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EVALUATING THE IMPACT OF ADVANCED PERIODONTAL THERAPIES ON ORAL HEALTH OUTCOMES AMONG PATIENTS WITH CHRONIC PERIODONTAL DISEASES

Original Article

Muhammad Haris Zia*[1], Humaira Rehman[2], Zakir Hussain[3], Aurangzaib Akram[4], Rija Jafri[5], Amna Peerzada[6]
[1]Assistant Professor, Periodontology, Watim Dental College & Hospital, Rawalpindi, Pakistan.
[2]Bachelor of Dental Surgery (BDS), Watim Medical and Dental College, Rawalpindi, Pakistan.
[3]Consultant Oral and Maxillofacial Surgeon (FCPS), Benazir Hospital, Quetta, Pakistan.
[4]Dow University of Health Sciences, Karachi, Pakistan.
[5]Bachelor of Dental Surgery (BDS), Karachi Medical and Dental College (KMDC), Karachi, Pakistan.
[6]Dentist, Dr. Ishrat-ul-Ibad Khan Institute of Oral Health Sciences, Pakistan.
Corresponding Author: Muhammad Haris Zia, Assistant Professor, Periodontology, Watim Dental College & Hospital, Rawalpindi, Pakistan, harriz1@hotmail.com

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ABSTRACT

Background: Chronic periodontitis is a prevalent inflammatory disease leading to progressive destruction of the tooth-supporting structures and deterioration in oral health-related quality of life. Advances in periodontal therapy, including regenerative and adjunctive modalities, have broadened treatment options, yet comparative data from real-world settings remain limited.

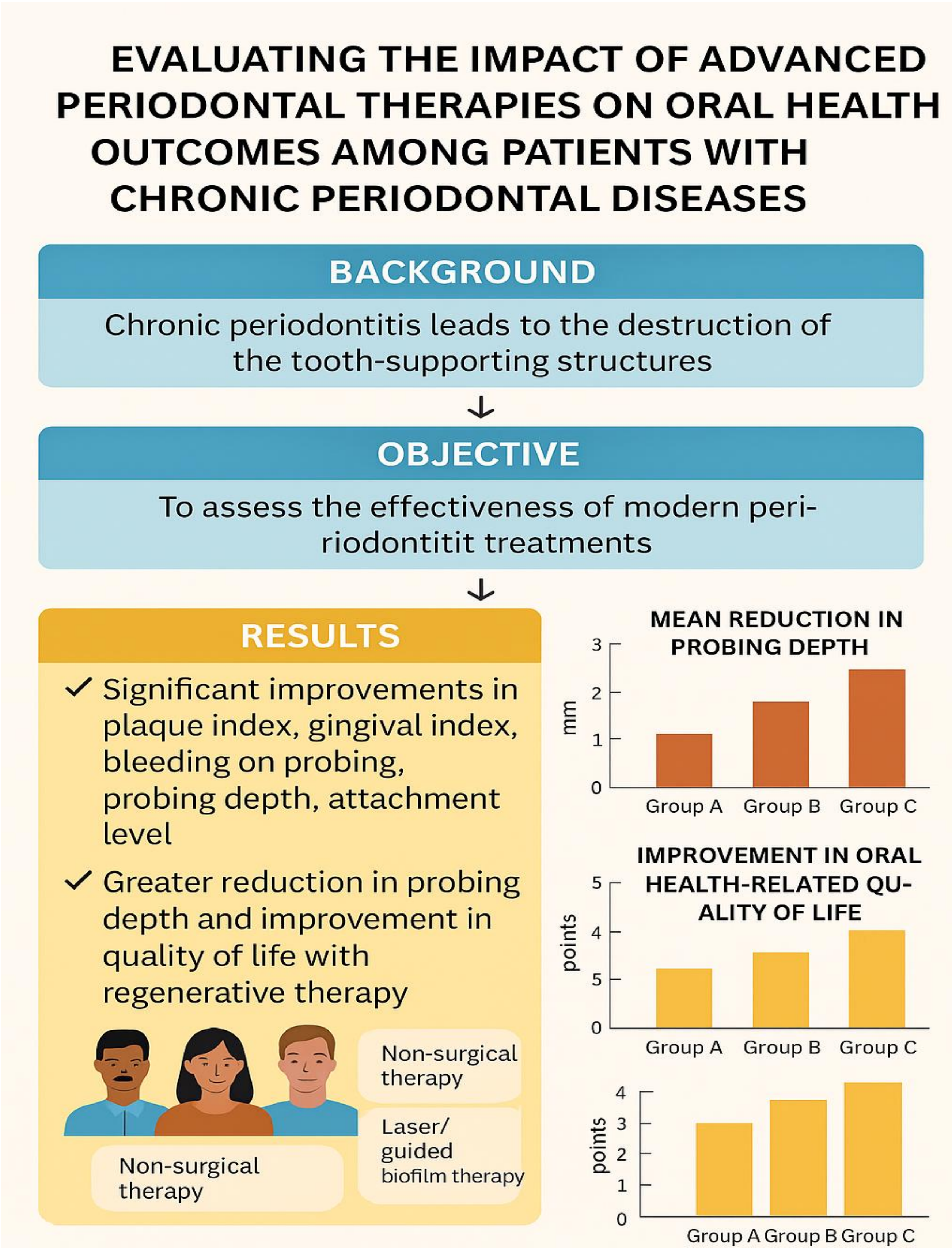
Objective: To assess the effectiveness of modern periodontal treatments in improving clinical outcomes and preventing disease progression among patients with chronic periodontitis in a tertiary care setting in Lahore, Pakistan.

