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Adjunctive Use of Chlorhexidine and Metronidazole Gels in Periodontal Disease: An Observational Study

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ABSTRACT

Periodontal inflammation is characterized by gingival bleeding, pocket formation, and compromised oral health. **Objectives:** To evaluate the periodontal effects of Chlorhexidine (CHX) gel and Metronidazole (MET) gel in individuals with periodontal inflammation. **Methods:** This observational longitudinal study included a total of 48 participants who were enrolled at the Dental OPD and divided into two groups. Group A received 0.2% CHX gel, and Group B received 0.8% MET gel. Both gels were applied twice daily for 14 days following scaling and root planing. Oral hygiene maintenance and adherence to gel application were monitored through patient diaries and follow-up visits. Clinical parameters, including bleeding on probing (BOP), probing depth (PD), periodontal index score, and oral hygiene index (OHI), were recorded at baseline and after 14 days using a standardized periodontal probe. **Results:** In the CHX group, BOP significantly reduced from 26.13 ± 8.14 to 15.38 ± 6.36 ($p = 0.001$), while OHI improved from 22.67 ± 5.55 to 5.71 ± 2.90 ($p < 0.001$). Similarly, the MET group demonstrated a significant reduction in BOP from 24.67 ± 3.25 to 8.58 ± 3.78 ($p < 0.001$) and OHI from 24.58 ± 5.11 to 6.71 ± 3.22 ($p < 0.001$). However, no significant change was observed in probing depth for either group (CHX: $p = 0.705$; MET: $p = 0.705$). **Conclusions:** The use of CHX and MET gels significantly decreases BOP and improves OHI, but no significant change was on probing depth, demonstrating their effectiveness in reducing periodontal inflammation without affecting pocket depth.

INTRODUCTION

Periodontal diseases, including gingivitis and periodontitis, are among the most prevalent oral health concerns worldwide. These conditions primarily result from the accumulation of dental plaque, a key etiological factor [1]. Plaque buildup triggers an inflammatory response that can lead to the loss of gingival tissue, bone, and periodontal ligament, ultimately forming periodontal pockets and increasing the risk of tooth loss [2]. Dental plaque consists of bacterial colonies embedded within a matrix of salivary glycoproteins and extracellular components [3]. Research shows that chronic periodontitis develops due to a variety of microorganisms, which both initiate and advance the disease condition [4]. The bacterial biofilm is mainly disturbed through mechanical methods like scaling and root planing. However, studies indicate that mechanical debridement by itself may occasionally be inadequate in eliminating the microorganisms responsible for periodontal diseases. For this reason, chemical agents for plaque removal have become increasingly favored as supplementary treatments alongside mechanical therapy [5, 6]. The primary objective in managing gingivitis is the elimination

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of disease-causing bacterial pathogens, which has led to the use of multiple treatment approaches, including systemic and topical antimicrobial therapies. However, prolonged use of systemic antibiotics can result in the development of resistance and may also cause adverse effects such as nausea and diarrhea. Consequently, topical antimicrobial agents such as Chlorhexidine and Metronidazole have gained increasing attention for their ability to directly target periodontal pathogens. When combined with mechanical plaque removal, these agents not only improve treatment outcomes but also help to more effectively slow the progression of the disease [6, 7]. Chlorhexidine is widely regarded as the gold standard among antiseptic mouth rinses due to its broad-spectrum antimicrobial activity and strong substantivity. Its mechanism of action involves disruption of bacterial cell walls, which causes cytoplasmic leakage and ultimately leads to cell death. Recent clinical studies and meta-analyses have demonstrated modest but significant improvements with its use. Sustained-release delivery systems, such as chlorhexidine chips, have shown greater clinical efficacy with probing depth reductions of about 0.5–0.6 mm and improvements in gingival indices at one to three months, while gels demonstrated less consistent benefits [8, 9]. Chlorhexidine demonstrates potent antibacterial action in periodontal pockets through the rapid binding of its positively charged molecules to negatively charged bacterial cell surfaces. It is considered safe, with limited issues of patient tolerance and low potential for microbial resistance. Nonetheless, its fast elimination from the periodontal pocket quickly reduces the local concentration to below therapeutic levels following subgingival application, resulting in diminished treatment efficacy [10]. Although it is effective, its long-term use is often discouraged based on the side effects experienced: an unpleasant taste, possible taste alteration, and undesirable tooth staining, which may pose a compliance problem with the patients [11]. Metronidazole is a well-established antimicrobial agent with selective activity against obligate anaerobes, particularly Gram-negative rods and spirochetes commonly implicated in periodontal infections. Local delivery of metronidazole gel has been shown to significantly reduce bacterial load in gingival crevicular fluid, thereby aiding in infection control [12]. Research has shown that Metronidazole gel is effective in bringing down the total number of bacteria in the gingival crevicular fluid, helping in controlling periodontal infection [13]. While Metronidazole gel has shown promising antibacterial effects, its additional benefits beyond mechanical debridement remain controversial [14]. Several studies have evaluated the systemic use of metronidazole alone or in combination with scaling and root planing (SRP) for the management of gingivitis. These investigations have demonstrated notable improvements in both microbiological and clinical parameters [15]. Such favorable outcomes have also contributed to a reduced need for surgical interventions targeting the gingiva and supporting periodontal structures. Furthermore, the local application of metronidazole in gel form, delivered directly to pathogen-specific sites, has been shown to achieve higher drug concentrations at the targeted area [16]. Chlorhexidine, while regarded as the gold standard, is limited by rapid clearance from periodontal pockets and adverse effects such as staining and altered taste, which affect compliance. Metronidazole, on the other hand, demonstrates selective antimicrobial activity against anaerobic pathogens, but evidence regarding its long-term benefits as a locally delivered gel remains inconsistent.

