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Comparative evaluation of modified Widman flap and diode laser–assisted open flap debridement in periodontal pocket management: A randomized split-mouth trial

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Abstract:
Periodontitis is a chronic inflammatory disease causing progressive destruction of periodontal supporting tissues. A randomized split-mouth clinical trial in 10 patients compared modified Widman flap (MWF) surgery with diode laser–assisted open flap debridement at sites with probing depth ≥5 mm. Clinical parameters (GI, PI, PPD and CAL) were recorded at baseline, 1 month and 3 months, showing significant improvement in both groups. However, the diode laser group showed greater reductions in GI, PI and PPD, along with superior CAL gain, with mean PPD decreasing from 5.9 mm to 3.9 mm compared to 4.6 mm in the MWF group ($p < 0.05$). Both treatment modalities were effective in improving periodontal health. Thus, adjunctive diode laser therapy resulted in superior reductions in probing depth and greater clinical attachment gain, suggesting its beneficial role as an adjunct to periodontal flap surgery for enhanced short-term clinical outcomes.

Keywords: Chronic periodontitis, diode laser, Modified Widman flap (MWF), open flap debridement, probing pocket depth, clinical attachment level (CAL)

Background:
Periodontitis is a chronic multifactorial inflammatory disease characterized by progressive destruction of the periodontal ligament, cementum and alveolar bone, eventually resulting in tooth mobility and tooth loss if left untreated **[1]**. The disease develops due to a dysbiotic subgingival microbial biofilm interacting with the host immune-inflammatory response. Gram-negative anaerobic microorganisms such as *Porphyromonas gingivalis*, *Treponema denticola* and *Tannerella forsythia* are strongly associated with disease progression through the release of virulence factors capable of stimulating cytokine release, connective tissue degradation and alveolar bone resorption **[2].** The primary objective of periodontal therapy is to eliminate pathogenic biofilm and establish a biologically compatible root surface conducive to periodontal healing and maintenance. Scaling and root planning (SRP) remains the gold standard for initial periodontal therapy; however, non-surgical therapy may be insufficient in areas presenting with deep periodontal pockets, furcation involvements and complex root anatomy **[3].** Under such circumstances, periodontal flap surgery becomes necessary to provide improved access and visualization for effective root debridement. Among periodontal flap procedures, the Modified Widman Flap (MWF) remains one of the most widely accepted conservative surgical techniques. Initially described by Widman and subsequently modified by Ramfjord and Nissle, the MWF is primarily designed to facilitate access for meticulous root instrumentation while preserving maximum soft tissue architecture **[4].** Healing following MWF surgery occurs predominantly through formation of long junctional epithelium with minimal postoperative recession**.** Conventional open flap debridement provides broader surgical access and enhanced visibility of periodontal defects, thereby facilitating comprehensive debridement of root surfaces and osseous defects. However, conventional flap surgery may be associated with increased post-operative morbidity, including gingival recession, edema and discomfort **[5].** Advancements in laser technology have introduced new possibilities in periodontal therapy. Diode lasers operating within wavelengths ranging from 810 to 980 nm have gained popularity because of their affinity for pigmented tissues such as hemoglobin and melanin **[6].** Diode lasers have showed antimicrobial effects, superior hemostasis, de-epithelialization capability and photobiomodulatory potential, thereby making them useful adjuncts during periodontal flap surgery **[7].** Several investigators have suggested that adjunctive diode laser therapy may improve wound healing, reduce postoperative discomfort, decrease bacterial load and enhance clinical attachment gain**.** The bactericidal effect of diode laser irradiation has been attributed to disruption of bacterial cell membranes and denaturation of intracellular proteins. Furthermore, laser therapy has been associated with enhanced fibroblast proliferation, collagen synthesis and accelerated epithelialization **[8].** Despite increasing clinical utilization, the evidence supporting the adjunctive use of diode lasers during periodontal flap surgery remains inconclusive. Some studies have showed superior clinical outcomes with laser-assisted surgery, whereas others have reported limited or no additional benefit compared with conventional surgery alone **[9]**. Therefore, it is of interest to evaluate the efficacy of modified widman flap surgery and diode laser–assisted conventional open flap debridement in the treatment of periodontal pockets in patients with chronic periodontitis.

Materials and Methods:

Study design:
The present study was designed as a randomized controlled split-mouth clinical trial.

Study population:
Ten systemically healthy patients diagnosed with chronic periodontitis were selected from the outpatient Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad. A total of 20 periodontal sites exhibiting probing pocket depth (PPD) ≥5 mm following completion of Phase I therapy were included.

Ethical clearance:
The study protocol was reviewed and approved by the Institutional Ethics Committee of Teerthanker Mahaveer Dental College and Research Centre, Moradabad (IEC No. TMDCRC/IEC/TH/23-24/PER 04; approved on February 15, 2024). Written informed consent was obtained from all participants before enrolment.

