Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Comparison of Two Local Drug Delivery Systems in the Management of Chronic Periodontitis

[1]Priya Sharma, [2]Gaurav Kansal, [3]Harveen Singh, [4]Isharpreet Singh, [5]Aasiya Gul

[1,4]M.D.S. Student, [2]Professor, [3]Professor and Head, [5]Assistant Professor, Department of Periodontology, Genesis Institute of Dental Sciences and Research, Ferozepur, Punjab, India

ABSTRACT:

Background: Chronic periodontitis is a prevalent inflammatory disease characterized by progressive destruction of periodontal tissues, driven by a dysbiotic biofilm and host inflammatory response. While scaling and root planing (SRP) is the foundation of non-surgical periodontal therapy, residual pockets and persistent inflammation often necessitate adjunctive interventions. Local drug delivery (LDD) systems such as chlorhexidine chips and doxycycline gels offer targeted antimicrobial activity, potentially enhancing clinical outcomes by maintaining therapeutic drug levels within periodontal pockets. However, direct comparative evidence between commonly used LDD agents remains limited. **Aim:** To compare the clinical effectiveness of two local drug delivery systems—chlorhexidine gluconate chip (PerioChip®) and doxycycline hyclate gel (Atridox®)—as adjuncts to scaling and root planing in the management of chronic periodontitis. **Materials and Methods:** This randomized, parallel-group controlled clinical study included 20 systemically healthy patients diagnosed with chronic periodontitis. Participants were allocated into two groups: Group A received PerioChip®, and Group B received Atridox®, following full-mouth SRP. Clinical parameters including probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), and plaque index (PI) were recorded at baseline and follow-up. Statistical analysis was performed using SPSS version 26.0, with $p < 0.05$ considered significant. **Results:** Both treatment groups demonstrated significant improvements from baseline across all clinical parameters ($p < 0.001$). In Group A (PerioChip®), mean reductions were 1.54 mm in PPD, 1.18 mm in CAL, 33.80% in BOP, and 25.80% in PI. In Group B (Atridox®), reductions were greater, with 1.82 mm in PPD, 1.44 mm in CAL, 38.40% in BOP, and 29.20% in PI. Inter-group comparisons showed statistically significant superiority of Atridox® across all parameters ($p < 0.05$). Although 90% of participants in Group B exhibited a good response compared to 70% in Group A, this difference was not statistically significant ($p = 0.24$). **Conclusion:** Both PerioChip® and Atridox® effectively enhanced periodontal healing when used as adjuncts to SRP. However, Atridox® demonstrated modest but statistically significant superior clinical outcomes, suggesting its potential advantage in managing chronic periodontitis.

Keywords: Chronic periodontitis, Local drug delivery, PerioChip®, Atridox®, Scaling and root planning

Received: 02 November, 2025 Accepted: 04 December, 2025 Published: 05 December, 2025

Corresponding Author: Isharpreet Singh, M.D.S. Student, Department of Periodontology, Genesis Institute of Dental Sciences and Research, Ferozepur, Punjab, India

This article may be cited as Sharma P, Kansal G, Singh H, Singh I, Gul A. Comparison of Two Local Drug Delivery Systems in the Management of Chronic Periodontitis. J AdvMed Dent Scie Res 2025; 13(12):1-7.

INTRODUCTION

Chronic periodontitis is a prevalent, biofilm-mediated inflammatory disease that leads to progressive destruction of the supporting structures of the teeth, characterized clinically by periodontal pocket formation, loss of clinical attachment and eventual tooth loss if left untreated. It poses a major public health burden worldwide, with severe forms affecting a substantial proportion of adults and contributing significantly to impaired oral function, reduced quality of life and increased treatment needs. Epidemiological data have shown that severe periodontitis ranks among the most common chronic conditions globally, with prevalence rising with age and peaking in middle adulthood.This growing burden is particularly relevant in developing countries and low-resource settings, where limited access to regular dental care and preventive services may exacerbate disease progression and late presentation. In addition to local tissue destruction, chronic periodontitis has been increasingly recognized as a condition with important systemic implications, given its association

