LOW-LEVEL LASER THERAPY: ENHANCING SURGICAL OUTCOME OF CORONALLY ADVANCED FLAP OUTCOMES FOR ISOLATED GINGIVAL RECESSION

Running Title: Low-Level Laser Therapy in Coronally Advanced Flap for Gingival Recession

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Keywords

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Abstract

Background: Gingival recession is a common issue that can impact how your smile looks and your oral health. The coronally advanced flap (MCAF) is a surgical procedure to treat gingival recession and enhance the esthetics. This procedure is often combined with low level laser therapy (LLLT) which is believed to enhance overall treatment results.

Objective: The goal of this research was to assess how effective LLLT is when used alongside MCAF in decreasing the depth and width of recession and improving the clinical attachment level within a span of 6 months.

Methods: Twenty patients, with Miller Class I or II gingival recession defects were divided into two groups -one receiving MCAF alone and the other receiving MCAF along with LLLT treatment in a randomized manner. The clinical measurements of GRD (gingival recession depth) GRW (gingival recession width) and CAL (attachment level) were evaluated at the beginning of the study and at the 3 month and 6-month marks to evaluate the progress. The results, between the two groups were compared and statistically analyzed.

Results: Both groups had same values, for GRD and GRW measurements initially. By month 3 of observation period the experimental group exhibited significant decreases in GRD (0.40 ± 0.35 mm vs. 1.10 ± 0.50 mm; $p = 0.01$) and GRH (0.50 ± 0.30 mm vs. 1.20 ± 0.60 mm; $p = 0.002$). The enhancements persisted after 6 months showing that those, in test group achieved results for gingival recession depth (0.50 ± 0.25 mm vs. 1.60 ± 0.45 mm; $p = 0.001$) as well as gingival recession width (0.60 ± 0.35 mm vs. 1.70 ± 0.55 mm; $p = 0.001$). The test group also experienced improvement, in clinical attachment level gain during both follow up periods.

Conclusion: Low Level Laser Therapy (LLLT) greatly improves the results of MCAF procedure by decreasing Gingival Recession Depth (GRD) and Gingival Recession Width (GRW) while improvement in clinical Attachment Level (CAL) during the 6 months post treatment follow up. Thus, the incorporation of LLLT, in the treatment of gingival recession may be considered.

Introduction

Patients often worry about gingival recession and may need professional consultation to decide whether it can be treated only by non-surgical methods or by surgery, and also to prevent its further progress and occurrence. [1] The prevalence rate of gingival recession in men and individuals over 30 years old is 37.8% in the 30–39 age group and 90.4%, among older individuals.[2] Although it is usually asymptomatic recession can lead to root sensitivity, root caries susceptibility and aesthetic issues especially affecting the anterior teeth.[3] Root coverage procedures are frequently influenced by aesthetic considerations as a result. The main goal, in treating gingival recession was to reduce recession and increase the amount of keratinized tissue present.[4,5] However modern approaches now focus on achieving complete root coverage (CRC) to meet the preferences of patients. Among the techniques that have been developed the modified coronally advanced flap (MCAF) has shown a high level of predictability resulting in, around 86. 67 % CRC.[3,6] Variations of the MCAF technique that involve connective tissue grafts have enhanced success rates. They may necessitate a second surgical site potentially leading to discomfort for patients after the procedure. Despite the progress made in this area of dentistry, achieving results in treating recession continues to pose a significant challenge. [7-10]

Low level laser therapy (LLLT) has become an addition, to treatments and is showing great promise in aiding the healing process after procedures in the field.[11] First introduced by Mester back in 1971 LLLT works by using bio-modulation to boost the healing of wounds. The laser triggers ATP production in cells leading to changes in metabolism that speed up cell multiplication increase growth and help, with building tissue.[12,13] These actions help promote skin healing, collagen creation, blood vessel formation and the release of growth factors resulting in stronger wound recovery overall. LLLT also shows pain relieving effects by decreasing the frequency of nociceptor firing and nerve conduction; thus, offering post-operative pain relief to patients. [14,15]

Clinical studies have shown that Low Level Laser Therapy (LLLT) provides advantages in procedures when used alongside the MCAF method for treating Miller's Class II recession defects compared to using MCAF alone. Furthermore, laser assisted surgeries help decrease bleeding during operations, reduce tissue damage, enhance accuracy and speed up recovery times. These benefits highlight the potential of LLLT to enhance the effectiveness of methods. [11,16,17]

Considering these challenging results, a randomized (control) split-mouth clinical trial was created to analyse the clinical effectiveness of MCAF+LLLT to that of MCAF alone. Aim of this study is to find out effect of LLLT on clinical results while treating gingival recession, and providing information of its role as additional therapy.