Methods: A retrospective cohort study was conducted over 12 months, analyzing records of 200 patients with moderate to severe chronic periodontitis. Patients were categorized into three treatment groups: non-surgical therapy, laser/guided biofilm therapy, and regenerative/surgical therapy. Primary outcome measures included plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing pocket depth (PPD), and clinical attachment level (CAL). Secondary outcomes assessed oral health-related quality of life using the OHIP-14 questionnaire. Data were analyzed using paired t-tests, ANOVA, and Pearson's correlation, with $p < 0.05$ considered statistically significant.

Results: Significant improvements were observed in all clinical parameters after 12 months ($p < 0.001$). Mean PPD and CAL reductions were 2.49 mm and 2.11 mm, respectively. Regenerative therapy demonstrated the greatest PPD reduction (2.71 mm) and OHIP-14 improvement (4.5 points), followed by laser therapy (2.43 mm and 3.9 points) and non-surgical therapy (1.89 mm and 2.7 points). Strong inverse correlations were found between clinical improvements and quality-of-life scores ($r = -0.68$, $p < 0.001$).

Conclusion: Advanced periodontal therapies significantly enhance clinical and patient-centered outcomes. Regenerative and adjunctive modalities offer superior benefits over conventional approaches, supporting their integration into comprehensive periodontal care strategies.

Keywords: Chronic periodontitis, Clinical attachment level, Guided biofilm therapy, Laser therapy, Oral health-related quality of life, Periodontal regeneration, Periodontal therapy, Plaque index, Probing pocket depth, Regenerative surgery.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BACKGROUND
Chronic periodontitis leads to the destruction of the tooth-supporting structures
OBJECTIVE
To assess the effectiveness of modern peri-riodontitit treatments
RESULTS
Significant improvements in plaque index, gingival index, bleeding on probing, probing depth, attachment level
Greater reduction in probing depth and improvement in quality of life with regenerative therapy
Non-surgical therapy
Laser/ guided biofilm therapy
Non-surgical therapy
MEAN REDUCTION IN PROBING DEPTH
mm
0
1
2
3
Group A
Group B
Group C
IMPROVEMENT IN ORAL HEALTH-RELATED QU-ALITY OF LIFE
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Group A
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Group C
points
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4
Group A
Group B
Group C