with cardiovascular disease, diabetes mellitus, adverse pregnancy outcomes and other chronic inflammatory disorders through shared inflammatory and genetic pathways.[1]The pathogenesis of chronic periodontitis is now understood as the result of a complex interplay between a dysbiotic subgingival biofilm and a susceptible host. Dental plaque alone is not sufficient to cause disease; rather, qualitative shifts in the microbial community, including the emergence of keystone pathogens and pathobionts, drive a chronic, dysregulated host immune response within the periodontal tissues.[2] This sustained inflammatory milieu leads to breakdown of collagen fibers, pocket formation, and alveolar bone resorption. Genetic and epigenetic factors, along with environmental influences such as poor oral hygiene, smoking and metabolic abnormalities, modulate individual susceptibility and the severity of periodontal breakdown.Contemporary concepts emphasize that effective management of chronic periodontitis must therefore target both the microbial challenge and the host response, while also addressing patient-related risk factors to achieve long-term disease control.[3],[4]Conventional non-surgical periodontal therapy, primarily scaling and root planing (SRP), remains the cornerstone of treatment for most patients with chronic periodontitis. Mechanical debridement aims to disrupt and remove supra- and subgingival biofilm and calculus, smooth root surfaces, and allow re-establishment of a compatible host–microbe equilibrium. Numerous clinical trials have demonstrated that SRP can achieve significant reductions in probing pocket depth, gains in clinical attachment and improvements in bleeding indices in mild to moderate disease. However, SRP alone may be insufficient in deep or anatomically complex sites, furcation areas, and in patients with high microbial loads or compromised host response. Residual pockets and persistent pathogenic microbiota have been frequently reported following mechanical therapy, and these sites are known to be at increased risk for continued disease progression and tooth loss.[5]As a result, various adjunctive strategies, including systemic antibiotics, host modulation therapy and local delivery of antimicrobial agents, have been explored to enhance clinical outcomes and reduce the need for surgical intervention.Systemic antimicrobial therapy can improve clinical and microbiological parameters in selected cases, particularly in aggressive or generalized advanced periodontitis. Nonetheless, concerns about adverse effects, alteration of commensal flora and the growing problem of antimicrobial resistance have shifted attention towards localized approaches. Local drug delivery (LDD) systems were developed to place high concentrations of antimicrobial or host-modulating agents directly into periodontal pockets, with minimal systemic exposure.[6] Different delivery platforms—such as fibers, gels, chips, microspheres and films—have been designed to provide sustained release of active agents like tetracyclines, minocycline, doxycycline, metronidazole and chlorhexidine.[6] These systems can maintain therapeutic levels of the drug at the diseased site for extended periods, overcome limitations of patient compliance with topical rinses, and potentially improve the clinical efficacy of SRP in deep pockets by better penetrating biofilms and reaching protected niches.[6]Among the commercially available LDD systems, the chlorhexidine gluconate chip (PerioChip®) and the 10% doxycycline hyclate gel (Atridox®) are two widely used adjuncts in non-surgical periodontal therapy. PerioChip® is a biodegradable hydrolyzedgelatin matrix containing 2.5 mg chlorhexidine gluconate, designed to be inserted into periodontal pockets where it gradually releases the antiseptic over approximately one week. Clinical studies and systematic reviews have reported additional reductions in probing depth, improvements in clinical attachment level and decreases in plaque and bleeding indices when the chlorhexidine chip is used in combination with SRP compared with SRP alone.[7]Atridox® is a subgingivally delivered, controlled-release doxycycline hyclate gel formulated in a bioabsorbable polymer (Atrigel®) that solidifies in situ and releases the antibiotic over about seven days. Controlled clinical trials have shown that adjunctive use of 10% doxycycline gel can yield greater improvements in clinical parameters than mechanical therapy alone, with beneficial effects on subgingival microbiota.[6] Despite the evidence supporting each agent individually, there is relatively limited direct, head-to-head comparison of these two LDD systems in a standardized clinical setting, particularly in small, pragmatic trials conducted in tertiary care hospitals.