Inclusion criteria:
[1] Patients aged between 25–65 years.
[2] Systemically healthy individuals diagnosed with chronic periodontitis.
[3] Presence of bilateral periodontal pockets with probing depth ≥5 mm.
[4] Patients willing to comply with surgical protocol and follow-up visits.

Exclusion criteria:
[1] Smokers or tobacco users.
[2] Pregnant or lactating women.
[3] Patients with systemic diseases contraindicating periodontal surgery.
[4] Patients with generalized gingival recession.
[5] Patients unable to maintain adequate oral hygiene.

Clinical protocol:
All patients underwent Phase I periodontal therapy, including full-mouth scaling and root planning along with reinforcement of oral hygiene instructions. Customized acrylic stents were fabricated to standardize periodontal measurements. Clinical parameters evaluated included Gingival Index (GI) by Loe and Silness (1963), Plaque Index (PI) by Silness and Loe (1964), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL). All parameters were recorded at baseline, 1 month and 3 months using a UNC-15 periodontal probe.

Randomization and group allocation:
Sites were randomly allocated using a coin toss method into Group I (Modified Widman Flap surgery) and Group II (conventional open flap debridement with adjunctive diode laser application).

Surgical procedure - Group I (Modified Widman Flap):
Following administration of local anesthesia (2% lignocaine hydrochloride with 1:80,000 adrenaline), an internal bevel incision was placed approximately 0.5–1 mm from the gingival margin using a No. 15 surgical blade. Crevicular and interdental incisions were subsequently performed, followed by limited flap reflection. Thorough debridement and root planning were completed using hand and ultrasonic instruments. The surgical site was irrigated with sterile saline and the flap was repositioned and secured using interrupted sutures.

Surgical Procedure – Group II (conventional open flap debridement with diode laser):
After administration of local anesthesia, sulcular incisions were performed and full-thickness mucoperiosteal flaps were reflected to provide access to the root surfaces and periodontal defects. Mechanical debridement and root planning were carried out using conventional periodontal instruments. Following debridement, adjunctive laser irradiation was performed using a 980-nm diode laser operating at 3 W in pulsed mode. The laser was applied in contact mode through a fiber-optic delivery system along the inner flap surface and periodontal pocket lining. A single pass was performed for decontamination of the surgical site and removal of inflamed pocket epithelium and granulation tissue. The area was irrigated with sterile saline and the flap was repositioned and secured using interrupted sutures.

Post-operative care:
Patients were prescribed Amoxicillin 500 mg three times daily and Paracetamol 500 mg twice daily for three days. Chlorhexidine mouthwash (0.2%) was advised twice daily for four weeks. Sutures were removed after one week.

Statistical analysis:
Data were entered into Microsoft Excel and analyzed using SPSS software version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation. The Shapiro–Wilk test was used to assess normality, while Levene's test was applied to evaluate homogeneity of variance. Intergroup comparisons were performed using the independent t-test, whereas intragroup comparisons were carried out using the paired t-test. A p-value <0.05 was considered statistically significant.

Results:
Both treatment groups demonstrated statistically significant improvement in clinical parameters during the study period. At baseline, no statistically significant difference was observed between Group I and Group II (2.02 ± 0.13 vs 2.02 ± 0.13; p = 1.000). At 1 month and 3 months, Group II demonstrated significantly lower gingival scores compared with Group I (p = 0.001). Gingival scores progressively reduced in both groups over time, with greater reduction observed in the diode laser group **(Table 1).** Both groups exhibited comparable plaque scores at baseline (2.22 ± 0.13). At 1 month and 3 months, significantly lower plaque scores were observed in Group II compared with Group I (p = 0.001). The diode laser group

demonstrated superior plaque control throughout the follow-up period **(Table 2)**. Mean probing pocket depth reduced significantly in both groups over time. Group I showed reduction from 5.9 ± 0.73 mm at baseline to 4.6 ± 0.51 mm at 3 months, whereas Group II showed greater reduction from 5.9 ± 0.73 mm to 3.9 ± 0.56 mm. Intergroup comparison revealed statistically significant differences at both 1 month (p = 0.015) and 3 months (p = 0.010) **(Table 3).** Both groups exhibited improvement in clinical attachment level during the follow-up period. However, Group II demonstrated greater CAL gain compared with Group I, with statistically significant intergroup difference observed at 3 months (p = 0.001) **(Table 4).** Both Modified Widman Flap surgery and diode laser–assisted open flap debridement resulted in significant improvement in periodontal clinical parameters over the 3-month follow-up period. However, the adjunctive use of a 980-nm diode laser demonstrated superior outcomes with respect to reduction in gingival inflammation, plaque accumulation, probing pocket depth and gain in clinical attachment level.