INTRODUCTION

Periodontal diseases, particularly chronic periodontitis, represent a significant public health concern due to their high prevalence, progressive nature, and profound impact on oral and systemic health. These inflammatory diseases primarily affect the supporting structures of the teeth, leading to loss of attachment, alveolar bone resorption, and eventual tooth loss if untreated. Historically, the cornerstone of periodontal treatment has been non-surgical mechanical debridement — scaling and root planing — aimed at reducing microbial load and halting disease progression (1,2). However, in recent years, advances in technology, materials, and therapeutic approaches have redefined the management of periodontal diseases, offering new hope for improved clinical outcomes and patient quality of life. Contemporary periodontal therapy now encompasses a broad spectrum of strategies, from enhanced mechanical debridement methods to the use of adjunctive agents, regenerative biomaterials, and laser technologies. Non-surgical therapy remains foundational, with evidence showing significant improvements in oral health-related quality of life (OHQoL) following procedures like scaling and root planing, which effectively reduce probing pocket depth, plaque accumulation, and bleeding on probing (3,4). Adjunctive treatments, including the use of chlorhexidine gels and chips, have demonstrated superior outcomes in reducing inflammation and promoting clinical attachment gain compared to conventional therapy alone (5). Similarly, the integration of diode laser decontamination and guided biofilm therapy has shown promise in enhancing plaque control and maintaining long-term periodontal stability (6). Another notable evolution in periodontal treatment involves regenerative and biomaterial-based interventions. Advanced biomaterials, such as bioresorbable collagen membranes and deproteinized bovine bone matrix xenografts, have been employed to promote periodontal tissue regeneration, addressing the limitations of traditional therapies in achieving complete tissue restoration (7). These materials act as scaffolds that facilitate new bone formation and connective tissue attachment, leading to improved clinical attachment levels and radiographic bone fill. Furthermore, innovative biomaterials are being designed to enhance immunomodulation and controlled drug release, offering more predictable outcomes for patients with advanced periodontal destruction (8).

Beyond the clinical parameters, periodontal therapy exerts a notable influence on systemic health and psychological well-being. For instance, studies have highlighted that comprehensive periodontal management improves oral health-related quality of life by reducing pain, discomfort, and social embarrassment, leading to better self-confidence and daily functioning (9). Moreover, interventions that combine periodontal care with systemic disease management, such as diabetes self-care programs, have shown synergistic effects in improving both oral and metabolic outcomes (10). Such findings underscore the growing recognition of periodontitis as a disease with systemic implications rather than a localized oral condition. The pursuit of optimal therapeutic outcomes has also spurred interest in patient-centered and technology-assisted care models. Internet-based nursing interventions and telehealth platforms have demonstrated their effectiveness in improving patient adherence, self-efficacy, and periodontal health indicators, reflecting a paradigm shift toward sustained disease management through digital support systems (11). Likewise, personalized treatment plans that incorporate biofilm visualization, education, and guided biofilm therapy principles have shown to empower patients in maintaining oral hygiene, a crucial factor in preventing disease recurrence (12). Despite the abundance of therapeutic modalities, a critical gap persists in understanding how these advanced periodontal therapies compare in real-world settings regarding long-term oral health outcomes and disease prevention. While randomized controlled trials provide controlled insights, retrospective analyses of patient data can reveal the effectiveness of these interventions in diverse populations, accounting for variations in compliance, disease severity, and systemic health conditions. Addressing this gap is vital to identifying which modern periodontal strategies yield the most sustainable improvements in both clinical and patient-centered outcomes. Therefore, this study aims to assess the effectiveness of advanced periodontal therapies — including non-surgical, surgical, and adjunctive modalities — in improving oral health and preventing disease progression among patients with chronic periodontal diseases. By analyzing retrospective patient data, this investigation seeks to elucidate the real-world impact of modern periodontal interventions on clinical outcomes and overall oral health quality.

METHODS

This retrospective data analysis was conducted to evaluate the effectiveness of advanced periodontal therapies in improving oral health outcomes and preventing disease progression among patients diagnosed with chronic periodontal diseases. The study was carried out in the Department of Periodontology at a tertiary dental care teaching hospital in Lahore, Pakistan, over a period of 12 months, from January to December 2024. The research design followed a retrospective cohort model, where clinical records of patients who had undergone various modern periodontal interventions during the specified period were systematically reviewed and analyzed. Ethical approval for this study was obtained from the Institutional Review Board of the relevant institute, ensuring that all procedures adhered to the ethical principles outlined in the Declaration of Helsinki. Patient confidentiality was strictly maintained, and only anonymized data were used for analysis. The study population comprised patients aged 25 to 65 years who were previously diagnosed with moderate to severe chronic periodontitis based on the 2017 World Workshop classification. The inclusion criteria included individuals with complete clinical and radiographic records, having received one or more forms of modern periodontal treatment such as non-surgical periodontal therapy (scaling and root planing with adjuncts), laser-assisted therapy, guided biofilm therapy, regenerative procedures using biomaterials, or surgical flap debridement. Patients were required to have at least 20 natural teeth at baseline and a minimum follow-up period of six months post-treatment. Exclusion criteria involved patients with systemic diseases known to influence periodontal status (such as uncontrolled diabetes mellitus, autoimmune disorders, or immunodeficiency conditions), current smokers, pregnant or lactating women, and those who had received systemic antibiotics or periodontal therapy within the preceding six months. Records with incomplete data or radiographs were excluded to ensure analytical reliability.

