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Clinical Study of the Gingiva Healing after Gingivectomy and Low-Level Laser Therapy

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ABSTRACT

Objective: **The purpose of this study was to investigate gingival healing after gingivectomy and adjunctive use of low-level laser therapy (LLLT).** ***Background Data:*****LLLT has been used in animal experiments to examine the influence of laser radiation on the wound healing process since the 1960s. However, clinical trials in dentistry are scarce, and most of them refer to treatment after extraction of the third molars, with only a few reports in the area of periodontics.** ***Methods:*** **Twenty patients with periodontal disease were selected, and treatment was planned for gingivectomy to bilateral maxillary and mandibular premolar teeth. After surgery, one side was submitted to LLLT using a 685-nm wavelength, output power of 50 mW, and energy density of 4 J/cm^2. The other side was used as the control and did not receive laser irradiation. Healing was evaluated, clinically and biometrically, immediately post-surgery and at days 3, 7, 14, 21, 28, and 35. Results were submitted to statistical analysis.** ***Results:*** **Biometrical evaluation indicated a significant improvement in healing for the laser group at 21 and 28 days. Clinical evaluation showed better repair for the laser group, mainly after the third day.** ***Conclusion:*** **LLLT was an effective adjunctive treatment that appeared to promote healing following gingivectomy.**

INTRODUCTION

A MAJOR GOAL of periodontal therapy is to re-establish anatomical and physiological conditions conducive to long-term health and function of periodontium. Hyperplasia and/or overgrowth of the gingiva is rather common and related to a variety of etiologic factors and pathogenic processes, (e.g., dental plaque, mouth breathing, hormonal imbalance, medications).[1]

Gingivectomy is used in the elimination of suprabony periodontal pockets or pockets not extending beyond mucogingival junction. A gingivectomy may be indicated to remove diseased tissue, for prosthetic reasons, to improve esthetics and/or establish normal gingival architecture, and to reduce probing depth of periodontal pockets.

The wound healing process after gingivectomy is by secondary intention and takes about 5 weeks to re-establish normal gingival epithelialization. This finding tends to confirm the concept of a slow wound healing process.[2] In this regard, several studies have shown that the topical application of medicaments, antibiotics, or amino acids have resulted in improved healing of wounds by secondary intention.[3,4]

For any dental surgeon, improving clinical practice—providing effective pain relief and improved patient comfort following surgery—is a key objective. The dental application of lasers is a developing field with great promise. Low- and high-power lasers have been used in oral surgery, endodontics, periodontics, and restorative dentistry, among other specialties.[5–12] Soft tissue surgery using a variety of laser wavelengths has been reported.[5,8] These lasers help to remove a minimal amount

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of infected gingiva to shrink the periodontal pocket, and allow better access for scaling and root planing and patient oral hygiene. Lasers have been reported to reduce bleeding, result in minimal post-operative discomfort, and reduce the need for sutures. Nevertheless, due to the cost of instrumentation, surgical lasers are still not widely employed in private practice.

LLLT does not involve thermal interaction. Instead, the photon energy causes photochemical, photophysical, or photobiological effects in cells and tissue. It has been demonstrated that the effects of low-intensity lasers on biologic tissues are processed in different ways, through the mitotic activity induction of the epithelial cells, modification of the capillary density, stimulation of the local microcirculation, and increase of the *in vitro* and *in vivo* collagen synthesis.[13–16]

Low-level laser therapy (LLLT) is a promising treatment option for open wounds, and it has been examined on a clinical basis for treatment of rheumatoid arthritis, pain management, healing of atrophic ulcers, healing of indolent wounds, bone formation, and burns.[17–19] The literature shows that LLLT is able to stimulate proliferation of human periodontal ligament fibroblasts[20]; however, the therapeutic value of LLLT is still controversial, and clinical trials in dentistry are rarely reported.

A recent study has shown that LLLT did not accelerate healing of oral mucosa after gingivoplasty; treated and untreated gingiva showed no statistically significant differences with respect to epithelialization, inflammatory cells, collagen fibers, or number of fibroblasts.[21] However, it is well-known that a variety of parameters must be considered in order to obtain optimal results when using LLLT, such as wavelength, power level, distance from source to tissue, as must a variety of clinical factors, such as irradiation dose, exposure time, intensity, and method and number of irradiations.[22]

Obviously, increased application of laser technology and more specifically LLLT in periodontics will require a greater number of human clinical trials. Thus, the purpose of the present investigation is to evaluate gingival wound healing in human patients following simple gingivectomy, compared to gingivectomy plus adjunctive use of LLLT.

