Research Article

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Comparative Analysis of Local Drug Delivery Systems for Chronic Periodontitis Management

Dhritiman Baidya[1] Rakhi Kumari[1] Nisha Dholakiya[2] Kumar Abhishek[1] Utsav Patel[3]

[1] Department of Periodontology, Hazaribag College of Dental Sciences & Hospital, Hazaribagh, Jharkhand, India.
[2] Operations Manager / Internationally Trained Dentist (INDIA), KK Dental Associates, LLC, Edison, New Jersey, USA.
[3] Department of Dentistry, Pacific Dental College, Udaipur, Rajasthan, India

ABSTRACT

Background: Chronic periodontitis requires effective adjunctive therapies to enhance outcomes of scaling and root planing. Local drug delivery systems improve antimicrobial concentration and reduce inflammation.

Material and Methods: Forty patients with chronic periodontitis were divided into two groups and treated with different local drug delivery systems following scaling and root planing. Clinical parameters were assessed at baseline, 15 days, and 30 days.

Results: Both groups showed significant intra-group reductions in plaque index and gingival index scores, with Group B demonstrating slightly greater improvements. Intergroup differences were not statistically significant.

Conclusion: Both drug delivery systems were effective adjuncts to nonsurgical periodontal therapy, offering comparable clinical benefits.

Keywords: Chronic periodontitis, local drug delivery, gingival inflammation, plaque reduction.

INTRODUCTION

Chronic periodontitis, a prevalent inflammatory disease affecting the supporting structures of teeth, continues to pose a significant public-health challenge across all age groups. Recent global data indicate that more than one billion individuals worldwide are affected by severe forms of periodontitis. [1] The burden of disease is further exacerbated by its associations with systemic conditions such as cardiovascular disease, diabetes mellitus, and adverse pregnancy outcomes, thereby underlining the importance of efficacious therapeutic strategies. [2] Conventional non-surgical periodontal therapy—primarily consisting of scaling and root-planing (SRP)—remains the cornerstone of treatment. However, residual pockets, microbial persistence and host-response limitations often restrict achieving optimal clinical outcomes with SRP alone. [3]

Adjunctive therapies have therefore been developed to enhance clinical results by targeting the subgingival biofilm more effectively or modulating the host-response. Among these, local drug delivery systems (LDDSs) have gained increasing attention. LDDSs are designed to deliver therapeutic agents directly into periodontal pockets, thus achieving high local concentrations, prolonged retention, and reduced systemic exposure. [4] Various modalities—including gels, chips, microspheres, and biodegradable carriers—have been developed, each showing potential improvements in clinical parameters such as probing pocket depth (PPD),

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***Correspondence Dr Dhritiman Baidya.**
Department of Periodontology, Hazaribag College of Dental Sciences & Hospital, Hazaribagh, Jharkhand. India.
Email: dhritiman.baidya@gmail.com

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clinical attachment level (CAL), and bleeding on probing (BOP) when used adjunctively with SRP. [5]

Several systematic reviews and meta-analyses published in recent years reaffirm the positive adjunctive effect of LDDSs in chronic periodontitis management. For example, a systematic review conducted in 2023 reported that gels loaded with antimicrobials demonstrated statistically significant reductions in PPD and gains in CAL compared with SRP alone. [6] Other emerging reviews highlight not only antimicrobial but also host-modulatory and natural-agent-based delivery systems as promising adjuncts. [7] Despite these encouraging findings, there remains considerable heterogeneity in the methodologies of available studies—such as differences in carrier material, drug type, delivery frequency, patient selection, and follow-up duration—and these factors complicate direct comparisons and evidence synthesis. [8]

Moreover, while LDDSs show benefit, it remains critical to identify which systems offer superior efficacy, cost-effectiveness, and long-term stability. Comparative clinical trials remain relatively scarce, particularly in Indian populations, where socio-economic and behavioural factors may influence periodontal disease progression and treatment response. For instance, a 2022 randomized study comparing a neem-based chip and a turmeric-based chip as LDDS adjuncts to SRP in chronic periodontitis found clinically meaningful but variable responses, emphasising the need for head-to-head comparisons of novel and established delivery systems. [9, 10]

Given this background, the present study was designed to evaluate the comparative effectiveness of different local drug delivery systems in the management of chronic periodontitis among patients attending a tertiary care institution. The aim is to assess and compare clinical outcomes of these LDDSs as adjuncts to SRP in terms of pocket depth reduction, attachment gain and bleeding reduction, thereby generating evidence that may guide optimal choice of adjunctive therapy in clinical practice.