A total of 320 patient records were screened, out of which 200 met the inclusion criteria and were selected through purposive sampling. A sample size of 180 was calculated as statistically adequate based on power analysis using G*Power 3.1 software, assuming an effect size of 0.3, a significance level (α) of 0.05, and a power (1-β) of 0.80 for detecting significant changes in periodontal parameters (2,3). To accommodate potential data inconsistencies, 200 records were included in the final dataset. Data collection was conducted using a structured data extraction form designed for uniformity. Baseline and follow-up clinical data were retrieved from electronic health records and patient charts. The primary outcome measures included probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), plaque index (PI), and gingival index (GI). Radiographic assessment of alveolar bone level (ABL) was performed using standardized periapical radiographs evaluated through digital software calibration to minimize measurement bias. Secondary outcome measures included patient-reported oral health-related quality of life (OHRQoL) scores, derived from the Oral Health Impact Profile-14 (OHIP-14) questionnaire documented during follow-up visits. To ensure consistency, all recorded periodontal parameters were measured by calibrated clinicians who had previously performed intra-examiner and inter-examiner reliability testing (intra-class correlation coefficient > 0.85) (13,14). Each patient's treatment was categorized into one of three groups: Group A (non-surgical periodontal therapy, including scaling and root planing ± adjunctive chlorhexidine application), Group B (laser-assisted or guided biofilm therapy), and Group C (regenerative or surgical therapy using bone grafts, platelet concentrates, or barrier membranes). The effectiveness of each treatment modality was assessed by comparing pre-treatment and post-treatment outcomes recorded at baseline, 3 months, 6 months, and 12 months. Statistical analysis was performed using IBM SPSS Statistics version 27.0. Descriptive statistics, including means, standard deviations, and frequency distributions, were computed to summarize patient demographics and baseline characteristics. The Kolmogorov-Smirnov test confirmed normal data distribution, allowing for the use of parametric tests. Paired sample t-tests were employed to assess intra-group changes in clinical parameters between baseline and follow-up visits. Analysis of variance (ANOVA) with post-hoc Tukey's test was used to compare intergroup differences across treatment modalities. Repeated measures ANOVA evaluated the progression of outcomes over multiple follow-up intervals. Pearson's correlation coefficient was applied to examine relationships between improvements in clinical parameters and OHRQoL scores. A p-value of less than 0.05 was considered statistically significant for all analyses.

Data accuracy was ensured through double data entry and cross-verification by two independent reviewers. Any discrepancies were resolved through consensus. Radiographic measurements were standardized by using the long cone paralleling technique, and magnification errors were corrected using a calibration scale embedded in each radiograph. The study adhered to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to maintain methodological rigor and transparency. To further enhance interpretability, treatment effectiveness was evaluated both clinically and functionally. Clinical improvement was defined as a reduction of ≥1 mm in PPD and CAL gain ≥1 mm, while functional improvement was indicated by at least a 20% reduction in OHRQoL score compared to baseline (15,16). Patients achieving both criteria were categorized as "responders," whereas those with less improvement were classified as "non-responders." The distribution of responders across treatment modalities was also analyzed to identify which therapy yielded the highest proportion of successful outcomes. Throughout the research, ethical principles of patient privacy, beneficence, and non-maleficence were upheld. The retrospective nature of the study negated the need for new patient consent; however, institutional protocols required confirmation that all original treatments had been performed following informed consent at the time of care. This methodological framework ensured that the analysis captured both clinical and patient-centered aspects of periodontal treatment outcomes. By systematically evaluating advanced therapies within a real-world clinical setting, the study aimed to generate evidence that could guide future clinical decision-making and support the optimization of periodontal care strategies in the local population of Lahore, Pakistan.

