Inclusion and Exclusion Criteria: Patients selected for the study were in good health and free from systemic and periodontal diseases. Additionally, all participants had completed any antibiotic or anti-inflammatory drug therapies at least two weeks prior to the study. To ensure the homogeneity of the sample, the following inclusion and exclusion criteria were applied:
Inclusion Criteria:

- Age: Patients aged between 20 and 60 years;
- Health Status: Good general health without systemic diseases;
- Gingivitis Diagnosis: Diagnosis of gingivitis with

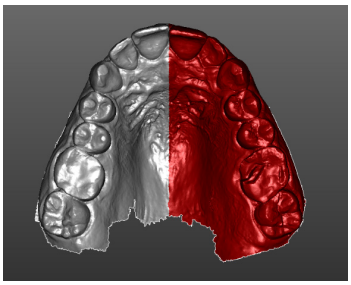

Fig. 1. Visualization of the imported STL files in Optical Revenge Dental 5.0, showing the initial scans before division into hemi-arches (maxilla).

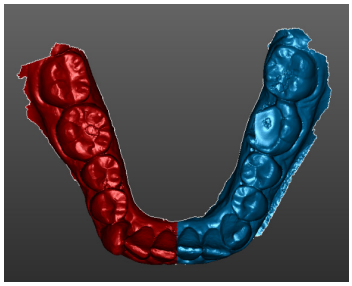

Fig. 2. Visualization of the imported STL files in Optical Revenge Dental 5.0, showing the initial scans before division into hemi-arches (mandible).

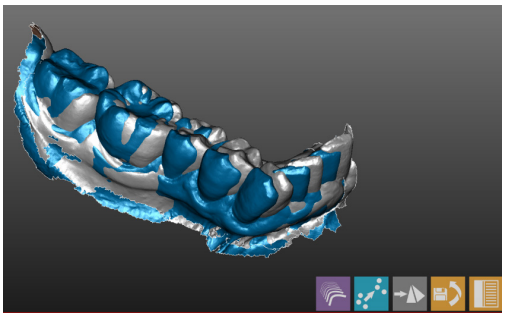

Fig. 3. Automated alignment of two sections of the same subject in the scanning software, initiated by the operator after inserting the second scan.

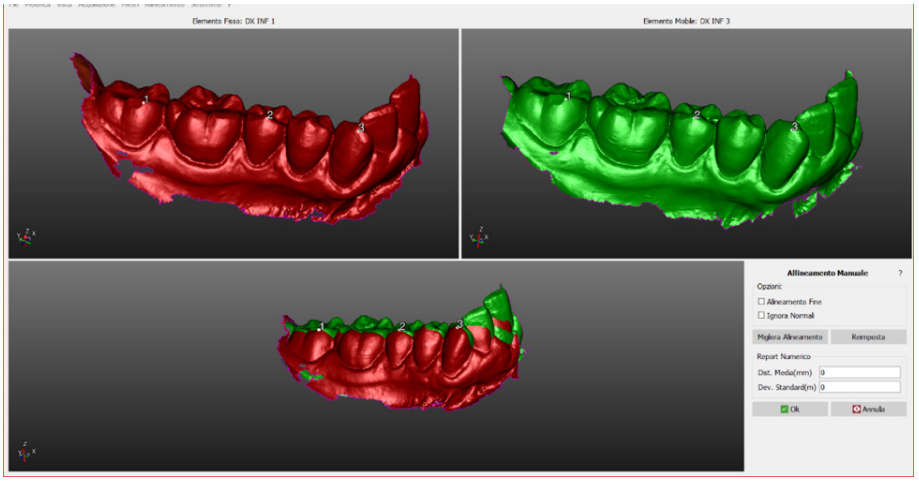

Fig. 4. Manual optimization of the alignment through the selection of reference points, enhancing the precision of the volumetric analysis.

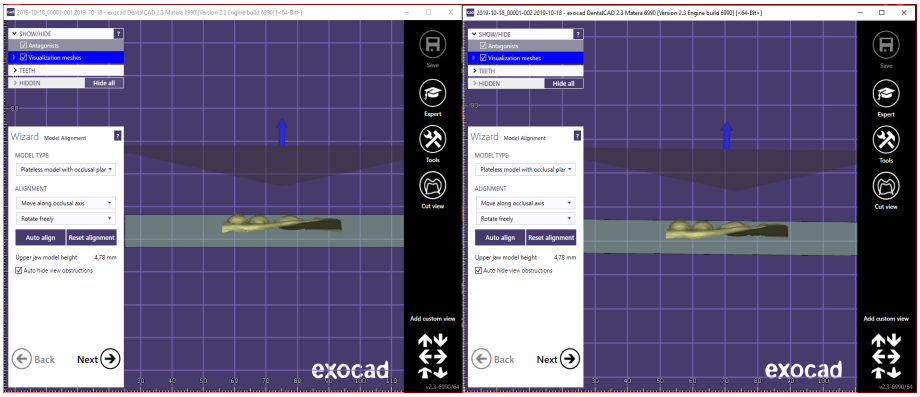

Fig. 5. Visualization of the mesh cleaning and alignment process using Exocad Model Creator, showing the fixed surface base and the parallel positioning of the cleaned impressions for detailed evaluation.