Methodology

This study was conducted as a prospective, randomized, controlled, split-mouth, single-blinded clinical trial to evaluate the effect of Low-Level Laser Therapy (LLLT) on wound healing following the Modified Coronally Advanced Flap (MCAF) procedure for the treatment of isolated gingival recession. The study aimed to compare the clinical outcomes of MCAF alone (control group) versus MCAF with adjunctive LLLT (test group) over a six-month follow-up period. Each patient had bilateral gingival recession defects, with one side randomly assigned to the test or control group using a coin-toss method. The study design ensured that each patient acted as their own control, thereby minimizing individual variability.

Sample Size

The study included 20 patients, each presenting with bilaterally symmetrical isolated gingival recessions classified as Miller's Class I or Class II. This sample size was determined based on previous studies evaluating wound healing in gingival recession management, with considerations for statistical power and feasibility. Given the split-mouth design, a total of 40 surgical sites were analyzed, with 20 sites assigned to the control group (MCAF alone) and 20 sites assigned to the test group (MCAF + LLLT). The sample size was deemed adequate to detect clinically meaningful differences in recession reduction, keratinized tissue width, and wound healing outcomes between the groups.

Patient Selection

Patients were selected based on predefined inclusion and exclusion criteria. The inclusion criteria required participants to be aged 20–55 years, have Miller's Class I or II gingival recession, and present with at least one bilaterally symmetrical buccal recession defect in the maxillary arch due to traumatic tooth brushing. Only patients with a full-mouth plaque score of ≤15% and thick gingival phenotype (≥1.2 mm) were considered eligible. Additionally, participants had to provide written informed consent before enrollment. The exclusion criteria included patients who had undergone any regenerative periodontal therapy within the past six months, smokers, individuals with systemic conditions affecting wound healing, pregnant or lactating women, and those with teeth deemed hopeless for retention.

Clinical Protocol

All participants underwent an initial phase of periodontal therapy, which included scaling and root planing, along with personalized oral hygiene instructions to ensure optimal plaque control. Two weeks after completing this initial phase, baseline clinical parameters were recorded using a standardized acrylic occlusal stent and a UNC-15 probe. The recorded parameters included gingival recession depth (GRD), gingival recession width (GRW), width of keratinized tissue (WKT), periodontal probing depth (PD), and wound healing index (WHI). A visual analogue scale (VAS) was also used to assess post-operative pain perception.

Surgical Procedure

Local anesthesia was administered using 2% lignocaine with 1:100,000 epinephrine to ensure patient comfort. The MCAF technique was performed in both the test and control sites. A buccal intrasulcular incision was made using a No.15 Bard Parker (BP) blade, extending horizontally 3 mm into the mesial and distal interdental papillae. Two oblique beveled vertical incisions were made at the line angles of the most mesial and distal teeth, extending beyond the mucogingival junction to allow sufficient mobilization of the flap. A full-thickness mucoperiosteal flap was elevated using Molt's periosteal elevator, ensuring extension 3–4 mm apical to the bone margin. The exposed root surfaces were gently debrided using Gracey's curettes. Tension-free coronal advancement was facilitated, by severing the pull of the flap. The flap was then repositioned 1–2 mm coronally to the cemento-enamel junction (CEJ) to compensate for post-surgical shrinkage. A sling suture technique was used to stabilize the flap in the coronal position, along with interrupted sutures on the vertical incisions using 4-0 Mersilk suture material.

Laser Therapy Protocol

In the test group, LLLT was applied using a diode laser (810 nm, 120 mW, continuous mode, A.R.C. Laser FOX, Germany). Laser irradiation was delivered in contact mode at a 90° angle to the surgical site. The protocol involved 5-minute irradiation of the exposed root surface, the inner flap surface, and the adjacent surgical area before suturing. Another 5-minute irradiation was performed immediately after suturing, followed by daily irradiation for 5 minutes over the next five consecutive days. In the control group, a sham laser application was performed to maintain blinding.

Post-Operative Care

Following surgery, patients were prescribed 0.2% chlorhexidine mouth rinse, to be used twice daily for two weeks. Ibuprofen (400 mg, thrice daily for three days) was recommended for pain relief. Patients were instructed to avoid brushing and flossing at the surgical site for two weeks and to refrain from vigorous chewing. Follow-up evaluations were scheduled at 6 weeks, 3 months, and 6 months post-surgery to assess healing and clinical outcomes.