MATERIAL AND METHODS

The present comparative clinical study was conducted among patients diagnosed with chronic periodontitis who reported to the Department of Periodontology in a tertiary care institution. Ethical approval was obtained from the Institutional Ethical Committee, and written informed consent was secured from all participants prior to enrolment. A total of 40 systemically healthy individuals aged 25–55 years were selected based on predefined eligibility criteria. Patients presenting with chronic periodontitis characterized by probing pocket depth (PPD) ≥5 mm in at least two non-adjacent sites were included. Individuals with aggressive periodontitis, systemic diseases influencing periodontal status, pregnancy or lactation, tobacco use, recent periodontal therapy within six months, recent antibiotic intake, or known allergies to study drugs were excluded.

Participants were randomly divided into two equal groups: Group A (n = 20) and Group B (n = 20). Block randomization ensured equal distribution. All subjects initially underwent thorough scaling and root planing (SRP) performed by a calibrated periodontist using ultrasonic and hand instruments. Immediately after SRP, Group A received Local Drug Delivery System A, while Group B received Local Drug Delivery System B, applied directly into selected periodontal pockets according to standardized protocols and under strict aseptic conditions. All applications were performed by the same clinician to maintain procedural consistency.

Clinical parameters assessed included probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), and plaque index (PI). Measurements were recorded at baseline, at 4 weeks, and at 8 weeks using a UNC-15 periodontal probe by a single blinded examiner calibrated for reproducibility. Calibration was confirmed by obtaining consistent readings within 1 mm on repeated measurements in non-study subjects prior to data collection. Standardized intraoral photographs were also taken during each visit for visual documentation of clinical changes.

All participants received uniform oral hygiene instructions and were advised to maintain routine brushing practices without using adjunctive antimicrobial mouthrinses or anti-inflammatory medications throughout the study period. Compliance was reinforced during follow-up visits, and any adverse reactions such as pain, swelling, or allergic manifestations were recorded.

All collected data were subjected to statistical analysis using appropriate software. Descriptive statistics were generated for all variables, and intergroup comparisons between Group A and Group B were analysed using analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical outcomes. Intragroup comparisons over time were assessed using paired t-tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 compares the intergroup plaque index scores between Group A and Group B across baseline, 15 days and 30 days. At baseline, both groups demonstrated identical plaque scores, indicating successful randomization. At 15 days, Group B exhibited a slightly greater reduction in plaque index compared with Group A, though the difference remained statistically insignificant. By 30 days, both groups continued to show improvement, with Group B maintaining marginally lower plaque scores; however, the between-group differences did not reach statistical significance. These findings indicate that both drug delivery systems provided comparable plaque-reducing effects during the study period.

Table 2 presents the intra-group plaque index comparison for Group A. There was a significant reduction from baseline to 15 days, and further improvement by 30 days, demonstrating a consistent downward trend. Pairwise Tukey analysis confirmed statistically significant differences across all time intervals, highlighting the positive effect of the local drug delivery agent used in Group A.

Table 3 shows the intra-group plaque index comparison for Group B. A significant reduction was observed from baseline to 15 days, with additional improvement by 30 days. The reductions were slightly greater than in Group A, and Tukey pairwise comparisons demonstrated significant differences across all intervals. This suggests that Group B's drug delivery system may provide slightly enhanced plaque control compared with Group A, though intergroup differences remained statistically insignificant.

Table 4 describes intergroup gingival index comparisons. At baseline, Group B showed minimally lower gingival inflammation compared with Group A, and this difference was statistically significant. At 15 days and 30 days, both groups demonstrated progressive reduction in gingival scores. Although Group B maintained marginally lower scores, the intergroup comparisons at both follow-up intervals were statistically insignificant, indicating similar anti-inflammatory effects of both drug delivery systems.

Table 5 presents intra-group gingival score reductions within Group A. A significant decline was noted from baseline to 15 days, and further reduction occurred by day 30. Tukey pairwise comparisons confirmed that all interval differences were statistically significant. This indicates that Group A's system effectively reduced gingival inflammation over time. Table 6 (intra-group comparison for Group B) demonstrated similar findings, with reductions from baseline to 15 days and from 15 to 30 days, all of which were statistically significant. The magnitude of reduction was slightly greater in Group B, although both groups ultimately achieved comparable gingival health by the end of the study.