PSR code 1-2;
- Drug Therapy: Completion of any antibiotic or anti-inflammatory therapies at least two weeks before participation;
- Oral Hygiene: Regular oral hygiene practices as assessed during initial consultation.

Exclusion Criteria: Patients with specific diagnoses of non-plaque-induced gingivitis were excluded from the study. Exclusion criteria included:
- Inflammation Caused by Systemic Factors: Such as pregnancy;
- Phlogistic-Hyperplastic Alterations: Related to the intake of antiepileptics, calcium channel blockers, and cyclosporine;
- Gingivitis Induced by Oral Contraceptives;
- Gingivitis Modified by Systemic Diseases;
- Gingivitis in Patients with Diabetes Mellitus;
- Gingivitis Associated with Blood Disorders: Such as leukemia;
- Malnutrition-Modified Plaque Gingivitis: Including chronic deficiencies of vitamins A, C, and D, although these are rare in Europe.

Clinical Protocol

Before initiating the study, each patient was comprehensively briefed about the experimental methods and objectives. This briefing included a thorough explanation of the study's purpose, detailed descriptions of the procedures involved, potential risks, anticipated benefits, and the importance of their participation. Patients

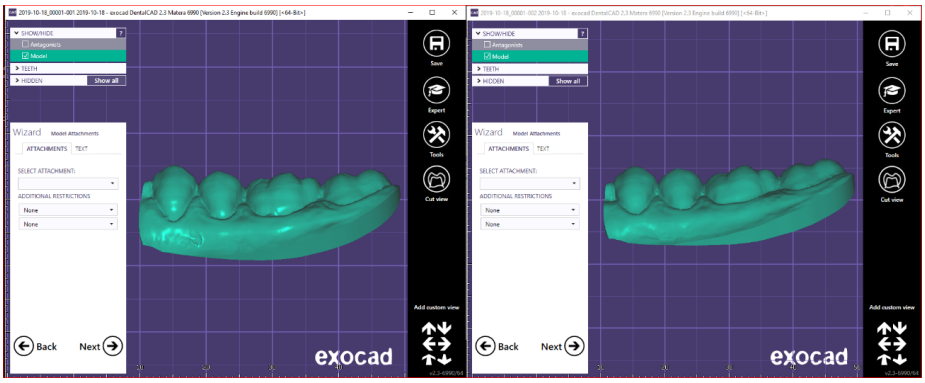

Fig. 6. STL files.

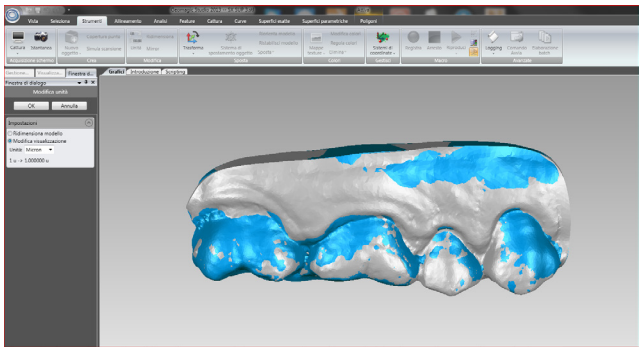

Fig. 7. Importing the files into Geomagic Studio 13 for volumetric analysis, showing the calculated volume in mm².

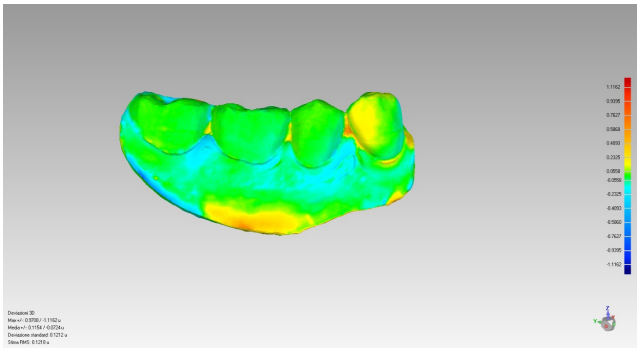

Fig. 8. Colorimetric evaluation of volume using the specialized analysis tool, showing volume differences with blue indicating lower volume, green indicating equal volume, and yellow/red indicating higher volume.

were given ample opportunity to ask questions and clarify doubts. Following this, each patient signed an informed consent form, which detailed the study protocol, ensuring compliance with ethical standards set by the Helsinki Declaration. This consent process ensured that all participants fully understood their role and the nature of the study, providing their voluntary agreement to participate.

