



Laser Assisted Modified Widman Flap Surgery for the Management of Moderate to Severe Chronic Periodontitis

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Abstract

Introduction: Chronic periodontitis remains highly prevalent and often requires surgical therapy when nonsurgical approaches are insufficient. Evidence on adjunctive diode-laser use during modified Widman flap (MWF) surgery in Vietnamese patients is limited. The present study aimed to describe the clinical characteristics of Vietnamese patients with chronic periodontitis and to evaluate the 6-month outcomes of diode-laser-assisted MWF surgery.

Methods: In this prospective single-arm clinical study, 41 patients (26–68 years; mean 42.0 ± 9.8) presenting with moderate-to-severe chronic periodontitis were consecutively treated at Hue Central Hospital. After initial therapy, an MWF was performed. The wound bed and pocket walls were irradiated with an 810 nm diode laser (0.7–0.8 W, continuous mode, 30–40 s per site). Clinical variables—Plaque index (PI), gingival index (GI), bleeding on probing (BOP %), probing depth (PD) and clinical attachment level (CAL)—were recorded at baseline, 1 week, 3 months and 6 months. Changes were analysed with paired t-test (SPSS 16.0; $\alpha=0.05$).

Results: Baseline mean PD and CAL were 5.99 ± 0.53 mm and 5.19 ± 1.06 mm, respectively. Significant improvements ($P < 0.01$) were observed at all follow-ups. At 6 months, PD decreased by 3.07 ± 1.63 mm and CAL gained 2.16 ± 0.94 mm. GI dropped from 2.42 ± 0.53 to 0.51 ± 0.74 , PI from 2.35 ± 0.72 to 0.56 ± 0.90 , and BOP from 77.68 ± 17.51 % to 33.92 ± 19.75 %. Overall, 78 % of cases achieved a “good” therapeutic response, with no serious adverse events.

Conclusion: The diode-laser-assisted MWF produced substantial and sustained reductions in inflammation, plaque accumulation, pocket depth and attachment loss in Vietnamese patients with moderate-to-severe chronic periodontitis. The technique appears to be an effective surgical adjunct and warrants controlled comparative trials.

Keywords: Chronic periodontitis, Modified Widman flap, Diode laser, Probing depth, Clinical attachment level

Introduction

Chronic periodontitis (CP) is a multifactorial biofilm-driven disease characterized by progressive destruction of the periodontal ligament and supporting alveolar bone, ultimately leading to tooth loss.¹ The Global Burden of Disease Study ranks severe periodontitis among the top ten most prevalent chronic conditions worldwide, affecting nearly one in every nine adults. Epidemiological surveys across Southeast Asia report a 40–50% prevalence of moderate-to-severe CP, yet access to definitive periodontal surgery in the region remains limited.^{2,3}

While non-surgical scaling and root planing (SRP) forms the therapeutic foundation, anatomical complexity and the presence of deep infrabony pockets often preclude complete bacterial eradication.⁴ The modified Widman flap (MWF), first introduced by Ramfjord and Nissle, offers unparalleled visual and mechanical access for meticulous root debridement with minimal postoperative recession.^{5,6} Longitudinal studies suggest that MWF provides an additional 0.5–0.8 mm of clinical attachment

gain compared with SRP alone.^{7,8}

Over the last two decades, diode lasers (≈ 810 – 980 nm) have emerged as promising adjuncts to periodontal surgery.⁹ Their selective affinity for pigmented pathogens and inflamed epithelium affords effective bacterial reduction, enhanced haemostasis and potential biostimulation of periodontal fibroblasts. Meta-analyses report significantly greater reductions in probing depth (PD) and bleeding on probing (BOP) when diode-laser irradiation is combined with open-flap debridement.¹⁰

Despite these advances, robust data on laser-assisted MWF in Asian cohorts remain scarce, particularly beyond the early 3-month healing period. Accordingly, the present prospective study aimed to evaluate 6-month clinical outcomes of an 810 nm diode-laser-assisted MWF in Vietnamese adults with moderate-to-severe CP. We hypothesized that adjunctive laser therapy would yield significant improvements in PD, clinical attachment level (CAL), BOP and plaque index (PI) compared with those at baseline.

Materials and Methods

Study Design and Ethical Approval

A prospective interventional study without a control arm was performed in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Hue Central Hospital. All participants provided written informed consent.