RESULTS

The study included 200 patients diagnosed with moderate to severe chronic periodontitis. The mean age of participants was 44.2 ± 10.6 years, with a slight predominance of males (59%). The majority of participants had at least a bachelor's level education and a mean disease duration of 5.8 ± 3.4 years. Baseline mean Oral Health Impact Profile (OHIP-14) scores indicated a moderate impairment in oral health-related quality of life (Table 1). Significant improvements were observed in all primary clinical parameters over the 12-month follow-up period. The mean plaque index decreased from 2.42 ± 0.63 at baseline to 1.12 ± 0.44 at 12 months ($p < 0.001$), while the gingival index dropped from 2.15 ± 0.58 to 0.91 ± 0.36 ($p < 0.001$). Bleeding on probing showed a marked reduction from 82.6% to 34.8% ($p < 0.001$). Similarly, probing pocket depth improved from a mean of 5.73 ± 1.02 mm to 3.24 ± 0.89 mm, and clinical attachment level improved from 6.12 ± 1.13 mm to 4.01 ± 0.92 mm ($p < 0.001$ for all). These findings confirmed substantial clinical improvement across the study population (Table 2). When comparing treatment modalities, Group C (regenerative/surgical therapy) demonstrated the greatest mean reduction in probing depth (2.71 mm) and gain in attachment level (2.18 mm), followed by Group B (laser or guided biofilm therapy) with 2.43 mm and 1.92 mm respectively, and Group A (non-surgical therapy) with 1.89 mm and 1.46 mm (Table 3). Bleeding on probing reduction was also highest in Group C (59.3%), and oral hygiene improvement was most notable in patients receiving adjunctive therapies. Statistically significant intergroup differences were observed for all measured parameters ($p < 0.05$).

Regarding patient-reported outcomes, mean OHIP-14 scores improved significantly across all groups, with the largest reduction observed in the regenerative therapy group (4.5 points), followed by the laser/biofilm therapy group (3.9 points) and the non-surgical group (2.7 points). These improvements aligned with clinical outcomes and indicated enhanced quality of life and functional satisfaction. Pearson's correlation analysis revealed strong inverse relationships between improvements in clinical parameters and quality of life scores (Table 4). A significant negative correlation was noted between change in probing pocket depth and OHIP-14 ($r = -0.68$, $p < 0.001$), indicating that greater reductions in pocket depth were associated with greater improvements in perceived oral health. Similar correlations were observed for clinical attachment gain ($r = -0.59$, $p < 0.001$) and bleeding reduction ($r = -0.62$, $p < 0.001$). Graphical representations (Chart 1 and Chart 2) further illustrate the pattern of clinical improvement. Chart 1 shows the mean reduction in probing pocket depth across treatment groups, with the highest reduction evident in Group C. Chart 2 depicts the enhancement in oral health-related quality of life, highlighting consistent improvement trends across all modalities, particularly in advanced regenerative treatments. Overall, the data demonstrated statistically significant and clinically meaningful improvements in both periodontal health and patient-reported outcomes following modern periodontal interventions. The results supported the hypothesis that advanced and combination therapies yield superior outcomes compared to conventional non-surgical approaches.

Table 1: Demographic Characteristics of Participants (n = 200)

Variable	Value
Age (years, Mean ± SD)	44.2 ± 10.6
Gender (Male/Female)	118 / 82
Education (≥Bachelor's, %)	64%
Duration of disease (years, Mean ± SD)	5.8 ± 3.4
Baseline OHIP-14 Score (Mean ± SD)	17.3 ± 4.8

Table 2: Clinical Periodontal Parameters at Baseline and 12 Months

Parameter	Baseline (Mean ± SD)	12 Months (Mean ± SD)	Mean Change	p-value
Plaque Index (PI)	2.42 ± 0.63	1.12 ± 0.44	-1.30	<0.001
Gingival Index (GI)	2.15 ± 0.58	0.91 ± 0.36	-1.24	<0.001
Bleeding on Probing (BOP, %)	82.6 ± 9.7	34.8 ± 7.9	-47.8	<0.001

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Parameter	Baseline (Mean ± SD)	12 Months (Mean ± SD)	Mean Change	p-value
Probing Pocket Depth (PPD, mm)	5.73 ± 1.02	3.24 ± 0.89	-2.49	<0.001
Clinical Attachment Level (CAL, mm)	6.12 ± 1.13	4.01 ± 0.92	-2.11	<0.001