Initial Assessment: The initial assessment phase involved performing the Periodontal Screening and Recording (PSR) to exclude individuals with periodontitis. The PSR system utilizes a specially designed probe to measure the depth of periodontal pockets and assess other clinical signs, assigning a score to evaluate periodontal health. This step was crucial in ensuring that only patients with gingivitis (PSR code 1-2) were included in the study. Following the PSR assessment, a comprehensive evaluation and recording of all relevant clinical parameters were conducted. These parameters included gingival redness, edema, the presence of dental biofilm (Plaque Index, PI), Bleeding on Probing (BoP), and probing depth (PPD) measurements.

Baseline Data Collection

Baseline data collection involved capturing detailed 3D images of the oral cavity using Carestream Dental's CS3600 intraoral scanner. This initial scan served as a reference point for subsequent evaluations and provided a detailed record of the patients' oral condition at the start of the study. Immediately after the baseline scan, patients were administered a 0.20% chlorhexidine (CHX) mouth rinse for 30 seconds. Chlorhexidine is known for its antibacterial properties, and the rinse aimed to reduce microbial load, ensuring a cleaner oral environment before treatment.

Professional Oral Hygiene Session and Randomization

Each patient then underwent a professional oral hygiene session. This session included scaling and polishing to remove plaque, tartar, and other debris from the teeth and gums. The study utilized a split-mouth design to compare the efficacy of two treatment modalities. In this design, one half of each patient's mouth was randomly assigned to receive causal therapy combined with diode laser treatment (experimental therapy), while the other half received only traditional causal therapy (control therapy). Randomization was conducted using a simple randomization method, ensuring unbiased allocation and eliminating selection bias.

Home Care Instructions

Following the professional oral hygiene session, patients were provided with comprehensive instructions on maintaining oral hygiene at home. These instructions covered proper brushing techniques, including the use of soft-bristle toothbrushes and fluoride toothpaste, and the importance of flossing to remove interdental plaque. Patients were also advised on the use of mouth rinses if recommended and educated on dietary

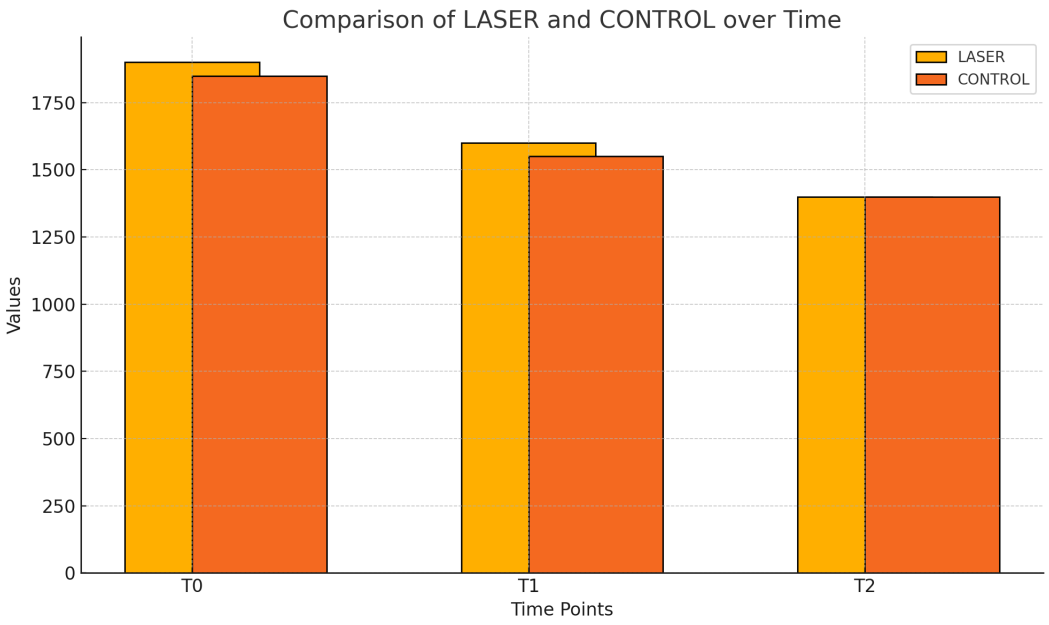

Fig. 9. Histogram comparing the results obtained from the volumetric analysis of the two T0, T1 and T2 therapy groups.