Statistical Analysis

All data were entered into Microsoft Excel and analyzed using SPSS version 23. Normality tests were conducted to determine the data distribution. Comparative analyses between the test and control groups were performed using the Kruskal–Wallis test and the Mann–Whitney U test for non-parametric data. A p-value <0.05 was considered statistically significant.

Control Group (Preoperative and 6 months)	Test Group (Preoperative and 6 months)
	
	

Result

The objective of this research was to evaluate the efficacy of low-level laser therapy (LLLT) in conjunction with MCAF in reducing the depth and width of gingival recession and enhancing clinical attachment levels over a period of six months.

Table 1: Gingival Recession Depth (Mean ± SD) at Different Time Points

Time Point	Group	n	Mean Recession Depth (mm) ± SD	p-value
Baseline	Control	20	3.30 ± 0.90	0.65
	Test	20	3.40 ± 0.85	
Month 3	Control	20	1.10 ± 0.50	0.01*
	Test	20	0.40 ± 0.35	
Month 6	Control	20	1.60 ± 0.45	0.001*
	Test	20	0.50 ± 0.25	

Table 1 shows how the depth of recession (GRD) changed over time in both the control group (advanced flap, without low level laser therapy) and the test group (coronally advanced flap with low level laser therapy). Initially the GRD values were similar, in both groups. There was no statistical difference (p = 0.65). By the end of the 3rd month of the study period both sets of participants showed decreased gingival recession depth (GRDs) compared to their initial measurements. However, it was found that the participants in the test group experienced a reduction in GRDs (0.40 ± 0.35 mm) as opposed to those in the control group (1.10 ± 0.50 mm). This difference was observed to be statistically significant, with a p value of 0.01. At 6 months, on in this study, the test group participants showed reduced gingival recession depth of around 0.50 ± 0.25 mm compared to those in control group, with an average of about 1.60 ± 0.45 mm, A difference that showed significant statistical meaning with a p value of 0.001. The results indicate that incorporating low level laser treatment into the flap surgery greatly decreased the gingival recession depth and fosters better long-term results when compared to the traditional method.

Table 2: Gingival Recession Width (Mean ± SD) at Different Time Points

Time Point	Group	n	Mean Recession Width (mm) ± SD	p-value
Baseline	Control	20	3.90± 0.70	0.75
	Test	20	4.00 ± 0.65	
Month 3	Control	20	1.20 ± 0.60	0.002*
	Test	20	0.50 ± 0.30	
Month 6	Control	20	1.70 ± 0.55	0.001*
	Test	20	0.60 ± 0.35	

Table 2 shows the comparison of the width of gingival recession (GRW) between the control and test groups, at various intervals. Initially there was no difference in GRW, between the control group (measuring 3·90 ± 0·70 mm) and the test group (measuring 4·00 ± 0·65 mm) with a p value of 0·75. By the third month, mark of the study period both groups of participants displayed decreases, in gum recession width compared to the starting point. Interestingly though the group undergoing the treatment exhibited a prominent reduction (measuring 0·50 ± 30 mm) in comparison to the control groups, reduction (measuring 1·20 ± 6.0 mm) resulting in a statistically significant variance (with a p value of 0.002). Moving ahead to the six-month follow-up, the study group sustained a narrow gum recession width (measuring 0.60 ± 0.35 mm) and was significantly greater than in control group (1.70 ± 0.55 mm) with a significant p value (significant, at p = 0·001). This finding highlights the effectiveness of using low level laser therapy to enhance the outcomes of gingival recession width improvement when combined with the advanced flap technique, for better aesthetic and clinical results.

Discussion

This study findings indicate that LLLT significantly enhances reduction in gingival recession and improves clinical outcomes when compared to traditional MCAF procedures without laser treatment. Gingival recession remains a prevalent concern in periodontal therapy, necessitating both non-surgical and surgical interventions to improve aesthetic and functional outcomes. Various techniques, including pedicle grafts, connective tissue grafts, free autogenous grafts, and guided tissue regeneration, have been explored to manage recession defects. Among these, the coronally advanced flap is preferred due to its ability to preserve native blood supply while minimizing donor site morbidity. The technique can be further enhanced with adjunctive treatments such as platelet-rich fibrin, collagen membranes, and enamel matrix derivatives. With the advent of laser technology, various forms of laser therapy, including photodynamic therapy, laser phototherapy, and LLLT, have emerged, with LLLT gaining significant attention due to its biostimulatory effects.