Patient Selection

Forty-one adults (≥ 25 years) with moderate (PD 5–6 mm, CAL 3–4 mm) or severe CP (PD ≥ 6 mm, CAL ≥ 5 mm) were recruited according to the 2015 update of the American Academy of Periodontology classification.¹¹ Exclusion criteria were as follows: acute periodontal abscess, aggressive periodontitis, systemic conditions affecting healing (uncontrolled diabetes, cardiovascular disease, HIV), smoking, pregnancy/lactation, antibiotic therapy within 3 months, poor oral hygiene compliance, and unwillingness to attend reviews.

Initial Therapy

All patients received oral-hygiene instruction and supra-/subgingival SRP with ultrasonic and hand instruments. Re-evaluation at 4 weeks ensured adequate plaque control (PII ≤ 2.5) before surgery.

Surgical Protocol

Local anaesthesia with 2 % lidocaine containing epinephrine 1:100,000 was administered. Conventional MWF incisions were made on both buccal and lingual aspects extending one tooth mesially and distally to the involved area, sparing papillae. Full-thickness flaps were elevated to the alveolar crest, granulation tissue was removed, and root surfaces were meticulously planed.

Laser Irradiation

An 810-nm diode laser (Picasso®, AMD Lasers, USA) with a 90° fibre tip (5–10 mm) was activated (0.7–0.8 W, continuous mode). Each defect wall was lasered for 30–40 seconds in sweeping horizontal/vertical strokes while maintaining contact. Carbonised debris on the tip was wiped with damp gauze as required. The endpoint was fresh bleeding from the connective tissue, but total energy per site did not exceed 45 seconds.

Flaps were repositioned and sutured with 5-0 Vicryl (internal papilla) and 6-0 Prolene (external). Periodontal dressing was not applied. Post-operative care included 0.12 % chlorhexidine rinses twice daily for 2 weeks and ibuprofen 400 mg as needed.

Clinical Measurements

A calibrated examiner ($\kappa > 0.85$) recorded PII, GI, BOP %, PD and CAL (UNC-15 probe, ≤ 25 g force) at six sites per tooth. Examinations were performed at baseline (T0), 1 week (T1), 3 months (T2) and 6 months (T3).

Statistical Analysis

Data were analysed with SPSS v16.0 (IBM, USA). Normality was verified by the Shapiro–Wilk test. The paired t-test or the Wilcoxon signed-rank test compared follow-up values with baseline. A global “good outcome” was defined as simultaneous improvement in at least four of five parameters. PD and CAL were prespecified as primary endpoints; no formal multiplicity adjustment was applied for secondary outcomes given their correlation and exploratory intent. Interpretation emphasized effect sizes and consistency across time points; 95% CIs were reported where applicable. Significance was set at $P < 0.05$.

Results

Forty-one systemically healthy adults (22 females, 19 males; mean $\pm$ SD age 42.0 ± 9.8 years, range 26–68) completed every scheduled visit, yielding a 100 % retention rate and a robust data set for analysis. At baseline, the cohort exhibited a substantial inflammatory burden: the mean PD was 5.99 ± 0.53 mm and the mean clinical attachment level (CAL) was 5.19 ± 1.06 mm. Plaque accumulation and gingival inflammation were also pronounced, with the PII and the gingival index (GI) registering 2.35 ± 0.72 and 2.42 ± 0.53 , respectively, while bleeding on probing (BOP) affected 77.68 ± 17.51 % of sites (Table 1). Disease severity skewed toward the advanced end of the spectrum: severe CP was present in 61 % of patients, whereas the remaining 39 % met the criteria for moderate disease (Table 2).

Adjunctive diode-laser-assisted MWF surgery produced an immediate and pronounced improvement in oral hygiene parameters. One week after surgery, the mean PII fell by almost two full units ($\Delta = -1.98$, $P < 0.01$) and remained low throughout the six-month observation period, stabilizing at 0.56 ± 0.90 by the final recall (Table 3). Gingival inflammation followed a parallel trajectory: GI dropped from 2.42 ± 0.53 to 0.51 ± 0.74 , and BOP declined by 43.8 percentage points to 33.92 ± 19.75 %, indicating sustained suppression of soft-tissue inflammation.

Table 1. Baseline periodontal parameters (n = 41)

Parameter	Minimum	Maximum	Mean $\pm$ SD
GI	1.0	3.0	2.42 ± 0.53
PII	1.0	3.0	2.35 ± 0.72
PD (mm)	4.0	6.7	5.99 ± 0.53
CAL (mm)	3.0	6.4	5.19 ± 1.06
BOP (%)	38.8	100	77.68 ± 17.51

GI, Gingival index; PII, Plaque index; PD, Probing depth; CAL, Clinical attachment level; BOP, Bleeding on probing.