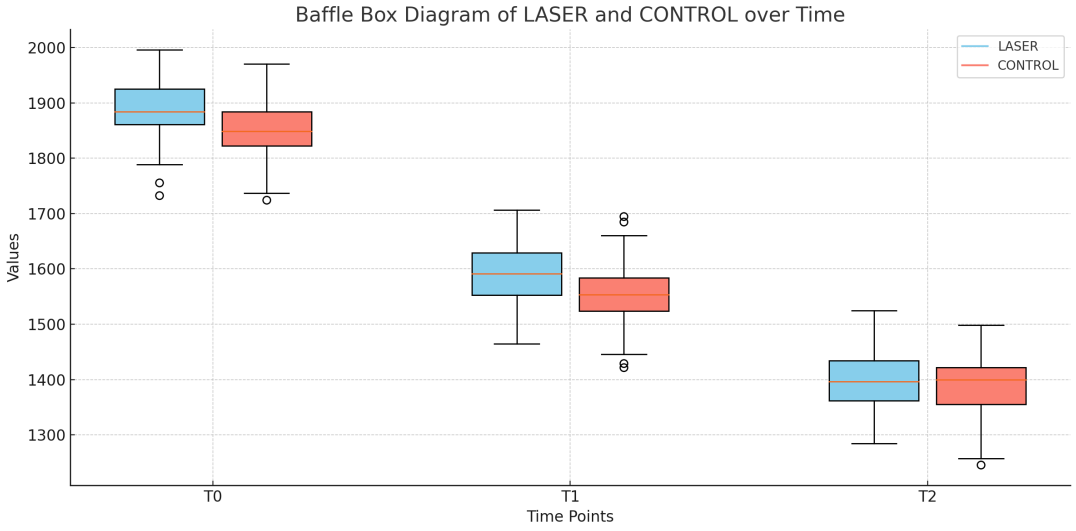

Fig. 10. Baffle box diagram representing the evolution of the experimental and control group at T0, T1 and T2.

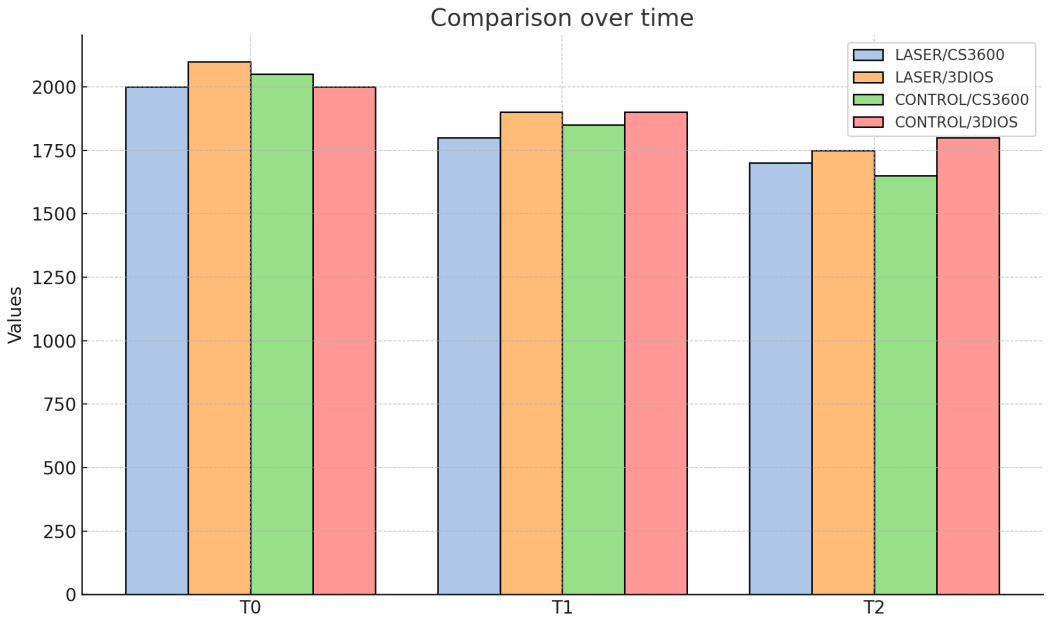

Fig. 11. Histogram comparing the values obtained from the volumetric analysis of patients on which the double scan was carried out.

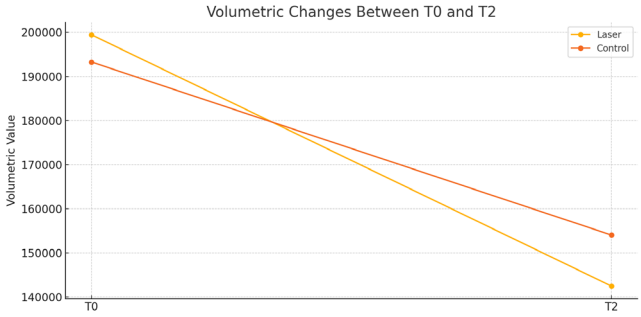

Fig. 12. Volumetric Changes Between T0 and T2

habits that could impact oral health, such as reducing the intake of sugary foods and beverages. Visual aids, demonstrations, and written materials were provided to reinforce these instructions and ensure patients could effectively manage their oral hygiene.