METHODS

Twenty patients were selected who fulfilled the study's inclusion criteria. Gingivectomy had been planned for each patient to involve the bilateral mandibular and maxillary bicuspid teeth. Each subject signed a detailed informed consent form, and ethical approval was granted by the Dentistry School's Research Ethics Committee of the University of São Paulo, Brazil.

In all cases, presurgical preparation consisted of scaling and root planing, oral hygiene instructions, occlusal equilibration, and dietary evaluation. Using a periodontal probe with William's markings (Hu-Friedy) at pretreatment, initial probing depths were recorded for the mid-buccal, and mesial and distal interproximal surfaces of each bicuspid tooth.

Following a simple gingivectomy consisting of excision of the soft tissue wall carried out to the base of the clinical pocket, the surgical site of one quadrant was irradiated with a diode laser (model IR 500; Laser Beam, Rio de Janeiro, Brazil), using 50-mW output power, λ = 685 nm (visible emission), continuous wave, and beam diameter of 2 mm. The laser-treated side was irradiated immediately after surgery, and at 24 h, and 3 and 7 days post-surgery (p.s.). The irradiation was made in contact mode, scanning an area of about 1 cm^2 during 80 sec corresponding to an energy density of 4 J/cm^2, while holding the delivery tip perpendicular to the tissue surface. The scanning velocity was approximately 1 mm/sec. Subsequent to the gingivectomy procedure, control sites were not exposed to laser irradiation.

At conclusion of the prescribed treatments, all surgical sites were covered with a periodontal dressing (Coe-Pak). All periodontal dressings were changed at 24 h, and days 3 and 7 p.s. In the event that periodontal dressings were lost prior to clinical evaluation appointments, patients were instructed to report to the treatment clinic for replacement.

Photographs were taken of the treatment sites at pre-surgery, immediately post-surgery, and at 24 h, and 3, 7, 14, 21, and 35 days p.s. The photographs were used by three periodontists to score three clinical parameters. These examiners were blinded

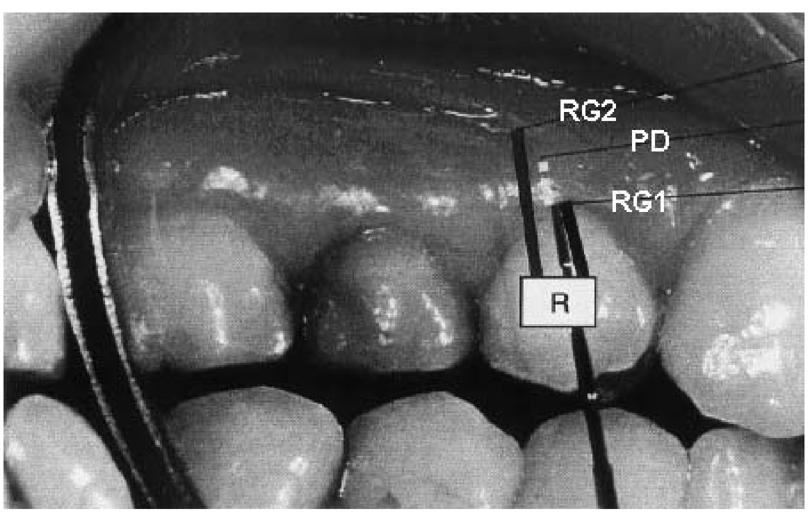


FIG. 1. Representation of the distance between the resin-gingival margins (RG1), distance between the resin-gingival phlegm margins (RG2), and probing depth (PD). R, composite resin (reference)

