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Comparative Study of Nd: YAG Laser and Platelet-Rich Plasma (PRP) in the Treatment of Periodontitis Using a Split-Mouth Design

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ABSTRACT

Aim: This study aimed to compare the efficacy of ND: YAG laser and PRP in the treatment of chronic periodontitis using a split-mouth design. **Subjects and Methods:** A randomized clinical trial was conducted on 30 patients diagnosed with chronic periodontitis. Each patient received ND: YAG laser treatment on one side of the mouth and PRP on the other. Clinical parameters include Probing Depth (PD), and Gingival Index (GI). Clinical Attachment Level (CAL), Plaque Index (PI), and radiographic bony defect were assessed at baseline, 1 month, and 6 months post-treatment. The Mann- Whitney U test was used for statistical analysis. **Results:** Treatment with the ND: YAG laser led to a significantly larger decrease in all clinical parameters when contrasted with the PRP treatment. This was statistically significant at both the 1-month and 6-month post-treatment evaluations (p\<0.001). Those who received ND: YAG laser treatment showed reductions in PD, GI, CAL, PI, and radiographic bony defects. **Conclusion:** The ND YAG laser treatment demonstrated superior efficacy over PRP in the management of chronic periodontitis. These findings suggest that the ND YAG laser could be a more effective treatment modality for chronic periodontitis, contributing to improved patient outcomes. However, future studies with larger sample sizes and longer follow-up periods are warranted to confirm and extend these findings modality

KEYWORDS

Chronic periodontitis, ND YAG laser, Platelet Rich Plasma, PRP, split-mouth design, randomized clinical trial.

INTRODUCTION

Periodontitis, an advanced oral disease, is characterized by chronic inflammation of the periodontal tissues that support and surround the teeth 1. Often a consequence of poor oral hygiene, this condition is marked by the accumulation of dental plaque that harbors bacteria. If not properly managed, these bacteria produce toxins that trigger an inflammatory response in the gum tissue, leading to periodontitis[(1)]. The World Health Organization reports that nearly 10% of the global population is affected by periodontitis, underscoring its importance as a public health issue[(2)].

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Beyond being a dental issue, untreated periodontitis can result in tooth loss and has been linked with systemic health complications. Clinical research has shown associations between periodontitis and increased risk of cardiovascular diseases, diabetes, and adverse pregnancy outcomes, among other health conditions[3].

The primary goal of periodontitis treatment is to control the infection and consequently stall the progression of the disease. Traditional treatment strategies for periodontitis are divided into non-surgical and surgical procedures[4].

Non-surgical treatments are usually the initial defense against periodontitis. These include scaling and root planning—deep-cleaning procedures that remove plaque and tartar deposits on the tooth and root surfaces. Antimicrobial agents and antibiotics may also be utilized to manage bacterial infection, either systemically or locally delivered into the periodontal pockets[5].

If non-surgical interventions are insufficient, surgical treatments, such as flap surgery, bone grafts, or tissue grafts, are recommended[6].

Despite the proven effectiveness of these traditional treatments, they bear limitations, including patient discomfort and potential complications. Hence, the continuous pursuit of novel, minimally invasive therapeutic alternatives[7].

A promising alternative treatment modality is the use of Platelet-Rich Plasma (PRP). PRP, a concentration of platelets in a small volume of plasma, boasts a rich content of growth factors that promote wound healing and tissue regeneration[8, 9]. In periodontitis treatment, PRP has been used to enhance healing following periodontal surgery, particularly in bone grafting procedures, stimulating bone regeneration and soft tissue healing, and leading to improved clinical outcomes. However, while initial results are encouraging, more extensive clinical trials are needed to definitively establish the effectiveness of PRP in periodontitis treatment[10, 11].