Table 2. Baseline Distribution of Periodontal Severity (n = 41)

Severity	Index Definition	n	%
Moderate CP	PD 5–6 mm and/or CAL 3–4 mm	16	39.0
Severe CP	PD ≥ 6 mm and/or CAL ≥ 5 mm	25	61.0

CP, Chronic periodontitis; PII, Plaque index; PD, Probing depth; CAL, Clinical attachment level; BOP, Bleeding on probing.

The intervention also effected substantial pocket reduction. The mean PD fell to 4.40 ± 0.98 mm at week 1 and continued to recede, reaching 2.92 ± 1.63 mm at month 6—a cumulative decrease of 3.07 mm (Table 4, $P < 0.01$). Notably, nearly three-quarters of initially deep pockets (≥ 6 mm) converted to a shallow, maintainable morphology (≤ 3 mm) by the final visit (data not tabulated), enhancing long-term plaque control prospects.

These morphological changes translated into tangible periodontal repair. CAL improved by 0.76 mm within the first postoperative week and by 2.16 mm over six months, with 68 % of individual sites gaining ≥ 2 mm of attachment (Table 5). When composite outcomes were considered, 78 % of participants satisfied the predefined criterion for a “good response,” defined as simultaneous improvement in at least four of five clinical variables.

Treatment was well tolerated. No serious adverse events occurred, and patient-reported discomfort was generally mild, resolving within 48 hours with standard non-steroidal analgesics. Sutures were uneventfully removed on day 7 in all cases, and no delayed wound-healing phenomena were observed.

Discussion

Principal Findings

This prospective 6-month evaluation demonstrates that incorporating an 810-nm diode laser into the MWF protocol yields rapid and durable improvements across all cardinal periodontal parameters—PD, CAL, BOP, and plaque accumulation.^{12–14} Within 1 week, a mean attachment gain of 0.76 mm was detected¹⁴ and continued to accrue to 2.16 mm at 6 months, while the PD fell by > 3 mm.^{12,13} These magnitudes exceed the 2-mm threshold regarded as clinically relevant in periodontal regenerative studies and outperform the 1.5–2.0 mm gains commonly reported for conventional MWF alone.^{5,15} Seventy-eight percent of our patients achieved a composite “good outcome,” underscoring the predictability of the laser-assisted approach.¹⁶

Table 3. Plaque Index Change Over 6 Months (n = 41)

Time point	Mean $\pm$ SD	Δ vs. baseline	P
Baseline	2.35 ± 0.72	—	—
1 week	0.37 ± 0.70	–1.98	< 0.01
3 months	0.48 ± 0.84	–1.87	< 0.01
6 months	0.56 ± 0.90	–1.79	< 0.01

Table 4. Probing Depth Change Over 6 Months (n = 41)

Time point	Mean $\pm$ SD (mm)	Δ vs. baseline	P
Baseline	5.99 ± 0.53	—	—
1 week	4.40 ± 0.98	–1.59	< 0.01
3 months	3.57 ± 1.25	–2.42	< 0.01
6 months	2.92 ± 1.63	–3.07	< 0.01

Comparison With Previous Studies

Beyond diode platforms, Er:YAG lasers provide efficient calculus ablation and comparable clinical gains, yet they typically require larger handpieces and higher capital costs. Nd:YAG systems offer potent bactericidal and coagulative effects but may carry a steeper learning curve. In low-resource settings, the compact footprint, lower acquisition cost, and straightforward maintenance of 810–980 nm diode units can improve feasibility and adoption without sacrificing clinical efficacy reported in meta-analyses.

Our findings align with the bactericidal and anti-inflammatory advantages reported by Kreisler et al¹⁷ and Sgolastra et al,¹⁸ who described additional PD reductions of 0.5–1.2 mm when diode irradiation followed open-flap debridement. The absolute PD reduction observed here (3.07 mm) is greater than 2.3 mm reported in a recent cohort treated with SRP + laser only, suggesting that the combination of open-flap access and laser disinfection may be synergistic.¹⁹ Meta-analytic evidence further supports the superiority of laser-augmented surgery over flap surgery alone for both short- and medium-term endpoints.¹⁸

When benchmarked against alternative antimicrobials, our 56 % drop in BOP parallels the haemostatic effect of locally delivered chlorhexidine gels yet avoids the transient taste disturbance and staining associated with those agents. Er:YAG-assisted flaps have achieved comparable CAL gains but require bulky optics and incur higher equipment costs, limiting adoption in low-resource settings such as Vietnam.²⁰ Viewed through this lens, the portable and relatively inexpensive diode platform offers an attractive balance of efficacy, safety and affordability.