This study demonstrated a significant reduction in gingival recession depth (GRD) in the test group (MCAF with LLLT) compared to the control group (MCAF without LLLT). At baseline, GRD values were comparable, with no statistical difference (p = 0.65). By the third month, both groups exhibited reductions in GRD; however, the test group showed a more substantial decrease (0.40 ± 0.35 mm) compared to the control group (1.10 ± 0.50 mm), a statistically significant difference (p = 0.01). At six months, the test group maintained a lower GRD of 0.50 ± 0.25 mm, whereas the control group recorded a GRD of 1.60 ± 0.45 mm (p = 0.001). These results highlight that LLLT enhances the long-term stability of gingival recession depth reduction, reducing the likelihood of recession relapse. Similarly, at baseline, there was no significant difference in GRW between the two groups (3.90 ± 0.70 mm in the control group and 4.00 ± 0.65 mm in the test group, p = 0.75). By the third month, while both groups exhibited a reduction in GRW, the test group demonstrated a more prominent reduction (0.50 ± 0.30 mm) compared to the control group (1.20 ± 0.60 mm), with statistical significance (p = 0.002). By six months, the test group maintained a lower GRW (0.60 ± 0.35 mm), whereas the control group exhibited a wider GRW of 1.70 ± 0.55 mm (p = 0.001). These findings suggest that LLLT enhances the effectiveness of recession width reduction, contributing to improved aesthetics and clinical outcomes. The observed benefits of LLLT in this study align with prior research on its biostimulatory effects. LLLT has been shown to stimulate fibroblast proliferation, increase cell viability, and enhance protein synthesis, thereby accelerating tissue regeneration. In vitro studies have reported that low-level laser irradiation enhances the proliferation rate of human gingival fibroblasts, promoting early epithelization and better extracellular matrix synthesis [14]. A systematic review further substantiates that diode laser-based

LLLT enhances fibroblast activity and increases gingival tissue repair following surgical interventions [15]. One of the primary advantages of LLLT is its ability to mitigate post-operative symptoms. Pain perception following periodontal plastic surgery is a significant concern, with prior studies reporting that up to 60% of patients experience discomfort during the first week post-surgery. [16-19] The present study employed a visual analog scale (VAS) to assess pain levels, revealing a significant reduction in pain intensity in the test group. Blinding was maintained to ensure unbiased pain assessment, with patients unaware of the treatment allocation. The significant reduction in post-operative pain in the LLLT group aligns with previous studies by Ozelick et al. [20] and Heidari et al. [21], which demonstrated superior pain relief in laser-treated sites. These findings reinforce LLLT as an effective tool for improving patient comfort in periodontal surgical procedures.

The success of mucogingival surgery relies on clot formation, blood supply maintenance, and granulation tissue formation. Thick gingival phenotypes, which are rich in vascularity, are advantageous for optimal healing. LLLT has been documented to stimulate growth factors, activate fibroblasts, and enhance neovascularization, thereby improving wound stability [22]. In the present study, post-operative observations revealed that vertical incisions in the test group merged more seamlessly with adjacent soft tissue compared to the control group, where delayed integration was noted in a few cases. The reduction in edema in the test group further supports improved healing, as observed in prior studies by 23.Damante, C.A et al. [23]. Moreover, the periodontal health indices recorded at baseline, three months, and six months demonstrated expected improvements following periodontal intervention, including scaling and root planing. While all indices improved over time, inter-group comparisons revealed no major differences between test and control groups in terms of clinical attachment levels or pocket depth changes. The absence of significant pocket depth alteration suggests that LLLT specifically aids in soft tissue healing without adversely affecting deeper periodontal structures. Despite the promising findings, several limitations must be acknowledged. The sample size of 30 sites may limit the generalizability of the results. Future studies with larger sample populations and longer follow-up periods are warranted to confirm the long-term stability of LLLT outcomes. Additionally, while our split-mouth design helped control patient-specific variability, evidence suggests that systemic effects of laser therapy could have influenced overall healing responses. A parallel-arm study design may help clarify these potential confounders.

Conclusion

This research has shown that using low level laser therapy (LLLT) along, with the coronally advanced flap (MCAF) can greatly improve the outcomes of treating gingival recession in clinical settings. When LLLT was incorporated into the treatment alongside CAF there were reductions in both the depth and width of gingival recession (GRD and GRW). Improvement was noticed as early as 3 months and were sustained, up to 6 months later. These results emphasize how LLLT can speed up healing processes and enhance coverage of soft tissue while ensuring the long-term stability of the gingival margin. Using LLLT alongside treatments can improve the success of gingival surgical procedures, thus improving the smiles and esthetics of the individuals. More research is needed to validate these findings and investigate the other modes in which LLLT could benefit gingival health and various gingival surgical treatment procedures in the future.

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