Another innovative approach is the use of lasers in periodontal therapy, specifically, the Neodymium-Doped Yttrium Aluminum Garnet (ND: YAG) laser. The Nd: YAG laser, operating at a wavelength of 1064 nm, demonstrates high absorption in hemoglobin and melanin, which provides excellent hemostasis and appropriate penetration depth into soft tissue. This quality enables the laser to access and disinfect periodontal pockets, remove the pocket sulcular epithelium, and reduce the microbial load. Moreover, the Nd: YAG laser exhibits a bactericidal effect on periodontal pathogens, potentially aiding in disease control[12].

The use of the Nd: YAG laser in periodontal therapy may offer several advantages over traditional therapies, such as less postoperative discomfort, improved healing, and reduced treatment time. It has been shown to promote wound healing and tissue regeneration, paralleling the effects seen with PRP therapy. Additionally, the Nd: YAG laser can cause less bleeding, swelling, and discomfort compared to traditional periodontal surgery, thereby offering a more patient-friendly alternative[12, 13].

Despite these benefits, a comprehensive understanding and acceptance of laser therapy in periodontitis treatment are still forthcoming. More robust, high-quality randomized controlled trials are necessary to confirm the safety and efficacy of ND: YAG laser treatment in periodontitis and to compare it with traditional treatments and other novel therapies like PRP[14]. This study aims to evaluate and compare the effectiveness of ND: YAG laser and Platelet-Rich Plasma (PRP) therapy in treating chronic periodontitis.

PATIENTS AND METHODS

The study will be conducted in the Department of Oral Medicine and Periodontology, Faculty of Dentistry, Zagazig University. It will involve 30 patients. The proposed study will utilize a split-mouth design, in which each patient's mouth will be divided into two sides. One side will undergo

treatment with Platelet-Rich Plasma (PRP), while the other side will be treated with the Neodymium: yttrium-aluminum-garnet (Nd: YAG) laser. This design allows for each patient to serve as their control, minimizing the effects of inter-individual variability.

Inclusion Criteria:

1. Only patients who have been diagnosed with chronic periodontitis will be included in the study.
2. Adults aged 25 years and above.
3. Presence of Periodontal Pockets: Patients must have at least two non-adjacent teeth with periodontal pockets measuring 5mm or greater. This ensures that the disease is at a stage where the effects of the treatments can be effectively measured.
4. There must be radiographic evidence of bone loss on both sides of the patient's mouth. This is another indicator of the severity of the periodontitis and will help in assessing the efficacy of the treatments.

Exclusion Criteria:

1. Patients with good general health without any history of systemic disease
2. Pregnant women
3. Patients who are smokers
4. Patients who have received periodontal treatment within the past six months
5. Patients who have used antibiotics or anti-inflammatory drugs within the past three months
6. Patients who were willing to cooperate and complete the duration of the study were included.

Preoperative Assessment:

Clinical periodontal parameters, including probing depth (PD), clinical attachment level (CAL), gingival index (GI), and plaque index (PI), will be recorded. Radiographic examinations will be conducted to assess alveolar bone levels.

Surgical Procedure:

Under local anesthesia, SRP will be performed on both sides of the mouth. For the PRP side, PRP will be prepared according to established protocols and injected into the periodontal pockets after SRP[^10^]. For the Nd: YAG side, laser treatment will be conducted at specified parameters following SRP.

Preparation of Platelet Rich Plasma (PRP)

1. The procedure for PRP preparation was based on the method described by Kazuhiro Okuda et al.
2. An hour before the periodontal surgery, 8-10 ml of whole blood was drawn from the patient's antecubital vein.
3. The blood was collected in a vacutainer that contained a 10% citrate anticoagulant solution.
4. The tubes were inverted multiple times to ensure thorough mixing of the blood and the anticoagulant.
5. The sample tube was then centrifuged in a standard centrifuge for 10 minutes at 2400 rpm.
6. This process separated the PRP and platelet-poor plasma (PPP) from the red blood cell fraction.
7. The PPP was discarded, leaving approximately 1 ml of PPP present above the buffy coat.
8. The 1ml of PPP, the entirety of the buffy coat, and 1ml of the red blood cell fraction rich in newly synthesized platelets were pipetted out and transferred to another test tube without an anticoagulant.
9. These test tubes were then centrifuged again, this time at 3600 rpm for 15 minutes. This process further separated PRP from PPP.