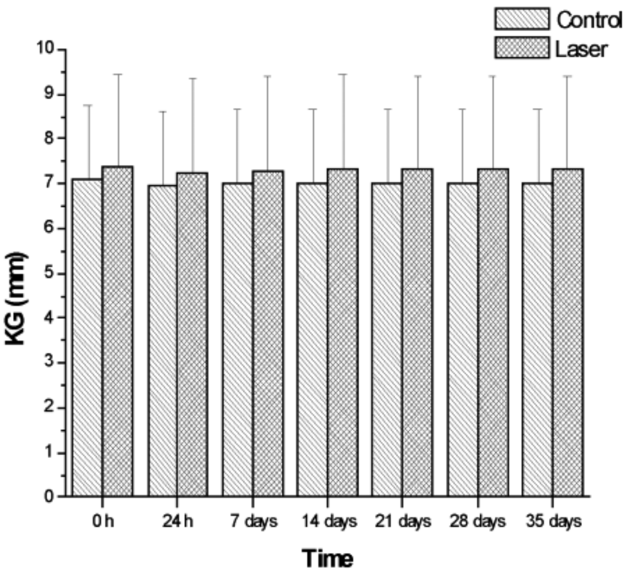


FIG. 2. Comparative analysis between control and laser groups for keratinized gingiva (KG) during the experimental period. Vertical bars represent the means ± standard deviation (SD) of 20 patients. No significant differences were observed ($p > 0.05$).

as to test versus control sites. The clinical parameters that were scored consisted of the following: tissue color (pink, red, bluish, or purple); tissue contour (normal, hyperplastic, or atrophic); and clinical status of the healing wound for the specific time interval (normal, better than normal, worse than normal).

For the purpose of analysis, a three-point scale was used to score healing of the surgical wound:

Score +1: indicating superior healing of laser-treated wounds compared to control sites
Score 0: indicating that laser-treated test sites and control sites exhibited the same degree of healing response
Score −1: indicating that control exhibited superior healing when compared to laser treated test sites

To assess agreement of scoring among the three periodontists, the nonparametric kappa test was used. The kappa index is interpreted as follows: <0.40, weak agreement; 0.40—0.75 interval, from reasonable to good agreement; >0.75, excellent agreement. The results were considered significant when $p < 0.05$.

For biometrical evaluation of the surgical wound, a composite resin reference was placed on the medial portion of the buccal surface, and it was used as a guide during all experimental periods to obtain the following measurements (Fig. 1): RG1, distance between the resin–gingival margins (measured with a drawing compass); RG2, distance between the resin–gingival phlegm margins (measured with a drawing compass); PD, probing depth (measured with a millimetric probe). Subtraction of RG1 from RG2 results in the amount of keratinized gingiva (KG), and subtraction of KG from PD results in the amount of attached gingiva (AG). The measurements were made and calibrated by a digital caliper. To obtain the data for statistical analysis, the RG1 and RG2 measurements were made pre- and immediately post-surgery, and at 24 h, and 7, 14, 21, 28, and 35 days of p.s.The PD measurements were made at pre-surgery, and 21, 28 and 35 days p.s. Patients were instructed to use good oral hygiene over the resin to avoid bacterial plaque.

Statistical analysis

Results were organized and plotted to submit them to statistical analysis. The comparisons between control and treated groups were done using the nonparametric Kruskal-Walis test. The Friedman test was used to compare wound healing of the control and laser groups at several time points. Significance was accepted at $p < 0.05$.

RESULTS

No significant statistical differences ($p > 0.05$) were found between the laser and control groups on each of the seven evaluated periods for the amount of keratinized gingiva (KG mean values; Fig. 2).

Regarding the probing depth values (PD mean values), Figure 3 shows that the groups were similar before surgery. At 21 and 28 days p.s., the control group values were significantly superior compared to the laser group ($p > 0.05$). At 35 days p.s., stability was observed.