Biological Plausibility

At 810 nm, diode energy is selectively absorbed by melanin and haemoglobin, ablating pigmented periodontal pathogens and inflamed pocket epithelium while sparing underlying connective tissue. In vitro work has demonstrated > 95 % reductions in *Porphyromonas gingivalis* and *Prevotella intermedia* after 10 seconds of diode exposure.²¹ Khadra et al reported enhanced fibroblast adhesion and collagen synthesis on titanium discs irradiated with similar parameters, suggesting that low-level laser therapy may accelerate wound maturation and attachment reinforcement.²² Together, these effects plausibly account for the early CAL gains and stable soft-tissue contour noted in our cohort.

Table 5. Clinical Attachment Level Change Over 6 Months (n = 41)

Time point	Mean $\pm$ SD (mm)	Δ vs. baseline	P
Baseline	5.19 ± 1.06	—	—
1 week	4.43 ± 0.80	–0.76	< 0.05
3 months	3.70 ± 1.17	–1.49	< 0.01
6 months	3.03 ± 0.94	–2.16	< 0.01

Clinical Implications

From a practitioner's perspective, the laser-augmented MWF confers several tangible advantages: superior visualization due to instant haemostasis, elimination of charcoal-coated sulcular epithelium that could harbour bacteria, and potential patient-centered benefits such as reduced postoperative discomfort and analgesic intake—outcomes reported elsewhere but not captured in our protocol.²³ The technique, therefore, fits well within a staged periodontal treatment plan, offering a middle ground between conservative SRP and regenerative grafting.

Strengths and Limitations

Key strengths include the strict calibration of a single surgeon, rigorous follow-up, and inclusion of real-world Vietnamese patients whose baseline indices mirror national surveys. Nonetheless, several limitations temper interpretation: (i) Absence of a concurrent control (conventional MWF) precludes strong causal attribution; (ii) 6-month follow-up does not address longer-term stability (relapse, tooth survival); (iii) There were no microbiological/biomarker or histologic endpoints; and (iv) Patient-reported outcomes (pain VAS, analgesic use, OHIP-14) were not collected.

Future Research

We propose randomized trials (diode-assisted vs conventional MWF) with ≥ 12 –36-month follow-up, integration of the quantitative microbial assays (qPCR/NGS) and inflammatory biomarkers, prospective collection of the patient-reported outcomes (pain VAS over 7 days, OHIP-14, time to normal activities, analgesic consumption), and head-to-head comparisons among diode, Er:YAG and Nd:YAG platforms including formal cost-utility analyses relevant to LMIC practice.

Conclusion

This investigation represents the inaugural clinical deployment and evaluation of diode-laser-assisted MWF surgery in Vietnam, demonstrating its safety and significant benefits in pocket-depth reduction and attachment-level gain for patients with moderate-to-severe CP. The technique shows promise as a future standard intervention in domestic periodontal departments, especially for deep, hard-to-manage pockets where conventional MWF is sub-optimal. In light of the single-arm design and medium-term horizon, our conclusions are deliberately circumspect; rigorous comparative trials incorporating microbiological endpoints and patient-reported outcomes are warranted before broad policy or purchasing decisions are made.

Authors' Contribution

Conceptualization: Hong Loi Nguyen.

Data curation: Hong Loi Nguyen.

Formal analysis: Viet Cuu Nguyen.

Investigation: Hong Loi Nguyen, Viet Cuu Nguyen.

Methodology: Hong Loi Nguyen.

Project administration: Hong Loi Nguyen, Viet Cuu Nguyen.

Software: Hong Loi Nguyen, Viet Cuu Nguyen.

Supervision: Hong Loi Nguyen.

Validation: Hong Loi Nguyen.

Visualization: Hong Loi Nguyen, Viet Cuu Nguyen.

Writing-original draft: Hong Loi Nguyen.

Writing-review & editing: Hong Loi Nguyen, Viet Cuu Nguyen.

Competing Interests

The authors have no conflicts of interest to declare.

Ethical Approval

This study was conducted following guidelines regulating research work on human subjects and after receiving institutional ethical committee approval from Hue Central Hospital.

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