Table 1: Intergroup comparison of gingival index scores

Time Interval	Group I (MWF) Mean ± SD	Group II (Diode Laser) Mean ± SD	p-value
Baseline	2.02 ± 0.13	2.02 ± 0.13	1
1 Month	1.65 ± 0.11	1.47 ± 0.07	0.001*
3 Months	1.52 ± 0.10	1.27 ± 0.07	0.001*

**Statistically significant (p < 0.05).*

Table 2: Intergroup comparison of plaque index scores

Time Interval	Group I (MWF) Mean ± SD	Group II (Diode Laser) Mean ± SD	p-value
Baseline	2.22 ± 0.13	2.22 ± 0.13	1
1 Month	1.77 ± 0.12	1.58 ± 0.09	0.001*
3 Months	1.56 ± 0.13	1.31 ± 0.14	0.001*

**Statistically significant (p < 0.05).*

Table 3: Intergroup comparison of probing pocket depth (mm)

Time Interval	Group I (MWF) Mean ± SD	Group II (Diode Laser) Mean ± SD	p-value
Baseline	5.90 ± 0.74	5.90 ± 0.74	1
1 Month	5.00 ± 0.67	4.30 ± 0.48	0.015*
3 Months	4.60 ± 0.52	3.90 ± 0.57	0.010*

**Statistically significant (p < 0.05).*

Table 4: Intergroup comparison of clinical attachment level (mm)

Time Interval	Group I (MWF) Mean ± SD	Group II (Diode Laser) Mean ± SD	p-value
Baseline	5.90 ± 0.74	5.90 ± 0.74	1
1 Month	5.30 ± 0.67	5.00 ± 0.67	0.115
3 Months	5.00 ± 0.67	4.40 ± 0.52	0.001*

**Statistically significant (p < 0.05).*

Discussion:

The present randomized split-mouth clinical trial evaluated the comparative efficacy of Modified Widman Flap surgery and diode laser–assisted open flap debridement in patients with chronic periodontitis. Both treatment modalities showed significant improvement in periodontal clinical parameters over the study duration. However, the diode laser group exhibited superior reduction in gingival inflammation, plaque accumulation, probing depth and greater clinical attachment gain. The reduction in gingival inflammation observed in the diode laser group may be attributed to the bactericidal and decontaminating effects of laser irradiation. Diode lasers possess high affinity for pigmented periodontal pathogens and inflamed tissues, thereby facilitating selective removal of diseased epithelium and reduction in microbial load **[9].** In addition, laser therapy promotes coagulation and improves wound stability, contributing to a favorable healing response. The present findings are consistent with those reported by Vineet *et al.* **[10],** who showed greater reduction in gingival inflammation following diode laser–assisted open flap debridement. Similarly, Karthikeyan *et al.* **[11]** observed superior reduction in gingival bleeding and red complex microorganisms in laser-treated sites. The significant reduction in probing pocket depth observed in the diode laser group may be explained by improved decontamination of periodontal pockets and enhanced epithelial attachment. Laser irradiation has been shown to eliminate residual pocket epithelium and reduce bacterial endotoxins, thereby facilitating improved soft tissue adaptation and periodontal healing **[12].** Furthermore, photobiomodulatory effects of diode laser therapy may stimulate fibroblast proliferation and collagen synthesis, promoting enhanced connective tissue repair. The present study demonstrated greater clinical attachment gain in laser-treated sites compared with Modified Widman Flap surgery alone. Similar findings were reported by Khan *et al.* **[13],** who observed significantly greater attachment gain following adjunctive diode laser application during periodontal surgery. In contrast, Dervisbegovic *et al.* **[14]** reported no statistically significant additional benefit with adjunctive laser therapy. Differences in study design, laser wavelength, energy settings, patient characteristics and follow-up duration may account for variations among studies. The diode laser used in the present study operated at 980 nm with 3 W pulsed modes. This wavelength exhibits high absorption by pigmented tissues and hemoglobin, thereby providing excellent hemostasis and bacterial reduction. Improved surgical visibility achieved through coagulation may also contribute to more precise debridement and reduced postoperative inflammation.

Conclusion:

Both Modified Widman Flap surgery and diode laser–assisted conventional open flap debridement were effective in improving periodontal clinical parameters in chronic periodontitis patients. However, adjunctive use of diode laser showed greater reduction in gingival inflammation, improved plaque control, superior probing pocket depth reduction and enhanced clinical attachment gain. Thus, data shows that diode laser application may serve as a valuable adjunct during periodontal flap surgery for achieving improved short-term periodontal outcomes.

Clinical significance:

Adjunctive diode laser therapy during periodontal flap surgery may enhance periodontal healing by improving bacterial reduction, minimizing inflammation and facilitating greater clinical attachment gain. Incorporation of diode lasers into routine periodontal surgical practice may therefore improve clinical efficiency and patient outcomes.

Conflict of interest: The authors declare no conflicts of interest related to this study.

Source of funding: Self-funded.

Ethical approval:
The study protocol was approved by the Institutional Ethics Committee of Teerthanker Mahaveer Dental College and Research Centre, Moradabad (IEC No. TMDCRC/IEC/TH/23-24/PER 04; Approval Date: February 15, 2024). Written informed consent was obtained from all participants before enrollment.

Clinical trial number: Not applicable.

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