Follow-Up Assessments

Follow-up assessments were scheduled at two intervals: 7 days and 14 days after the initial treatment session. During these visits, control scans were performed using the CS3600 intraoral scanner (Carestream Dental, Atlanta, GA, USA) to monitor changes in the oral cavity. Clinical indices, including gingival inflammation, bleeding on probing, plaque levels, and pocket depths, were re-evaluated and meticulously recorded. Additionally, patients were asked about any adverse effects or discomfort experienced during the study period, ensuring the safety and tolerability of the treatments were monitored and documented.

Use of Diode Laser for Tissue Biostimulation: For the experimental therapy, the Raffaello diode laser (Yoshida Dental Mfg. Co., Tokyo, Japan), a Class 2b medical device, was employed. The specific wavelength of the diode laser was selected for its effectiveness in targeting periodontal pathogens, particularly gram-negative anaerobic bacteria responsible for periodontitis. The biostimulatory properties of the laser, including its ability to promote cell proliferation, reduce inflammation, and enhance tissue regeneration, were leveraged to improve treatment outcomes. The laser treatment was applied according to a standardized protocol, ensuring consistent application across all patients.

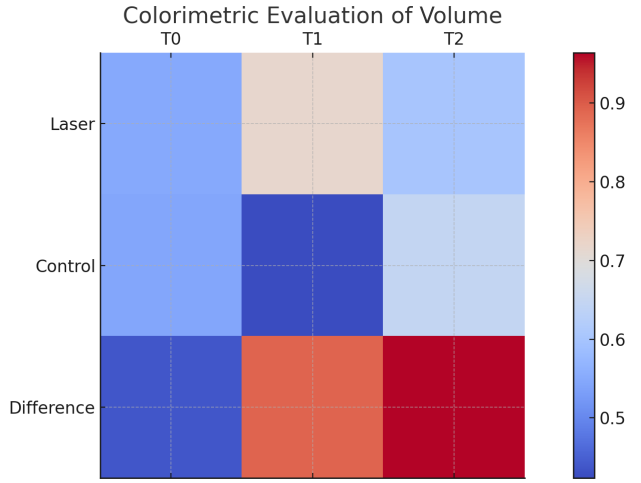

Fig. 13. Colorimetric evaluation of gingival volume.

Intraoral Scanning Protocol

Intraoral scanning was a critical component of the study, providing detailed 3D images of the patients' oral cavities. The primary device used was the CS3600 intraoral scanner (Carestream Dental, Atlanta, GA, USA). Additionally, for a subset of 6 patients, the Myray's 3Dios scanner (Cefla S.C., Imola, Italy) was employed as an additional control method. Intraoral scans were taken at three key points: at the beginning of the therapy, and during the two follow-up phases. These scanners captured 3D images of the following regions:

- Mandible: Including the entire lower dental arch and surrounding tissues.
- Maxilla: Including the entire upper dental arch and surrounding tissues.
- Buccal-occlusal surfaces: Including the buccal (cheek side) and occlusal (biting surfaces) views.

The acquisition interface of both scanners allowed for capturing images in two distinct modes:

1. Partial Arch Scanning: This mode focused on several teeth in the preparation area on both the mandible and maxilla, along with a buccal-occlusal recording. This method provided highly detailed images of specific areas requiring close examination and treatment planning.
2. Complete Arch Scanning: This comprehensive mode included the entire mandible, maxilla, and buccal-occlusal surfaces, providing a full overview of the oral cavity. This complete scan ensured that no area was overlooked and facilitated comprehensive monitoring of the treatment's effects.

The detailed imaging process facilitated precise monitoring of clinical outcomes, enabling thorough analysis and comparison of the effectiveness of the experimental and control therapies. The use of advanced intraoral scanners provided high-resolution images that were essential for accurate assessment and documentation.

Data Analysis and Outcome Measurement

The data collected from the clinical assessments and intraoral scans were meticulously analyzed to measure the outcomes of the experimental and control treatments. Statistical analysis was performed to compare the reduction in gingival inflammation, plaque levels, bleeding on probing, and pocket depths between the two treatment groups. The effectiveness of the diode laser in conjunction with causal therapy was evaluated against traditional causal therapy alone. The analysis aimed to determine the added benefits of laser therapy in managing gingivitis and improving periodontal health.

n of subjects	34
male	19
female	15
Average age ± DS	39.8 ± 14.3
minimum age	20
maximum age	58

Tab 1. Basic demographic data of the sample.