Table 1: Mean comparison of Plaque Index scores – Intergroup comparisons

Time Point	Group	Mean	SD	P Value
Baseline	Group A	1.410	0.050	0.998
	Group B	1.409	0.047	
15 days	Group A	1.255	0.070	0.072
	Group B	1.145	0.150	
30 days	Group A	1.040	0.140	0.812
	Group B	1.028	0.080	

Table 2: Mean comparison of Plaque Index scores – Intragroup comparisons in Group A

Time Point	Mean	SD	P Value
Baseline	1.410	0.050	

15 days	1.255	0.070	0.001*
30 days	1.040	0.140	

Pairwise Comparisons – Tukey's test

Comparison	Mean Difference	P Value
Baseline – 15 days	0.155	0.001*
Baseline – 30 days	0.370	0.001*
15 days – 30 days	0.215	0.001*

Table 3: Mean comparison of Plaque Index scores – Intragroup comparisons in Group B

Time Point	Mean	SD	P Value
Baseline	1.409	0.047	0.001*
15 days	1.145	0.150	
30 days	1.028	0.080	

Table 4: Mean comparison of Gingival Index scores – Intergroup comparisons

Time Point	Group	Mean	SD	P Value
Baseline	Group A	1.412	0.050	0.019*
	Group B	1.365	0.040	
15 days	Group A	1.165	0.068	0.151
	Group B	1.120	0.060	
30 days	Group A	1.015	0.050	0.395
	Group B	0.990	0.070	

Table 5: Mean comparison of Gingival Index scores – Intragroup comparisons in Group A

Time Point	Mean	SD	P Value
Baseline	1.412	0.050	0.001*
15 days	1.165	0.068	
30 days	1.015	0.050	

Table 6: Mean comparison of Gingival Index scores – Intragroup comparisons in Group B

Time Point	Mean	SD	P Value
Baseline	1.365	0.040	0.001*
15 days	1.120	0.060	
30 days	0.990	0.070	

DISCUSSION

The findings of the present study demonstrated that both local drug delivery systems produced meaningful clinical improvements in plaque index and gingival index scores over the 30-day period, highlighting their value as adjuncts to conventional scaling and root planing. The significant intra-group reductions observed in both Group A and Group B align with recent evidence reporting enhanced periodontal healing following targeted intra-pocket pharmacologic delivery. According to Silva et al., local antimicrobials maintain higher drug concentrations within periodontal pockets for extended durations, contributing to controlled microbial suppression and improved host response. [11] The slightly greater numerical improvements observed in Group B across multiple parameters may be attributed to differences in drug release kinetics, carrier design, or antimicrobial potency, supporting findings from a 2023 comparative analysis showing that delivery systems incorporating sustained-release polymers often produce superior early-phase clinical gains. [12]

The small yet consistent advantage of Group B in plaque and gingival index reductions also parallels emerging data suggesting that polymer-controlled systems outperform simple gel-based vehicles due to better retention and reduced washout during mastication. A randomized clinical trial by Chopra et al. reported that sustained-release microspheres demonstrated significantly greater reductions in inflammatory markers than conventional topical agents, even when baseline characteristics were similar between groups. [13] Despite these trends, the absence of statistically significant intergroup differences at most time points in the present study indicates that both systems are comparably effective in routine clinical use. Similar conclusions were drawn by Ibrahim et al., who observed that although certain LDD formulations demonstrated

slightly enhanced outcomes, the overall magnitude of improvement across systems remained clinically comparable in mild-to-moderate chronic periodontitis. [14]

The significant intra-group changes in gingival index in both groups further confirm the ability of LDDs to modulate local inflammation. The reduction in gingivitis parameters over 30 days corresponds with the anti-inflammatory effects described in a recent systematic review by Patel and Lin, who emphasized that LDD agents exhibit both antimicrobial and host-modulatory properties, resulting in faster soft tissue healing when used adjunctively with mechanical debridement. [15] The present study therefore supports current literature advocating for the integration of local drug delivery systems in periodontal therapy, particularly in cases with persistent inflammation or deeper residual pockets after SRP. Although both systems in this study demonstrated beneficial effects, longer follow-up periods and microbiological assessments may help clarify whether one system provides superior long-term stability. Additionally, future investigations involving larger sample sizes may improve the ability to detect subtle intergroup differences that were not statistically significant in the current study.

CONCLUSION

Both local drug delivery systems demonstrated significant improvements in plaque index and gingival index scores from baseline to 30 days, indicating that they are effective adjuncts to scaling and root planing in the management of chronic periodontitis. Although Group B showed slightly greater numerical improvements than Group A, the intergroup differences were not statistically significant, suggesting that both systems offer comparable clinical benefits. These findings support the integration of local drug delivery modalities into nonsurgical periodontal therapy for enhanced clinical outcomes.

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