This study aims to evaluate the efficacy of chlorhexidine (CHX) and metronidazole (MET) gels as adjunctive therapies to mechanical debridement in reducing periodontal inflammation and improving oral hygiene parameters.

METHODS

This observational longitudinal study was conducted at Bahria University Medical Sciences, Karachi, with ethical approval from its Ethical Review Committee (Ref. No. ERC 71/2022). The study took place at the Dental Periodontal OPD from November 2022 to April 2023, and institutional consent was obtained before commencement. A total of 48 participants aged 25–50 years diagnosed with periodontitis were recruited based on specific eligibility criteria. The sample size was calculated using the OpenEpi sample size calculator with a 95% confidence interval, 80% study power, and a 5% margin of error, which required a minimum of 42 participants; however, 48 were enrolled using a convenience sampling method to account for potential dropouts. Inclusion criteria required patients to have more than 20 teeth, a probing depth of 4–6 mm in at least two teeth per quadrant, and confirmed periodontitis, along with adherence to proper oral hygiene practices. Patients were excluded if they were pregnant or lactating, had dental prostheses, had undergone periodontal therapy in the last six months, or had a history of smoking, smokeless tobacco use, or allergy to metronidazole or chlorhexidine. Those with craniofacial syndromes, medications affecting gingival conditions (e.g., nifedipine, cyclosporine, phenytoin), or systemic diseases such as diabetes mellitus, cardiovascular disease, hematologic disorders, or immunodeficiency were also excluded. Informed consent was obtained in both Urdu and English from all participants. Participants were categorized into two groups based on the treatment they were already receiving at the Dental OPD. Group A included patients

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using 0.2% Chlorhexidine (CHX) gel, while Group B comprised those using 0.8% Metronidazole (MET) gel. Both gels were applied twice daily for three minutes, in the morning and evening, following scaling and root planing, for a period of 14 days. Oral hygiene practices and adherence to antiseptic gel application were observed as part of routine periodontal care. Participants were observed over 14 days, with two follow-up visits: one at day 7 to monitor adherence and oral hygiene practices, and a final assessment at day 14, at which endpoint periodontal parameters (OHI, BOP, PD) were recorded. Compliance was monitored using patient-maintained logs, periodic follow-up visits, and reminders by the research team. Data were collected by two trained investigators who conducted comprehensive periodontal assessments, including probing depth (PD), bleeding on probing (BOP), and Oral Hygiene Index (OHI). Baseline examinations were performed after scaling, root planing, and polishing to ensure uniform starting conditions. Clinical examinations were performed using a standard dental examination set, which included a mouth mirror, periodontal probe, and tweezers. Clinical parameters were recorded at baseline and at the 14-day follow-up, including the Oral Hygiene Index-Simplified (OHI-S), bleeding on probing (BOP), and probing depth (PD). The OHI-S, developed by Greene and Vermillion in 1964, evaluates oral hygiene status based on the presence of debris and calculus, using six representative tooth surfaces to provide a practical and reliable assessment [17]. Additionally, a CPITN (Community Periodontal Index of Treatment Needs) probe was used for assessing periodontal status. All instruments were sterilized according to standard infection control protocols prior to use, and measurements were conducted by trained investigators to ensure accuracy and consistency [18]. Data were analyzed using SPSS version 23.0. Descriptive statistics were presented as mean ± standard deviation for quantitative variables, while qualitative data were expressed as frequencies and percentages. Kolmogorov–Smirnov test assessed data normality. Independent sample t-tests were used for normally distributed variables, while Mann-Whitney U tests analyzed non-normally distributed variables. Chi-square tests compared categorical variables, and paired t-tests assessed within-group pre- and post-treatment differences. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 55 individuals were initially assessed for eligibility. After screening, a total of 48 participants meeting the inclusion criteria were included in the study, and all completed the study without any dropouts. Among the participants, 16 were female (33.3%) and 32 were male (66.7%). Marital status distribution showed that 3 individuals (6.3%) had never married, 41 (85.4%) were married, and 4 (8.3%) were previously married. In terms of educational background, 6 participants (12.5%) had no formal qualifications, 22 (45.8%) had qualifications below a degree level, and 20 (41.7%) held a degree or higher. Occupationally, 6 individuals (12.5%) were professionals, 20 (41.7%) were in intermediate-level jobs, 14 (29.2%) were manual workers, and 8 (16.7%) were unemployed. Regarding medical history, 18 participants (37.5%) had documented health conditions, while 30 (62.5%) reported no prior medical issues. This demographic data provides a comprehensive overview of the study population, aiding further analysis of potential health-related associations (Table 1).