10. The PRP was then collected in syringes and kept ready for application during the surgical procedure.

Treatment Procedure using Nd: YAG Laser

1. The Nd: YAG laser used in the study had a wavelength of 1064 nm and a fiber diameter of 320μm.
2. The treatment involved a single session with two entrances of the laser fiber into the periodontal pocket.
3. Safety glasses were worn by the patient, the dental assistant, and the operator to prevent eye damage.
4. Local anesthesia was administered to the patient if there was pain.
5. During the first pass into the pocket:
   - The laser was set at 3 W power.
   - The laser was set to micro-short pulse mode with a pulse width of 100μs and frequency of 20 Hz.
   - The laser fiber was placed parallel to the root surface of the tooth.
   - The fiber was moved from the base of the pocket with a lateral and coronal motion.
   - The treatment was applied to all six sites of the tooth.
6. Before the second laser passed into the pocket, root surface debridement was performed using a piezo-ultrasonic device.
   - This was done to remove any residual debris, calculus, and infected cementum.
7. During the second pass into the pocket:
   - The laser was set at 4 W power.
   - The laser was set to very long pulse mode with a pulse width of 600μs and frequency of 20 Hz.
   - This setting was intended to create a sticky and thick fibrin clot.

Postoperative Assessment and Follow-up Schedule:

Patients will be recalled at 1, 3, and 6 months postoperatively. The same clinical periodontal parameters will be evaluated at each recall visit.

Outcome assessment

Primary Outcomes:

1. Clinical Attachment Level (CAL): The CAL measurement provides an assessment of the periodontal tissue's health and attachment to the tooth. It's one of the most crucial parameters to assess disease progression and treatment effectiveness. A decrease in CAL indicates an improvement in periodontal health.
2. Probing Depth (PD): The depth of periodontal pockets is a significant indicator of periodontitis severity. A decrease in PD signifies a reduction in inflammation and an improvement in the health of periodontal tissues.

Secondary Outcomes:

1. Gingival Index (GI): This index measures the severity of gingivitis based on color, size, consistency, and bleeding on probing. A decrease in the GI score indicates improvement in gingival health.
2. Plaque Index (PI): This index assesses the amount of plaque, which is a significant cause of periodontal disease. A decrease in the PI score signifies better oral hygiene and a lower risk of disease progression.
3. Radiographic Bony Defect: Radiographs are used to evaluate the amount and pattern of bone loss around the teeth. Improvement in the radiographic bony defect indicates the successful regeneration of bone tissue, an essential aspect of periodontitis treatment.

Outcomes will be evaluated at baseline,

Immediately post-treatment, and at follow-Up visits at 1.3 and 6 months post-treatment.

Statistical analysis

Data were analyzed using SPSS software (version 25.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated for all clinical variables. The differences in clinical variables between the ND YAG laser treatment group and PRP treatment group at 1 month and 6 months post-treatment were analyzed using the Mann- Whitney U test, which is a non-parametric statistical test used to compare two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed, and the chi-square test for categorical variables. Statistical significance was set at $p<0.05$.

RESULTS

This study provides an informative comparison of the Neodymium-Doped Yttrium Aluminum Garnet (ND: YAG) Laser and Platelet-Rich Plasma (PRP) treatments for chronic periodontitis, with data collected at baseline, and then one and six months after treatment. The key indicators measured include Probing Depth (PD). Gingival Index (GI). Clinical Attachment Level (CAL), Plaque Index (PI), and Radiographic Bony Defect.

In Table 1, the Probing Depth (PD) data demonstrates that both the MD YAG Laser and PRP treatments were effective in significantly reducing PD. However, the ND: YAG Laser treatment outpaced PRP by achieving a lower PD, a difference that was statistically significant at both the one and six-month evaluations.