IP	VOL. MEDIAN (IQR1-IQR3)	VOL. AVERAGE (SD)
T0	LASER	54 (39-77)
	CONTROL	54 (41-75)
T1	LASER	10 (8-13)
	CONTROL	11 (10-20)
T2	LASER	10 (7-13)
	CONTROL	12 (10-19)

Tab 2. PI parameters reported as median (IQR1-IQR3) and average (SD).

BoP	VOL. MEDIAN (IQR1-IQR3)	VOL. AVERAGE (SD)
T0	LASER	31 (23-54)
	CONTROL	34 (28-45)
T1	LASER	3 (0-6)
	CONTROL	3 (1-6)
T2	LASER	2 (0-5)
	CONTROL	3 (1-5)

Tab 3. BoP parameters reported as median (IQR1-IQR3) and average (SD).

Reporting and Follow-Up

Upon completion of the study, the results were compiled and presented in a detailed report. The findings were shared with the patients, and follow-up care was provided as needed. Patients were encouraged to continue regular dental visits and maintain proper oral hygiene practices to sustain the benefits achieved during the study. Long-term follow-up studies were suggested to assess the durability of the treatment outcomes and the potential for recurrence of gingivitis or progression to periodontitis.

Statistical Analysis

The data collected were analyzed using IBM SPSS Statistics software (IBM Corp., Armonk, NY, USA). The purpose of the statistical analysis was to investigate any differences in volumetric variations and gingival-periodontal health parameters between the two therapy groups and within the same groups at each control point. To ensure the reliability and impartiality of the results, a double-blind analysis was conducted, where the operator performing the statistical and volumetric analyses was unaware of the group assignments of the data collected from the patients.

The normality of the data distribution was assessed using the Shapiro-Wilk test. Due to the irregular distribution of the data, non-parametric methods were applied for the analysis. Specifically, the Mann-Whitney U test was utilized to compare the two therapy groups. This test was chosen because it is suitable for non-normally distributed data and provides a robust comparison of the median values between the groups. The comprehensive statistical evaluation aimed to rigorously assess the efficacy of the two therapy modalities by comparing changes The comprehensive statistical evaluation aimed to rigorously assess the efficacy of the two

Volumetric Values	VOL. MEDIAN (IQR1-IQR3)	VOL. AVERAGE (SD)
T0		
SUP	LASER	182716 (159550;2038)
	CONTROL	174478 (153243;200798)
INF	LASER	199428 (171989;219775)
	CONTROL	193256 (175860;206012)
T1		
SUP	LASER	161343 (137177;182945)
	CONTROL	152097 (121954;162075)
INF	LASER	159581 (146246;198964)
	CONTROL	1748455 (156198;191156)
T2		
SUP	LASER	132744 (121958;1561305)
	CONTROL	135093 (120881;1535064)
INF	LASER	142475 (125364;160584)
	CONTROL	154054 (14479;17258)
T2-T0		
	LASER	-43881 (-57283;-300)
	CONTROL	-31726 (-55352;-21242)

Tab 4. Reported volumetric values as median (IQR1-IQR3) and average (SD).

therapy modalities by comparing changes in volumetric measurements and gingival-periodontal health parameters, thereby providing valuable insights into the relative benefits of each treatment approach.

Processing of collected data

At the beginning, all scans, which were presented in STL format, were imported into the data collection software. The STL files were then imported into the scanning software Optical Revenge Dental 5.0 (Optical Revenge S.r.l., Milan, Italy). Once both scans, obtained simultaneously from the same mouth in hemi-arch, were imported, they were divided by creating a section that included the elements of the posterior sectors. This process allowed the operator to obtain four hemi-arches from each individual scan (Fig. 1, Fig. 2).
Once these sections were obtained, sectoral alignment was carried out to proceed with the volumetric analysis. This operation allowed the alignment of two sections of the same subject, which automatically took place thanks to the software after the operator, having inserted a second scan, gave the command to align the second scan on the previous one (Fig. 3). Subsequently, the alignment was manually optimized through the choice of reference points (Fig. 4).
In the second phase, the hard tissues were used as reference points. Once superimposed, the images were paired with two different colors for an initial visual analysis: the most similar files had alternating colors. Files that were entirely or partially different showed large discrepancies, with one color prevailing over the other. After the alignment procedure, mesh cleaning operations were carried out to determine the areas to be analyzed. To create a model for each individual scan and perform a detailed evaluation, Exocad Model Creator (Exocad GmbH, Darmstadt, Germany) was used. This software allows a fixed surface to be used as the base of the section, and the impressions, once the cleaning operations have been carried out, were positioned parallel to the surface (Fig. 5).
This step was taken for the sections of both scans, ensuring that the two sections had the same identical distance at the highest point, which closed previously opened STL files (Fig. 6).
This procedure was necessary to create two completely overlapping sections to continue with the volumetric analysis. Finally, the files were imported into the software named Geomagic Studio 13 (3D Systems, Rock Hill, SC, USA). This software allowed for the calculation of volume in mm^2, with the unit of measurement established as mm (Fig. 7).
As both numerical values were available, it was possible to calculate the difference between them. In conclusion, a colorimetric evaluation was conducted using a specialized analysis tool that evaluated the volume using a colorimetric scale. This tool used µm (micrometers) as the reference unit of measurement and enabled the assessment of the volume of an area or entire section through a colorimetric scale involving three colors: blue for lower volume, green for equal volume between sections, and yellow/red for higher volume (Fig. 8). To perform all these evaluations accurately, it was necessary for the files to be as similar as possible. Therefore, sections of the obtained scans were created.

