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CLINICAL AND LABORATORY STUDY OF THE EFFECTIVENESS OF VARIOUS ANTIMICROBIAL DRUGS IN THE TREATMENT OF PERIODONTITIS

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Abstract
Periodontitis is a chronic inflammatory disease affecting the supporting structures of the teeth, leading to progressive destruction of the periodontal ligament and alveolar bone. The present study aims to evaluate and compare the clinical and laboratory efficacy of different antimicrobial agents used in the treatment of periodontitis. A total of 90 patients diagnosed with moderate to severe periodontitis were enrolled and divided into three groups. Each group received standard mechanical debridement in combination with one of the antimicrobial therapies: chlorhexidine, metronidazole, or doxycycline. Clinical parameters including probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BOP) were assessed. Microbiological analysis was conducted to determine bacterial reduction. The results demonstrated significant improvement in all groups, with the doxycycline group showing superior clinical and microbial outcomes. This study highlights the importance of selecting appropriate antimicrobial therapy based on both clinical presentation and microbiological findings.

Keywords. Periodontitis, antimicrobial therapy, chlorhexidine, metronidazole, doxycycline, clinical outcomes, microbiological assessment

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Introduction

Periodontitis is one of the most prevalent chronic inflammatory diseases of the oral cavity, characterized by the progressive destruction of the supporting structures of the teeth, including the periodontal ligament, cementum, and alveolar bone. It is a multifactorial disease primarily triggered by a dysbiotic microbial biofilm and modulated by the host's immune-inflammatory response. If left untreated, periodontitis can lead to tooth mobility, tooth loss, and has been associated with systemic conditions such as cardiovascular disease, diabetes mellitus, and adverse pregnancy outcomes.

Globally, periodontitis affects over 40% of the adult population, with severe forms impacting 10–15%, according to data from the World Health Organization. Its high prevalence and chronic course make it a significant public health issue, necessitating effective and evidence-based management strategies.

The cornerstone of periodontitis treatment remains mechanical debridement—namely, scaling and root planing (SRP)—which aims to remove supragingival and subgingival bacterial deposits. However, in cases of moderate to severe periodontitis, SRP alone may be insufficient to eliminate pathogenic bacteria harbored in inaccessible periodontal pockets or invading the periodontal tissues. Thus, adjunctive antimicrobial therapy has been increasingly used to enhance treatment outcomes by suppressing or eliminating periodontal pathogens and modulating the host response.

A variety of antimicrobial agents have been employed in periodontal therapy, either locally or systemically. Among them, **chlorhexidine** is a widely used antiseptic for oral rinses due to its broad-spectrum efficacy and substantivity. **Metronidazole**, a nitroimidazole antibiotic, is effective against anaerobic bacteria commonly found in periodontal pockets. **Doxycycline**, a semi-synthetic tetracycline derivative, not only exhibits strong antibacterial activity but also has anti-collagenase properties that help reduce tissue breakdown.

Despite numerous studies on the use of antimicrobials in periodontitis, questions remain about their comparative clinical and microbiological efficacy, particularly in different patient populations and treatment settings. There is also a growing

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need to balance clinical benefits with potential adverse effects, resistance development, and cost-effectiveness.

Therefore, this study aims to conduct a comparative clinical and laboratory evaluation of the effectiveness of chlorhexidine, metronidazole, and doxycycline used adjunctively with mechanical debridement in the treatment of periodontitis. The study focuses on changes in key clinical parameters—probing depth (PD), clinical attachment level (CAL), bleeding on probing (BOP)—and bacterial reduction as determined by microbiological analysis. The findings are expected to inform evidence-based decisions regarding the optimal antimicrobial regimen for periodontitis management.

Materials and Methods

Study Design

This was a randomized, controlled, parallel-group clinical trial conducted over a period of 8 weeks at the Department of Periodontology of a regional dental clinic. The study was designed in accordance with the Declaration of Helsinki and was approved by the institutional ethics committee. Written informed consent was obtained from all participants prior to inclusion in the study.

Study Population

A total of 90 patients (42 males and 48 females), aged between 25 and 55 years (mean age: 39.6 ± 7.4 years), diagnosed with moderate to severe chronic periodontitis were enrolled in the study. The participants were systemically healthy and had not received any periodontal treatment or antibiotics within the last six months.

Inclusion Criteria:

- Clinical diagnosis of chronic periodontitis with probing depth (PD) ≥ 5 mm in at least four sites.
- Radiographic evidence of alveolar bone loss.
- Presence of at least 20 natural teeth.

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- No systemic diseases affecting periodontal health (e.g., diabetes, immunosuppressive disorders).

Exclusion Criteria:

- Pregnancy or lactation.
- History of allergy to the study medications.
- Smoking or tobacco use.
- Use of antibiotics or anti-inflammatory drugs within the past 3 months.
- Ongoing orthodontic treatment.