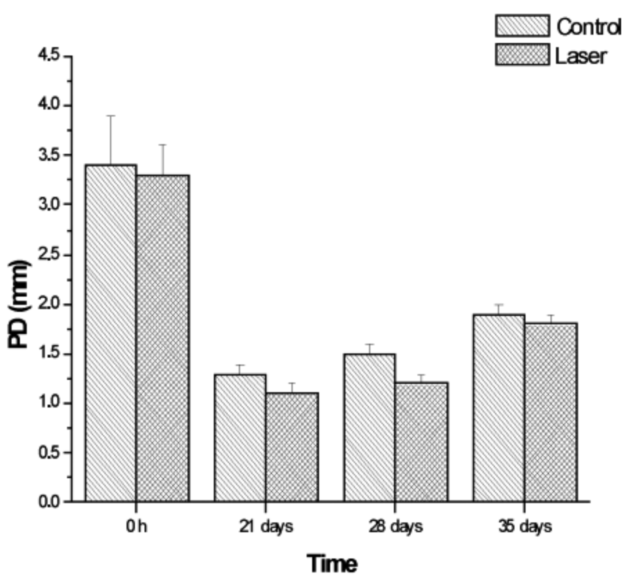


FIG. 3. Comparative analysis between control and laser groups for probing depth (PD) during the experimental period. Vertical bars represent the means ± SD of 20 patients. Significant differences were observed between laser and control groups on days 21 and 28 post surgery ($p > 0.05$).

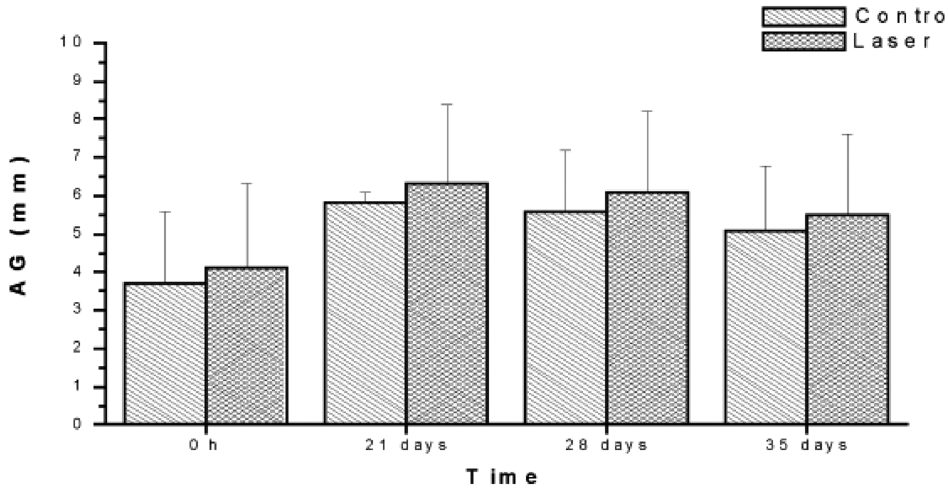


FIG. 4. Comparative analysis between control and laser groups for attached gingiva (AG) during the experimental period. Vertical bars represent the means ± SD of twenty patients. No significant differences were observed ($p > 0.05$).

The measurement of attached gingiva (AG mean values) showed no significant statistical differences between the groups, although the laser group had better results than the control group during the experimental period (Fig. 4).

Figure 5 presents the results obtained at clinical evaluation of wounds performed by three periodontists. During the immediate post-operative period and at 24 h p.s., both sides were similar. At day 3 p.s., there was a significant improvement in healing of the wounds treated with laser compared to the control wounds. At 7, 14, 21, 28, and 35 days p.s., the laser-treated group had better results in healing than did the control group. The agreement of scoring among periodontists was calculated with a 0.671 kappa index value considered significant ($p > 0.05$). Figure 6 illustrates gingival wound healing at day 21 p.s. for both laser and control groups.