MATERIAL AND METHODS

This randomized, parallel-group, controlled clinical study was conducted in the Department of Periodontology at Genesis Institute of Dental Sciences And Research, Ferozpur to compare the clinical effectiveness of two commonly used local drug delivery systems in the management of chronic periodontitis. The selected LDD systems were the chlorhexidine gluconate chip (PerioChip®) and doxycycline hyclate gel (Atridox®), both of which are readily available in the clinical market and widely used in periodontal therapy. Ethical approval was obtained prior to the commencement of the study, and written informed consent was secured from all participants.A total of 20 systemically healthy patients diagnosed with chronic periodontitis were recruited based on the established inclusion and exclusion criteria. Eligible patients were adults presenting with clinical signs of chronic periodontitis, including probing pocket depth ≥5 mm in at least two non-adjacent sites. Patients with systemic illnesses affecting periodontal health, history of periodontal therapy within recent months, use of antibiotics, known allergies to chlorhexidine or doxycycline,

pregnancy, lactation, or tobacco use were excluded. All patients underwent detailed periodontal examination and baseline evaluation.

Methodology

Participants were selected through consecutive sampling from individuals reporting to the periodontal outpatient clinic. After eligibility screening, the 20 patients were randomly divided into two equal groups using a simple randomization method. Group A received the chlorhexidine gluconate chip (PerioChip®), and Group B received doxycycline hyclate gel (Atridox®) as adjunctive therapy following scaling and root planing. Randomization ensured equal probability of assignment and minimized selection bias.

Clinical Procedures

All participants initially underwent full-mouth scaling and root planing performed with ultrasonic and manual periodontal instruments by an experienced periodontist. Following SRP, Group A received the PerioChip®, a biodegradable chip containing 2.5 mg chlorhexidine gluconate, inserted into selected periodontal pockets. Group B received Atridox®, a 10% doxycycline hyclate controlled-release gel, administered directly to the base of periodontal pockets using a prefilled syringe. Placement of both LDD agents was performed according to manufacturers' guidelines. Standardized post-procedural instructions were provided, and no systemic antibiotics were prescribed.

Clinical Parameters Assessed

Periodontal evaluation of probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), and plaque index (PI) was carried out at baseline and follow-up. All measurements were obtained using a UNC-15 periodontal probe by a single calibrated examiner blinded to the group allocation. Calibration exercises ensured reproducibility and minimized intra-examiner variation.

Clinical findings, demographic details, treatment allocation, and follow-up outcomes were recorded on structured data collection sheets specifically designed for the study. Manual entry of patient data was cross-checked by an independent reviewer to ensure accuracy and prevent transcription errors.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 26.0. Descriptive statistics were computed for all continuous variables. Intra-group comparisons between baseline and follow-up parameters were analyzed using paired t-tests. Inter-group comparisons were conducted using the independent t-test. Categorical variables were assessed using chi-square tests. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic Characteristics

The baseline demographic and clinical characteristics of the study participants were comparable between the two treatment groups. The mean age in Group A (PerioChip®) was 42.30 ± 6.12 years, while Group B (Atridox®) had a mean age of 41.80 ± 5.96 years. The difference in age distribution was statistically insignificant ($p = 0.84$), indicating that both groups were matched with respect to age. Gender distribution also showed no significant difference between the groups, with males comprising 60.00% of Group A and 50.00% of Group B ($p = 0.65$). Similarly, female participants accounted for 40.00% of Group A and 50.00% of Group B. The baseline periodontal parameters were also comparable between the groups. The mean probing pocket depth (PPD) at baseline was 5.96 ± 0.48 mm in Group A and 5.92 ± 0.44 mm in Group B, with no significant difference ($p = 0.81$). Likewise, clinical attachment level (CAL) at baseline showed no significant variation between the two study arms, recorded as 6.28 ± 0.56 mm in Group A and 6.34 ± 0.52 mm in Group B ($p = 0.72$).

Table 2: Intra-Group Comparison of Group A (PerioChip®)

Within Group A, the use of PerioChip® resulted in significant improvements in all assessed clinical parameters from baseline to follow-up. The mean PPD showed a marked reduction from 5.96 ± 0.48 mm at baseline to 4.42 ± 0.38 mm at follow-up, reflecting a mean reduction of 1.54 mm, which was statistically significant ($p < 0.001$). Similarly, CAL improved significantly, with values decreasing from 6.28 ± 0.56 mm at baseline to 5.10 ± 0.42 mm at follow-up, giving a mean gain of 1.18 mm ($p < 0.001$). Bleeding on probing (BOP) demonstrated a substantial decline from 62.40% ± 8.12% to 28.60% ± 6.44%, corresponding to a reduction of 33.80%, which was statistically meaningful ($p < 0.001$). Plaque index (PI) also showed significant improvement, decreasing from 68.20% ± 7.26% at baseline to 42.40% ± 6.22% at follow-up—a mean reduction of 25.80% ($p < 0.001$).