Table (1) *Probing Depth (PD)*

	Baseline	1 month	6 months
ND: YAG	6.5 ± 0.8	3.1 ± 0.5	2.8 ± 0.4
PRP	6.4 ± 0.7	4.3 ± 0.6	4.1 ± 0.5
p-value	>0.05	<0.001	<0.001

Table 2, which presents the Gingival Index (GI) results, shows a similar trend. Both treatments succeeded in reducing the GI from the baseline. Yet, the ND: YAG Laser treatment had a statistically significant greater reduction than the PRP treatment at both the one and six-month intervals.

Table (2) *Gingival Index (GI)*

	Baseline	1 month	6 months
ND: YAG	2.3 ± 0.5	1.1 ± 0.3	1.0 ± 0.2
PRP	2.2 ± 0.4	1.6 ± 0.3	1.5 ± 0.3
p-value	>0.05	<0.001	<0.001

The Clinical Attachment Level (CAL), shown in Table 3, was also significantly reduced by both treatments from the baseline. However, the ND XAG Laser treatment led to larger decreases in CAL than the PRP treatment at both one and six months post-treatment, with these differences being statistically significant.

	Baseline	1 month	6 months
ND: YAG	2.3 ± 0.5	1.1 ± 0.3	1.0 ± 0.2
PRP	2.2 ± 0.4	1.6 ± 0.3	1.5 ± 0.3
p-value	>0.05	<0.001	<0.001

	Baseline	1 month	6 months
ND: YAG	7.5 ± 1.1	4.0 ± 0.7	3.6 ± 0.6
PRP	7.4 ± 1.0	5.2 ± 0.8	5.0 ± 0.7
p-value	>0.05	<0.001	<0.001

Table 3 Clinical Attachment Level (CAL)

	Baseline	1 month	6 months
ND: YAG	2.3 ± 0.5	1.1 ± 0.3	1.0 ± 0.2
PRP	2.2 ± 0.4	1.6 ± 0.3	1.5 ± 0.3
p-value	>0.05	<0.001	<0.001

Table 4. featuring the Plaque Index (PI) results, indicates that both treatments effectively lowered PI from the baseline.

Yet, the ND.YAG Laser treatment was superior, with a significantly lower PI than the PRP treatment at both the one and six- month follow-ups.

Table (4) *Plaque Index (PI)*

	Baseline	1 month	6 months
ND: YAG	4.8 ± 0.7	3.7 ± 0.5	2.1 ± 0.4
PRP	4.7 ± 0.6	4.1 ± 0.3	3.3 ± 0.5
p-value	>0.05	>0.05	<0.001

Table 5 shows the comparison of radiographic bony defect measurements between the ND: YAG laser and PRP treatments for periodontitis at baseline, 1 month, and 6 months. While both treatments effectively reduced the bony defect over time, the ND: YAG laser treatment demonstrated a statistically significant greater reduction compared to the PRP therapy by the 6-month mark.

Table (5) *Radiographic Bony Defect*

	Baseline	1 month	6 months
ND: YAG	2.5 ± 0.6	1.2 ± 0.3	1.1 ± 0.3
PRP	2.4 ± 0.5	1.8 ± 0.4	1.7 ± 0.4
p-value	>0.05	<0.001	<0.001

Fig. (1) Illustrates the efficacy of Platelet-Rich Plasma (PRP) treatment for periodontitis. Panel (a) displays the baseline condition at the outset, while panel (b) showcases the same patient's progress after 6 months of treatment.