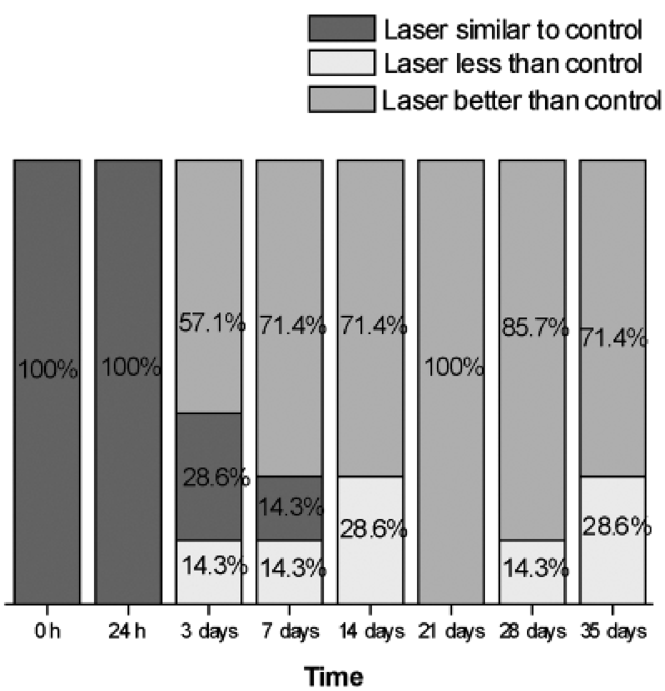


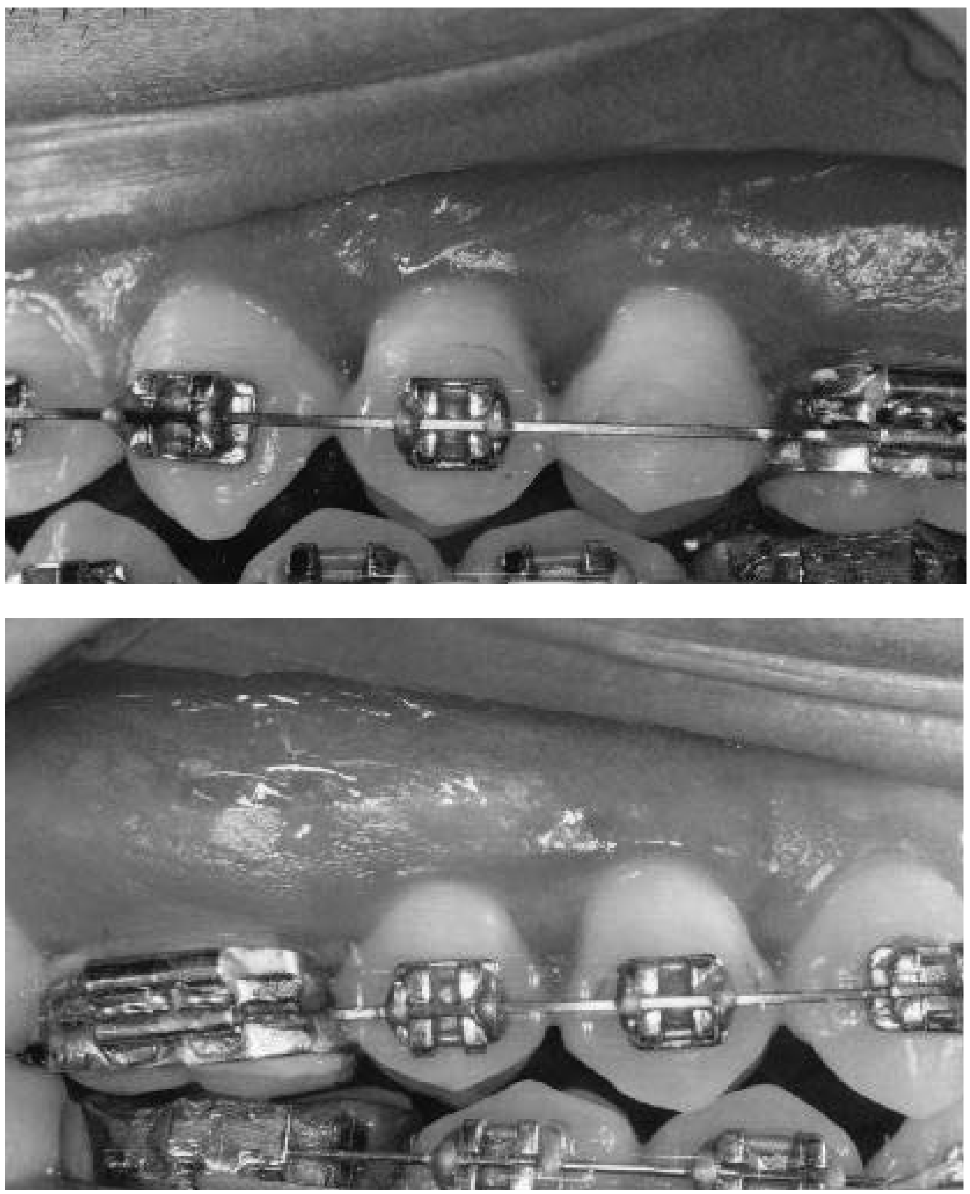
FIG. 5. Gingival wound healing for laser and control groups during the experimental period. The agreement of scoring among periodontists was significant ($p > 0.05$) with a 0.671 kappa index value (considered good).