RESULTS

All subjects completed the entire study without reporting any negative effects such as discomfort, burning sensation, tooth hypersensitivity, or laser-related pain. The basic demographic data of the sample are summarized in Table 1.
Both the experimental group and the control group showed improvements in clinical parameters such as the plaque index (IP) and bleeding on probing (BoP). However, there was no statistically significant difference between the diode laser group and the traditional causal therapy group (p-value > 0.05). These results are detailed in the following tables (Table 2, Table 3).
The figure illustrates the reduction in clinical indices (IP and BoP) for both groups at T0 (baseline), T1 (mid-study), and T2 (end of study). It clearly shows that both groups experienced significant improvements over time (Fig. 9). This indicates that both treatment modalities are effective in reducing plaque accumulation and gingival inflammation over the course of the study.
Volumetric Analysis: Both the experimental and control groups showed a reduction in the volume of gingival edema by at least 20%. The laser-treated group, in addition to traditional causal therapy, achieved a greater reduction in gingival volume (24% compared to 20% in the control group). However, there was no statistically significant difference between the two groups (p-value > 0.05). The volumetric values obtained are shown in Table 4.
The figure provides a histogram comparing the volumetric analysis results for the two therapy groups at T0, T1, and T2. It highlights the overall reduction in gingival volume for both groups over the study period (Fig. 10). This histogram visually demonstrates that while both treatments are effective, the addition of laser therapy does not provide a statistically significant advantage over traditional therapy alone.
The data obtained from the six patients who underwent double scanning with the 3Dios scanner were analyzed. There were no statistically significant differences (p-value > 0.05) between the scans obtained during the various control times with the CS3600 intraoral scanner and 3Dios scanner. A histogram comparing the volumetric analysis values obtained from the two different scanners was created (Fig. 11). This comparison ensures that the scanning methods used are reliable and consistent across different devices.
Volumetric Changes: This graph illustrates the compar-

ison of volumetric changes between the experimental group (Laser) and the control group (Control) from T0 (baseline) to T2 (end of study). The data show a reduction in gingival volume over time for both groups. The Laser group demonstrated a more substantial decrease in gingival volume compared to the Control group, highlighting the effectiveness of laser treatment in reducing gingival edema (Fig. 12). This indicates that while both therapies are effective in managing gingivitis, laser-assisted therapy may offer additional benefits in reducing gingival volume more efficiently.
Colorimetric Evaluation: This colorimetric evaluation visualizes the volumetric changes across different time points (T0, T1, T2) for the Laser and Control groups. The colorimetric scale ranges from blue, indicating lower volume, to green for equal volume, and yellow/red for higher volume. This visual representation aids in assessing the volumetric differences more clearly. Each row represents the Laser, Control, and Difference respectively, showcasing the variations in volume across the study period (Fig. 13). This colorimetric approach provides an intuitive and immediate understanding of how the gingival volume changes over time, with color variations highlighting areas of significant reduction or stability.