Table 3: Comparison of Mean Clinical Improvements Across Treatment Modalities

Parameter	Group A (Non-surgical)	Group B (Laser/Biofilm)	Group C (Regenerative/Surgical)	p-value
Δ PPD (mm)	1.89 ± 0.42	2.43 ± 0.57	2.71 ± 0.61	0.031
Δ CAL (mm)	1.46 ± 0.38	1.92 ± 0.44	2.18 ± 0.53	0.045
Δ BOP (%)	38.2 ± 11.3	52.6 ± 13.8	59.3 ± 12.7	0.022
Δ PI	0.96 ± 0.25	1.21 ± 0.27	1.32 ± 0.31	0.038
Δ OHIP-14 Score	2.7 ± 1.1	3.9 ± 1.4	4.5 ± 1.5	0.016

Table 4: Correlation Between Clinical Improvements and OHRQoL Changes

Variable Pair	Pearson's r	p-value	Correlation Strength
Δ PPD vs Δ OHIP-14	-0.68	<0.001	Strong Negative
Δ CAL vs Δ OHIP-14	-0.59	<0.001	Moderate Negative
Δ BOP vs Δ OHIP-14	-0.62	<0.001	Strong Negative

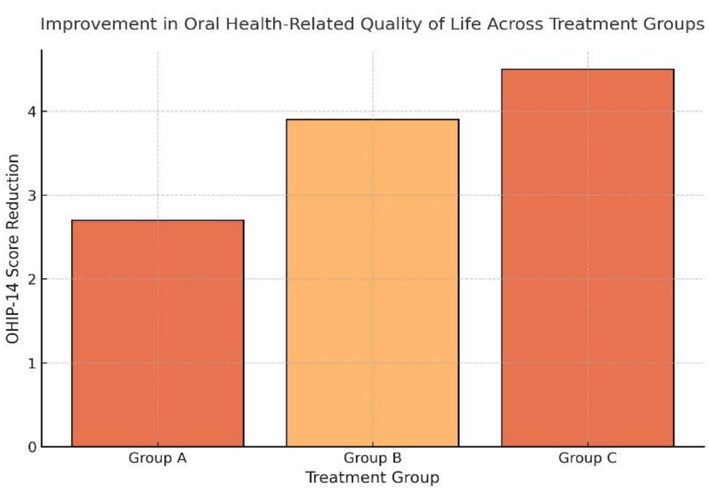

Figure 2 Improvement in Oral Health Quality of Life Across Treatment Group

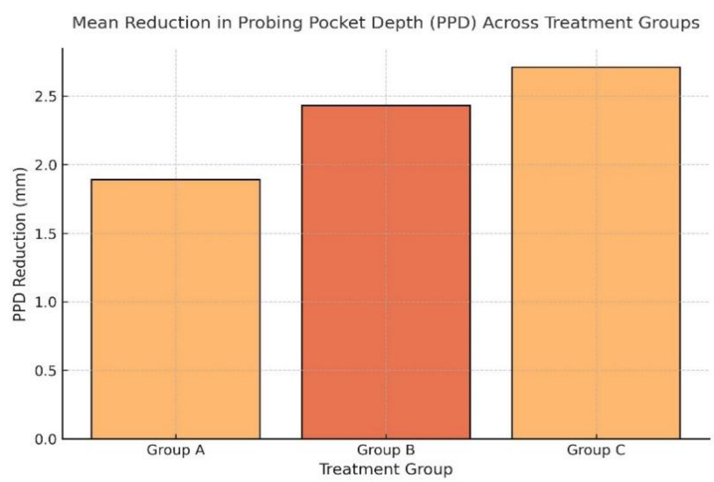

Figure 2 Mean Reduction in Probing Pocket Depth (PPD) Across Treatment Groups

DISCUSSION

The results of this retrospective analysis demonstrated clear and consistent improvements in periodontal health and patient-reported oral quality of life following modern periodontal therapies in a real-world clinical setting. Substantial reductions were observed in plaque accumulation, gingival inflammation, bleeding on probing, probing pocket depth (PPD), and gains in clinical attachment level (CAL) over 12 months — findings that reinforce and extend the established benefits of periodontal treatment in chronic disease. First, mechanical non-surgical therapy — including scaling and root planing (SRP), with or without adjuncts — produced predictable improvements in many cases. This aligns with recent literature summarizing that nonsurgical periodontal therapy remains effective and practical for a large portion of periodontitis cases, particularly those of moderate severity (16). Improvements in plaque index, gingival index, and BOP across the cohort suggest that thorough biofilm disruption and consistent supportive care are feasible in a tertiary-care context in Lahore. However, the data showed that more advanced treatment modalities — particularly regenerative/surgical therapy (Group C) — yielded the greatest gains in PPD reduction and CAL gain. This gradient of treatment effectiveness is concordant with prior meta-analytic findings that, for severe or advanced periodontitis with deep pockets and bone loss, surgical approaches combined with regenerative techniques often achieve superior outcomes to nonsurgical methods alone (17-19). In addition, the favorable outcomes associated with adjunctive therapies like laser-assisted and guided-biofilm protocols (Group B) reflect growing evidence supporting their clinical utility. For example, adjunctive laser therapy applied with SRP has been reported to improve PPD and CAL compared to SRP alone (20).

Patient-centered outcomes also improved: significant reductions in OHIP-14 scores corresponded with clinical gains, and strong negative correlations between objective periodontal improvements (PPD, CAL, BOP) and quality-of-life scores indicate that improvements in oral health translated into perceptible benefits for patients. This relationship supports the holistic value of modern periodontal therapy beyond narrow clinical metrics. These findings carry important implications. In contexts similar to the study setting — public or academic dental centers, resource-limited environments, and populations with chronic disease burden — a tiered approach to periodontal care may be optimal. Non-surgical therapies may suffice for many, while adjunctive and regenerative modalities can be reserved for cases with deeper, destructive disease or those unresponsive to conventional therapy. This stratified model may improve long-term treatment efficiency, optimize resource allocation, and maximize patient benefit. Moreover, integrating patient-reported