Table 3: Intra-Group Comparison of Group B (Atridox®)

Group B, which received Atridox®, also exhibited significant improvement across all clinical parameters. The mean probing pocket depth reduced significantly from 5.92 ± 0.44 mm at baseline to 4.10 ± 0.36 mm at follow-up, giving a mean reduction of 1.82 mm ($p < 0.001$). Clinical attachment level improved from 6.34 ± 0.52 mm to 4.90 ± 0.40 mm, resulting in a mean gain of 1.44 mm, which was statistically highly significant ($p < 0.001$). Bleeding on probing showed a notable reduction from 61.20% ± 7.84% at baseline to 22.80% ± 5.92% at follow-up, with a mean reduction of 38.40% ($p < 0.001$). Similarly, plaque index decreased markedly from

67.40% ± 6.98% to 38.20% ± 5.48%, showing an improvement of 29.20% ($p < 0.001$).

Table 4: Inter-Group Comparison of Mean Reductions

When comparing the mean reductions between the two groups, Group B (Atridox®) demonstrated significantly greater improvements across all clinical parameters compared to Group A (PerioChip®). The reduction in PPD was significantly greater in Group B (1.82 ± 0.24 mm) compared to Group A (1.54 ± 0.22 mm), with a p-value of 0.01, indicating a statistically meaningful difference. Similarly, CAL gain was higher in Group B (1.44 ± 0.18 mm) than in Group A (1.18 ± 0.20 mm), with a significant p-value of 0.02. Bleeding on probing reduction was also superior in Group B, showing a mean reduction of 38.40% ± 5.14% compared to 33.80% ± 4.62% in Group A ($p = 0.04$). Finally, plaque index reduction was significantly greater in Group B (29.20% ± 4.22%) compared to Group A (25.80% ± 3.84%), with a p-value of 0.03.

Table 5: Overall Treatment Response

The categorical assessment of overall treatment response revealed a higher proportion of good responders in Group B than in Group A. In Group A, 70.00% of participants demonstrated a good response, while 90.00% in Group B showed similar improvement. Moderate response was observed in 30.00% of Group A and 10.00% of Group B participants. No patients in either group experienced a poor response. The difference in treatment response between the groups, however, was not statistically significant ($p = 0.24$), indicating that although Atridox® appeared to yield a numerically higher proportion of favorable outcomes, the difference was not strong enough to be considered statistically meaningful.

Table 1. Baseline Demographic Characteristics of Study Participants (N=20)

Variable	Group A (PerioChip®) n=10	Group B (Atridox®) n=10	p-value
Mean Age (years)	42.30 ± 6.12	41.80 ± 5.96	0.84
Gender (Male %)	6 (60.00%)	5 (50.00%)	0.65
Gender (Female %)	4 (40.00%)	5 (50.00%)	—
Mean Baseline PPD (mm)	5.96 ± 0.48	5.92 ± 0.44	0.81
Mean Baseline CAL (mm)	6.28 ± 0.56	6.34 ± 0.52	0.72

Table 2. Intra-Group Comparison of Clinical Parameters in Group A (PerioChip®)

Parameter	Baseline Mean ± SD	Follow-up Mean ± SD	Mean Reduction	p-value
PPD (mm)	5.96 ± 0.48	4.42 ± 0.38	1.54	<0.001*
CAL (mm)	6.28 ± 0.56	5.10 ± 0.42	1.18	<0.001*
BOP (%)	62.40% ± 8.12	28.60% ± 6.44	33.80%	<0.001*
PI (%)	68.20% ± 7.26	42.40% ± 6.22	25.80%	<0.001*

Table 3. Intra-Group Comparison of Clinical Parameters in Group B (Atridox®)

Parameter	Baseline Mean ± SD	Follow-up Mean ± SD	Mean Reduction	p-value
PPD (mm)	5.92 ± 0.44	4.10 ± 0.36	1.82	<0.001*
CAL (mm)	6.34 ± 0.52	4.90 ± 0.40	1.44	<0.001*
BOP (%)	61.20% ± 7.84	22.80% ± 5.92	38.40%	<0.001*
PI (%)	67.40% ± 6.98	38.20% ± 5.48	29.20%	<0.001*