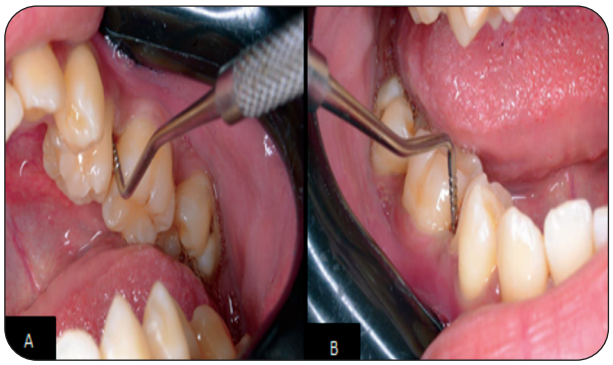

Fig. (2) Illustrates the efficacy of Nd:YAG Laser treatment for periodontitis. Panel (a) displays the baseline condition at the outset, while panel (b) showcases the same patient's progress after 6 months of treatment.

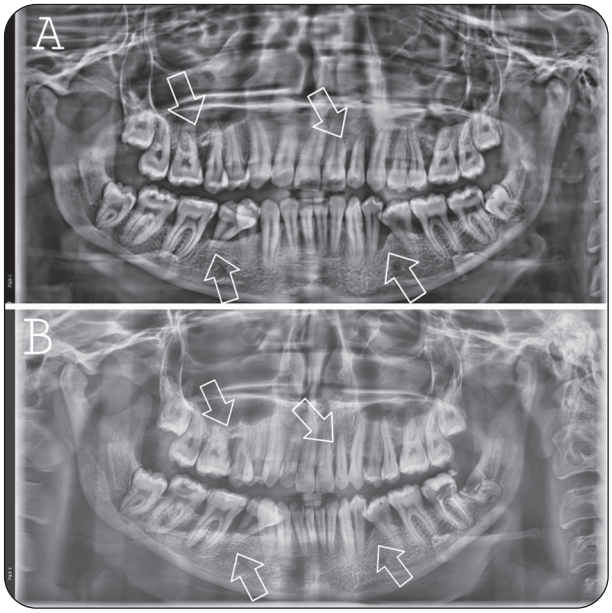

Fig. (3) Panoramic Radiographic comparison of two periodontitis treatments: PRP (a) and ND YAG Laser (b). The upper half showcases the baseline state at day 0, while the lower half reveals new bone formation after 6 months.

DISCUSSION

Periodontitis, a chronic inflammatory disease triggered by bacterial infection, adversely affects the supportive structures of teeth, leading to bone loss, gum recession, and potentially tooth loss if left untreated[15]. Recently, two treatment modalities have gained significant attention: the Neodymium-Doped Yttrium Aluminum Garnet (Nd: YAG) laser and Platelet-Rich Plasma (PRP) therapy[16,17]. This

study sought to compare these two therapeutic modalities using key parameters such as the Gingival Index (GI), Probing Depth (PD), Plaque Index (PI), radiographic bone defect, and Clinical Attachment Level (CAL).

The results of this study indicated that the Nd: YAG laser treatment was more effective than PRP across all evaluated parameters. The Nd: YAG laser has demonstrated effectiveness in reducing periodontal inflammation when used in conjunction with scaling and root planing[12]. This is further supported by a study by Qadri et al., which showed significant improvements in periodontal inflammation after the use of the Nd: YAG laser[15]. The bactericidal properties of the Nd: YAG laser and its ability to remove sub gingival calculus have been well-established[18], which could explain the improvements in GI, PD, PI, and CAL in our study. Furthermore, the laser's ability to stimulate fibroblast activity and promote wound healing could potentially account for the improvements in CAL and radiographic bone defects[13, 19].

On the other hand, despite some studies suggesting the effectiveness of PRP in periodontal treatment[20, 21], our findings appear to contradict these. PRP, known for its high concentration of growth factors, has been shown to foster wound healing and tissue regeneration[22]. However, the disparity between our results and those of previous studies could be due to differences in study design, patient population, and PRP preparation and application methods[19]. It is worth noting that our study directly compared Nd: YAG laser and PRP, whereas many existing studies have used PRP as an adjunct to other treatment modalities[21].