DISCUSSION

The results of our study provide insight into the ongoing debate surrounding the efficacy of diode laser treatment in managing plaque-induced gingivitis. Gingivitis, characterized by the inflammatory response of gingival tissues due to bacterial plaque accumulation, remains highly prevalent across all age groups and is recognized as the most common form of periodontal disease (29, 30). Effective clinical management of gingivitis is crucial for preventing the progression to periodontitis, with common clinical signs including erythema, edema, and bleeding (31).
Our study aimed to determine whether adjunctive diode laser therapy could expedite the resolution of gingival edema compared to traditional causal therapy alone. The findings indicate that both the experimental (diode laser) group and the control (traditional therapy) group experienced a reduction in edema over the treatment period. However, no statistically significant differences were observed between the two groups regarding clinical parameter improvements and edema reduction (32-37). These results align with the broader literature on the subject, which presents mixed findings. The role of diode lasers in periodontal therapy, particularly gingivitis, has been explored by various researchers with differing conclusions. For instance, T. Qadri et al.'s systematic review in 2016 suggested that combining scaling and root planing (SRP) with low-level laser therapy (LD, 800-980 nm) was more effective than SRP alone (38). This view supports the potential benefit of laser treatment in enhancing clinical outcomes, possibly due to the laser's ability to target and reduce bacterial biofilm and inflamed tissues effectively. Diode lasers' high absorption by blood hemoglobin might also contribute to their effectiveness in removing highly vascularized inflamed tissues, thereby reducing the signs of inflammation.
Conversely, D. E. Slot et al.'s systematic review found no significant advantages in clinical attachment level (CAL) and probing pocket depth (PPD) when comparing sites treated with diode laser (808-980 nm) plus SRP to those treated with SRP alone. However, Slot et al. did note a greater reduction in bleeding scores in the laser-treated group, suggesting some benefit in managing inflammation (39). This indicates that while diode lasers may not significantly improve all clinical parameters, they could still offer advantages in reducing specific symptoms such as bleeding. The ability of diode lasers to mitigate bleeding could be particularly beneficial in clinical settings where inflammation management is a primary concern.
Further complicating the narrative, F. Sgolastra et al.'s meta-analysis reported no statistically significant differences in clinical parameters between sites treated with diode laser plus SRP and those treated with SRP alone (40). This inconsistency in the literature highlights the need for more robust, large-scale studies to conclusively determine the efficacy of diode laser therapy in periodontal treatments. The variability in study designs, laser parameters, and treatment protocols across different studies could contribute to the conflicting results observed. Therefore, standardized methodologies and consistent treatment protocols are essential for accurately assessing the true benefits of diode laser therapy.
Our study contributes to this discourse by reaffirming the lack of significant difference between diode laser-assisted therapy and traditional therapy in reducing gingival edema. Both methods proved effective in decreasing inflammation over time, reinforcing the importance of conventional periodontal treatment protocols. This finding underscores the effectiveness of traditional SRP in managing gingivitis and suggests that while diode lasers might offer additional benefits, they are not necessarily superior to established treatment methods. It also emphasizes the need for clinicians to consider individual patient responses and preferences when incorporating new technologies into treatment plans.
The role of dental hygienists remains critical in monitoring patient adherence to oral hygiene practices and follow-up programs to prevent gingivitis or manage its symptoms effectively (17, 18). Their expertise ensures that both traditional and adjunctive therapies are applied correctly and that patients maintain good oral hygiene practices, which are foundational to preventing and managing gingivitis. Dental hygienists play a

vital role in educating patients about the importance of maintaining oral hygiene and providing personalized care plans to address individual needs. Their ongoing support and monitoring can help ensure the success of both traditional and adjunctive therapies, ultimately leading to better patient outcomes.

CONCLUSION

In conclusion, while our study did not find significant differences between diode laser-assisted therapy and traditional causal therapy in reducing gingival edema, both methods effectively decreased inflammation over time. This outcome highlights the efficacy of conventional periodontal treatments, such as scaling and root planing, in managing gingivitis and reducing associated symptoms like redness, edema, and bleeding.

The diode laser, although not shown to be significantly superior in this study, still demonstrated potential benefits. These include the precise targeting of inflamed tissues, potential bactericidal effects, and biostimulatory properties that could enhance tissue healing and reduce inflammation more effectively in certain cases. The laser's ability to reach and treat areas that might be difficult to access with traditional tools could offer advantages in comprehensive periodontal care, particularly for patients with complex cases of gingivitis or those who do not respond well to conventional treatments.

However, the lack of statistically significant differences in our findings suggests that the laser should be considered as an adjunct rather than a replacement for traditional therapies. The results underscore the importance of maintaining high standards in conventional periodontal practices, while also being open to integrating new technologies that could complement these methods.

Future research should focus on larger, well-designed studies to further explore the potential advantages of diode lasers and clarify their role in periodontal therapy. Such studies should aim to standardize laser parameters, treatment protocols, and assessment methods to reduce variability and enhance the reliability of results. Additionally, investigating the long-term effects of diode laser therapy on periodontal health, patient comfort, and overall treatment outcomes will provide more comprehensive insights into its efficacy.

Furthermore, examining patient-specific factors, such as age, severity of gingivitis, and overall health, could help identify which subgroups might benefit the most from laser-assisted therapy. Understanding these nuances will allow clinicians to tailor treatments more effectively and improve patient outcomes.

In addition to clinical parameters, future studies could also evaluate patient-reported outcomes, such as pain, satisfaction, and quality of life, to provide a holistic view of the benefits and drawbacks of diode laser therapy. These insights will be crucial for integrating patient perspectives into clinical decision-making and ensuring that treatments align with patient preferences and needs.

Overall, while diode laser therapy shows promise, it is essential to continue rigorous research and clinical evaluation to determine its optimal use in periodontal therapy. The integration of new technologies like diode lasers into dental practice should be based on robust evidence and a clear understanding of their benefits and limitations. As the field of periodontal therapy evolves, embracing both traditional and innovative approaches will be key to providing the best possible care for patients.

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