Table 4. Inter-Group Comparison of Mean Reductions in Clinical Parameters

Parameter	Group A (PerioChip®) Mean Reduction	Group B (Atridox®) Mean Reduction	p-value
PPD (mm)	1.54 ± 0.22	1.82 ± 0.24	0.01*
CAL (mm)	1.18 ± 0.20	1.44 ± 0.18	0.02*
BOP (%)	33.80% ± 4.62	38.40% ± 5.14	0.04*
PI (%)	25.80% ± 3.84	29.20% ± 4.22	0.03*

*Significant at $p < 0.05$.

Table 5. Overall Treatment Response Between Groups (Categorical Outcome)

Treatment Response	Group A (PerioChip®) n=10	Group B (Atridox®) n=10	p-value
Good Response (%)	7 (70.00%)	9 (90.00%)	0.24
Moderate Response (%)	3 (30.00%)	1 (10.00%)	—
Poor Response (%)	0 (0.00%)	0 (0.00%)	—

*Chi-square test used. $p > 0.05$ (not significant).

DISCUSSION

The present randomized clinical trial evaluated and compared the effectiveness of two widely used local drug delivery systems—chlorhexidine gluconate chip (PerioChip®) and doxycycline hyclate gel (Atridox®)—as adjuncts to scaling and root planing (SRP) in chronic periodontitis. In the current study, both groups started with comparable baseline characteristics: mean PPD was 5.96 ± 0.48 mm in the PerioChip® group and 5.92 ± 0.44 mm in the Atridox® group, while mean CAL was 6.28 ± 0.56 mm and 6.34 ± 0.52 mm, respectively. This is consistent with previous trials on local chlorhexidine delivery systems, where Heasman et al. (2001) included maintenance patients with residual pockets ≥5 mm and reported similar baseline PPD and CAL profiles before PerioChip® placement.[8]

Intra-group analysis of the PerioChip® group (Group A) showed a mean PPD reduction of 1.54 mm (from 5.96 ± 0.48 mm to 4.42 ± 0.38 mm) and a CAL gain of 1.18 mm (from 6.28 ± 0.56 mm to 5.10 ± 0.42 mm), both highly significant ($p < 0.001$). These improvements align with earlier evidence that adjunctive chlorhexidine devices enhance outcomes beyond SRP alone. Paolantonio et al. (2008) demonstrated that adding a chlorhexidine chip to SRP resulted in additional PPD reductions of 0.30 mm at 3 months and 0.55 mm at 6 months, and extra CAL gains of 0.28 mm and 0.64 mm, respectively, compared with SRP alone.[9]

When our PerioChip® outcomes are compared with those of Medaiah et al. (2014), some differences in absolute changes become apparent. In the present study, SRP plus PerioChip® yielded a 1.54 mm reduction in PPD and 1.18 mm gain in CAL at follow-up. Medaiah et al. (2014) reported greater absolute reductions over three months in a three-arm trial: mean PPD reductions of 2.8 mm in the SRP group, 2.6 mm in the SRP + chlorhexidine chip group, and 0.8 mm in the chip-alone group, with corresponding CAL gains of 2.8, 2.5, and 0.7 mm, respectively.[10] The comparatively smaller numerical improvements in our chip group may be related to differences in baseline pocket depth distribution, sample size, and follow-up duration; however, both studies agree that SRP remains the primary determinant of clinical improvement, with chlorhexidine chips acting mainly as a modest adjunct.

The reduction in inflammatory indices in the PerioChip® group in the present trial (BOP reduction of 33.80% and PI reduction of 25.80%) also supports the adjunctive value of chlorhexidine devices. Ma et al. (2020), in a meta-analysis of 15 randomized clinical trials, reported that sites treated with chlorhexidine chips plus SRP showed additional PPD reductions of approximately 0.63–0.75 mm and CAL gains of 0.54–0.68 mm at 1–6 months, along with improved gingival inflammation compared with SRP alone.[11] While our study did not include an SRP-only control arm, the pronounced reductions in BOP (from 62.40% to 28.60%) and PI (from 68.20% to 42.40%) in Group A are in line with the anti-inflammatory trends reported in this meta-analysis, suggesting that PerioChip® can help sustain plaque and bleeding control after mechanical debridement.