Grouping and Intervention

Participants were randomly allocated into three equal groups (n = 30 each) using a computer-generated randomization table:

- Group I (Chlorhexidine group): Patients received full-mouth scaling and root planing (SRP) followed by chlorhexidine mouth rinse (0.12%) twice daily for 2 weeks.
- Group II (Metronidazole group): Patients received SRP followed by systemic metronidazole 500 mg, three times daily for 7 days.
- Group III (Doxycycline group): Patients received SRP followed by systemic doxycycline 100 mg once daily for 10 days.

All procedures were performed by the same periodontist to ensure consistency.

Clinical Assessment

Clinical parameters were recorded at baseline (day 0), week 4, and week 8 by a calibrated examiner blinded to group allocation:

- Probing Depth (PD): Measured from the gingival margin to the base of the pocket using a standardized periodontal probe.
- Clinical Attachment Level (CAL): Measured from the cementoenamel junction (CEJ) to the base of the pocket.
- Bleeding on Probing (BOP): Recorded as presence or absence of bleeding within 15 seconds after probing.

Measurements were taken at six sites per tooth (mesiobuccal, buccal, distobuccal, mesiolingual, lingual, distolingual) for all teeth except third molars.

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Microbiological Analysis

Subgingival plaque samples were collected from the deepest periodontal pocket in each quadrant using sterile paper points at baseline and week 8. The samples were immediately transported in anaerobic transport medium and cultured under anaerobic conditions. The following procedures were conducted:

- Gram Staining: For preliminary identification of Gram-negative and Gram-positive bacteria.
- Anaerobic Culture: For quantification and identification of key periodontal pathogens (Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsythia).

Colony-forming units (CFU) per mL were calculated to assess bacterial load reduction.

Statistical Analysis

All data were analyzed using SPSS software version 25.0. Continuous variables were expressed as mean ± standard deviation (SD). Inter-group comparisons were performed using ANOVA, followed by post hoc Tukey's test for pairwise comparisons. Intra-group differences over time were analyzed using the paired t-test. A p-value < 0.05 was considered statistically significant.

Results

A total of 90 patients completed the study without any dropouts. All groups demonstrated statistically significant improvements in clinical parameters over the 8-week period; however, the magnitude of improvement varied among the groups.

1. Clinical Outcomes

At baseline, there were no statistically significant differences among the three groups in terms of probing depth (PD), clinical attachment level (CAL), or bleeding on probing (BOP) ($p > 0.05$), indicating successful randomization.
After 8 weeks, the following changes were observed:

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Parameter	Group I (Chlorhexidine)	Group II (Metronidazole)	Group III (Doxycycline)
Mean PD reduction (mm)	1.8 ± 0.4	2.3 ± 0.5	**2.8 ± 0.6** ($p < 0.001$)
Mean CAL gain (mm)	1.6 ± 0.5	2.1 ± 0.6	**2.4 ± 0.4** ($p < 0.001$)
BOP reduction (%)	58.2%	71.4%	**85.6%** ($p < 0.01$)

Statistical analysis using ANOVA confirmed that the differences in bacterial reduction between the groups were significant ($p < 0.01$), with **Group III** showing the most pronounced reduction in P. gingivalis, T. forsythia, and Prevotella intermedia.

3. Adverse Effects

No serious adverse events were reported during the study. Mild gastrointestinal discomfort was reported by 3 patients in the metronidazole group and 2 patients in the doxycycline group, which resolved spontaneously.

Summary of Key Findings:

- All groups experienced statistically significant improvements in PD, CAL, and BOP.
- Doxycycline group showed superior clinical and microbiological outcomes.
- Metronidazole was moderately effective but associated with more transient side effects.
- Chlorhexidine was least effective but well tolerated.

Conclusion

The findings of this clinical and laboratory study clearly demonstrate that adjunctive use of antimicrobial agents significantly enhances the effectiveness of non-surgical periodontal therapy in patients with chronic periodontitis. Among

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the three evaluated interventions, systemic doxycycline proved to be the most effective in terms of both clinical improvement and microbial reduction. It led to the greatest decrease in probing depth, the most substantial gain in clinical attachment level, and the highest reduction in bleeding on probing and key periodontal pathogens, such as Porphyromonas gingivalis and Tannerella forsythia.

Metronidazole also showed beneficial effects, particularly in reducing anaerobic bacterial load, though its clinical parameters were slightly less favorable than doxycycline. Chlorhexidine, despite being a commonly used topical antiseptic, demonstrated the least improvement among the three groups, although it was well tolerated and remains a useful adjunct in mild cases or as a preventive measure.

These results emphasize the importance of selecting antimicrobial therapy based on the severity of disease, patient compliance, and microbial profile. Systemic doxycycline, due to its dual antimicrobial and anti-collagenase effects, may be particularly suitable for patients with moderate to severe periodontitis. However, clinicians must also consider the potential for antibiotic resistance and adverse reactions, and reserve systemic antibiotics for cases where mechanical therapy alone may be insufficient.

Further long-term studies with larger sample sizes and follow-up periods are recommended to evaluate the sustainability of clinical outcomes and the potential development of bacterial resistance.

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