DISCUSSION

Healing of periodontal tissue after surgical treatment has long been a subject of study. In this clinical trial, post-gingivectomy wounds were assessed over a number of days to clarify whether laser treatment could or could not improve the healing process and post-surgical patient comfort.

Biometrical results showed that, when laser-treated wounds were compared with those of the control group, no significant statistical differences were found for keratinized gingiva and attached gingiva, but a significant statistical difference was found for probing depth on days 21 and 28 p.s. These data suggest that the laser-treated group had a faster recovery in these periods, with a reduction of pocket depth compared to that of the control group. This finding indicates that, in this period, the irradiated wounds underwent a better healing process than the wounds from the control group, probably because of higher collagen production leading to a better remodeling of the connective tissue and a reduction of the probing depth. The reduction of the probing depth in the early stages of healing is a very positive finding, because it makes it easier for the patient to keep the area clean, allowing better oral hygiene. On the day 35 p.s., probing depths were similar for both groups.

In clinical evaluation of the wounds, after the third day laser-treated wounds presented a better healing process with



A

B

FIG. 6. Gingival wound healing on the day 21 post surgery. (**A**) Control group. Note the edematous contour of the gingiva and its redness aspect. (**B**) Laser group. Observe the well-defined gingival contour and the pink color (denoting a more advanced repair compared to the control).

respect to color, contour, and mucosa healing. This result points to an improvement of the wound healing process for lased group. However, this improvement was not gradual; rather the laser group showed better results at all time periods. This is important for post-surgical patient comfort as it suggests enhanced pain relief for laser-treated wounds.

Many researchers using different parameters have investigated the effect of LLLT on wound healing. Although lasers have shown effectiveness in inducing changes within the cultured cells and, as a consequence, an increased healing effect, the optimal parameters to achieve this end have yet to be determined.[23] In this study, the selected parameters were based on Schindl et al.[24] (dose of 4 J/cm^2, exposure time of 80 sec, and power of 50 mW), and these were applied immediately after surgery, and at 24 h, and 3 and 7 days p.s.—an interval appropriate to daily practice in a dental office. Such parameters were considered to be effective for the gingival healing following gingivectomy.

The present findings differ from a recent study by Damante et al.,[21] which demonstrated that LLLT did not accelerate the healing of oral mucosa after gingivoplasty. Laser output power and method of irradiation may be the cause of the differences in results. Damante et al.,[21] used a 15-mW GaAlAs laser in a punctual mode on the wound. On the other hand, in the present study a 50-mW GaAlAs laser was applied in scanning mode over the injured area. Our results show that these parameters were adequate to trigger a faster healing process in laser-treated wounds when compared to control wounds.

Wavelength is another important parameter in the evaluation of the effects of laser radiation. Although it has not yet been possible to determine the best wavelength for each clinical situation, in this work a red laser (λ = 685 nm) was used since this wavelength seems to be the best option for open wounds.[22]

The mechanism of LLLT is not completely understood, but some studies have attempted to explain the effect of laser radiation on the biological system. A number of LLLT mechanisms that could improve wound healing have been postulated, and they include ATP synthesis, fibroblast proliferation, collagen synthesis, phagocytosis of macrophages, and acceleration of the inflammatory phase of wound healing. All these mechanisms can result in cellular proliferation and acceleration of the wound healing process.[15,16,20,25–28]

After gingivectomy, collagen formation and a better gingival tissue organization occur gradually within 3–4 weeks as the inflammation and the vascularity of the granulation tissue decrease, even if the gingival surface appears to be completely healed clinically 2–3 weeks after the surgical procedure. Collagen production on the granulation tissue occurs after fibroblast proliferation, which originates locally around the vascular, bone, and lamina propria areas.[2] Acceleration of the wound healing process with laser can be explained by a higher collagen synthesis in fibroblast and vascular proliferation on the connective tissue, coupled with higher mitotic activity in epithelial cells.

The encouraging results of this study indicate that LLLT could be used as an adjuvant element for surgical periodontal treatment within the investigated parameters. Clinical trials are important as researchers look for new therapies to improve the best available treatment options for patients. Further well-controlled clinical studies with sufficiently large sample sizes comparing various irradiation regimens are needed to optimize the use of LLLT after periodontal surgery.

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