The Atridox® group (Group B) demonstrated even greater intra-group improvements, with PPD reducing by 1.82 mm (from 5.92 ± 0.44 mm to 4.10 ± 0.36 mm) and CAL improving by 1.44 mm (from 6.34 ± 0.52 mm to 4.90 ± 0.40 mm), both statistically significant ($p < 0.001$). These results are consistent with those reported by Deo et al. (2011), who evaluated subgingival doxycycline hyclate as an adjunct to non-surgical therapy in chronic periodontitis and observed a mean PPD reduction of 3.03 mm in the doxycycline group compared with 2.30 mm in the SRP-only group, and CAL gains of 2.00 mm versus 1.13 mm, respectively, at six months.[12] Although the absolute changes in our trial are somewhat smaller—possibly due to differences in follow-up duration and initial disease severity—the pattern of superior pocket reduction and attachment gain with locally delivered doxycycline is clearly corroborated.

Our Atridox® findings also compare favorably with data from Singh et al. (2021), who evaluated 10% doxycycline hyclate gel in smokers and non-smokers with periodontitis. They reported a PPD reduction in smokers from 4.26 ± 0.12 mm to 3.20 ± 0.11 mm (change of 24.88%) and CAL improvement from 4.37 ± 0.14 mm to 3.59 ± 0.11 mm (16.90% change) after one month of SRP plus local doxycycline.[13] In our study, over the full follow-up period, Atridox® produced a larger absolute PPD reduction of 1.82 mm and CAL gain of 1.44 mm, which may reflect longer observation time, inclusion of non-smokers, and potential cumulative effects of sustained drug release. Nonetheless, both studies underscore that doxycycline gel can significantly enhance short-term and medium-term clinical healing in chronic periodontitis.

The pronounced reduction in BOP (38.40%) and PI (29.20%) in the Atridox® group in our study is also in agreement with previous work on doxycycline gels. Ahamed et al. (2013) evaluated controlled-release 10% doxycycline hyclate gel as an adjunct to SRP and reported that combination therapy achieved significantly greater improvements in clinical parameters, including PPD, CAL, and bleeding scores, than SRP alone at the end of follow-up.[14]

The present inter-group analysis showed that Atridox® provided statistically greater mean reductions in PPD (1.82 ± 0.24 mm vs 1.54 ± 0.22 mm; $p = 0.01$) and CAL (1.44 ± 0.18 mm vs 1.18 ± 0.20 mm; $p = 0.02$), and larger decreases in BOP (38.40% vs 33.80%; $p = 0.04$) and PI (29.20% vs 25.80%; $p = 0.03$) compared with PerioChip®. This relative advantage is consistent with broader reviews of local drug delivery, such as that by Szulc (2018), who summarized that tetracycline-class and chlorhexidine devices both produce additional PPD

reductions in the order of 0.5–1.0 mm when used adjunctively, but tetracycline/doxycycline preparations may show slightly greater gains in CAL and more pronounced modulation of the subgingival microbiota in some trials.[15]

Finally, the overall pattern of outcomes in this trial—significant intra-group improvements with both local delivery systems and a modest inter-group advantage for Atridox®—fits well within the broader evidence base on adjunctive local antimicrobials. Herrera et al. (2020), in a comprehensive systematic review and meta-analysis of 50 randomized trials, reported that adjunctive locally delivered antimicrobials provide additional mean PPD reductions of approximately 0.37 mm and CAL gains of 0.26 mm at 6–9 months compared with debridement alone, with no major safety concerns.[16]

CONCLUSION

The present study demonstrated that both PerioChip® and Atridox® were effective adjuncts to scaling and root planing in improving periodontal clinical parameters in patients with chronic periodontitis. While significant reductions in probing depth, clinical attachment gains, and improvements in bleeding and plaque indices were observed in both groups, Atridox® produced greater overall improvements than PerioChip®. Although the difference in categorical treatment response was not statistically significant, the numerical superiority of Atridox® suggests a modest clinical advantage. Overall, the findings support the use of local drug delivery systems as valuable adjuncts in the non-surgical management of chronic periodontitis.

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