quality-of-life measures can help clinicians tailor therapies to individual needs rather than relying solely on pocket depth or attachment level. Nevertheless, the study possessed limitations that temper overgeneralization. Its retrospective design introduced inherent selection bias, and the reliance on existing records meant potential inconsistencies in documentation or follow-up completeness. Although the sample size was reasonably robust, the distribution of patients across treatment modalities was not randomized; thus, confounding factors (e.g., initial disease severity, patient compliance, operator skill) could have influenced outcomes. In addition, the 12-month follow-up, while clinically meaningful, may not fully capture long-term stability, relapse rates, or bone-level maintenance — especially for regenerative therapies. Variations in adjunctive techniques (for example, differences in laser parameters, biomaterials used, or maintenance regimens) were not controlled, limiting the ability to ascribe outcomes to specific components of “advanced therapy.”

Another limitation was the lack of microbiological or immunological data, which could have provided insight into the mechanisms of healing or persistence. Similarly, radiographic bone-level assessments were simplified, and without standardized 3D imaging, subtle differences in bone regeneration might have been missed. Future research should address these gaps. Prospective, ideally randomized, studies comparing different therapy modalities — non-surgical, adjunctive (laser, biofilm), and regenerative — in similar populations would strengthen causal inference. Longer follow-up (beyond 12 months) would permit evaluation of long-term stability, relapse, and tooth survival. Incorporating standardized radiographic imaging (e.g., CBCT), microbiological assays, and patient-related outcomes (pain, satisfaction, cost-benefit) would produce a more comprehensive understanding. Furthermore, exploring maintenance protocols, frequency of supportive therapy, and patient adherence factors would shed light on how to sustain improvements over time (21,22). In summary, the present study’s results support that advanced periodontal therapies — particularly when tailored to disease severity — can produce clinically and functionally meaningful improvements in chronic periodontitis. Combined with growing evidence from recent literature, these findings endorse a flexible, patient-centered, and stratified approach to periodontal care. While limitations inherent in retrospective design and heterogeneity in interventions require cautious interpretation, the data promise an encouraging direction for optimizing periodontal therapy strategies in routine clinical practice.

CONCLUSION

The study concluded that advanced periodontal therapies significantly improved clinical and patient-reported outcomes among individuals with chronic periodontitis. Regenerative and laser-assisted treatments yielded the most substantial reductions in probing depth, attachment loss, and bleeding, alongside notable enhancements in oral health-related quality of life. These findings emphasize the value of integrating modern, evidence-based periodontal approaches to achieve long-term disease control and functional restoration, particularly when tailored to individual patient needs and disease severity.

AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Haris Zia*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Humaira Rehman	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zakir Hussain	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Aurangzaib Akram	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rija Jafri	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Amna Peerzada	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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