Factors specific to patients, such as the severity and extent of periodontitis, systemic health status, and lifestyle factors like smoking, which can significantly influence treatment outcomes, should not be disregarded[19]. Interestingly, some researchers propose that the combined use of lasers and PRP may yield superior results. Future research should consider exploring the combined use of Nd: YAG laser and PRP in periodontal treatment[17].

Despite the promising findings of our study, several limitations must be acknowledged. The heterogeneity in the severity and extent of periodontitis among the study participants could have affected the treatment outcomes. Additionally, the relatively short follow-up period could have limited our ability to assess the long-term effects of the treatments. Future research should aim to overcome these limitations by including a more homogenous study population and extending the follow-up period[12].

CONCLUSION

In conclusion, this study provides valuable insights into the comparative efficacy of ND: YAG laser treatment and Platelet-Rich Plasma (PRP) therapy in the management of periodontitis. Both treatments demonstrated effectiveness in reducing the Clinical Attachment Level (CAL), Probing Depth (PD), Gingival Index (GI), Plaque Index (PI), and Radiographic Bony Defect over time. However, the ND: YAG laser treatment exhibited a statistically significant superior performance in radiographic bony defect reduction by the 6-month mark.

These findings suggest that while PRP offers a beneficial approach in periodontitis treatment, the ND: YAG laser treatment may provide more pronounced long-term benefits, particularly concerning bone tissue regeneration. However, it is important to consider these results within the context of individual patient needs, tolerance, and response to treatment. Further large-scale, multi-center randomized controlled trials are recommended to confirm these findings and further explore the potential of these innovative therapies in periodontics.

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دراسة مقارنة بين ليزر Nd: YAG والبلازما الغنية بالصفائح الدموية في علاج التهاب اللثة باستخدام تصميم الفم المنقسم

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الملخص :

الهدف : دراسة تأثير ND: YAG و البلازما الغنية بالصفائح الدموية في علاج التهاب اللثة المزمن باستخدام تصميم الفم المنقسم.

المواد والاساليب: أجريت تجربة سريرية عشوائية على 30 مريضاً تم تشخيص إصابتهم بالتهاب اللثة المزمن. تلقى كل مريض العلاج بالليزر ND: YAG على جانب واحد من الفم والبلازما الغنية بالصفائح الدموية على الجانب الآخر. تشمل المعلمات السريرية عمق التحقيق (PD)، ومؤشر اللثة (GI). تم تقييم مستوى الارتباط السريري (CAL)، ومؤشر البلاك (PI)، والعيوب العظمية الشعاعية عند خط الأساس، بعد شهر واحد، و6 أشهر من العلاج. تم استخدام اختبار مان ويتني يو للتحليل الإحصائي.

النتائج: أدى العلاج باستخدام ليزر ND: YAG إلى انخفاض أكبر بكثير في جميع المعايير السريرية بالمقارنة مع علاج PRP. وكان هذا ذا دلالة إحصائية في تقييمات ما بعد العلاج لمدة شهر واحد و6 أشهر (قيمة الاحتمال <0.001). أظهر أولئك الذين تلقوا العلاج بالليزر ND: YAG انخفاضًا في عيوب PD وGI وCAL وPI والعيوب العظمية الشعاعية.

الخلاصة: أظهر العلاج بالليزر ND YAG فعالية متفوقة على PRP في علاج التهاب اللثة المزمن. تشير هذه النتائج إلى أن ليزر ND YAG يمكن أن يكون طريقة علاج أكثر فعالية لالتهاب اللثة المزمن، مما يساهم في تحسين نتائج المرضى. ومع ذلك، هناك ما يبرر إجراء دراسات مستقبلية بأحجام عينات أكبر وفترات متابعة أطول لتأكيد وتوسيع طريقة هذه النتائج.

الكلمات المفتاحية: التهاب اللثة المزمن، ليزر ND YAG، البلازما الغنية بالصفائح الدموية ، تصميم الفم المنقسم، تجربة سريرية عشوائية.