Table 1: Frequency Distribution of Socio-Demographic Data

Demographic Data	Category	n (%)	Within Groups (CHX)	Within Groups (MET)	p-Value
Gender	Female	16 (33.3%)	33.3%	33.3%	0.620
	Male	32 (66.7%)	66.7%	66.7%	
Marital Status	Never married	3 (6.3%)	4.2%	8.3%	0.836
	Married	41 (85.4%)	87.5%	83.3%	
	Divorced/Widowed	4 (8.3%)	8.3%	8.3%	
Educational Level	No qualification	6 (12.5%)	12.5%	12.5%	0.179
	Degree	20 (41.7%)	54.2%	29.2%	
Occupation	Professional	6 (12.5%)	20.8%	4.2%	0.325
	Intermediate	20 (41.7%)	33.3%	50.0%	
	Manual	14 (29.2%)	29.2%	29.2%	
	Unemployed	8 (16.7%)	16.7%	16.7%	
Medical History	Present	18 (37.5%)	33.3%	41.7%	0.766
	Absent	30 (62.5%)	66.7%	58.3%	

CHX: Chlorhexidine gel, MET: Metronidazole gel
*p < 0.05 indicates statistical significance

The number of teeth remained unchanged, with a mean of 25.54 ± 2.23 in the CHX group and 24.33 ± 1.88 in the MET group. Both Bleeding on Probing (BOP) and Oral Hygiene Index (OHI) showed significant reductions in both groups (BOP: CHX 26.13 ± 8.14 to 15.38 ± 6.36, MET 24.67 ± 3.25 to 8.58 ± 3.78, p<0.001; OHI: CHX 22.67 ± 5.55 to 5.71 ± 2.90, MET 24.58 ± 5.11 to 6.71 ± 3.22, p < 0.001). Probing Depth (PD) decreased in both groups (CHX 2.11 ± 0.65 to 1.25 ± 0.43; MET 2.35 ± 0.73 to 1.31 ± 0.57), but the change was not statistically significant (p=0.705) (Table 2).

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Table 2: Pre-Post Comparison of Periodontal Parameters Between CHX and MET Groups

Parameter	Group	Baseline Mean ± SD	Endpoint Mean ± SD	% Change	Cohen's d	t-Value	p-Value
Bleeding on Probing (BOP)	CHX	26.13 ± 8.14	15.38 ± 6.36	-41.1%	1.47	-4.496	0.001*
	MET	24.67 ± 3.25	8.58 ± 3.78	-65.2%	4.56	-4.496	0.000*
Probing Depth (PD)	CHX	2.11 ± 0.65	1.25 ± 0.43	-40.8%	1.56	-0.381	0.705
	MET	2.35 ± 0.73	1.31 ± 0.57	-44.3%	1.59	-0.381	0.705
Oral Hygiene Index (OHI)	CHX	22.67 ± 5.55	5.71 ± 2.90	-74.8%	3.83	-3.845	0.000*
	MET	24.58 ± 5.11	6.71 ± 3.22	-72.7%	4.61	-3.845	0.000*

In both CHX and MET groups, Bleeding on Probing (BOP) showed a significant reduction from baseline to endpoint (CHX: 26.13 ± 8.14 to 15.38 ± 6.36, t=-4.496, p=0.001; MET: 24.67 ± 3.25 to 8.58 ± 3.78, t=-4.496, p<0.001). Oral Hygiene Index (OHI) also improved significantly in both groups (CHX: 22.67 ± 5.55 to 5.71 ± 2.90, t=-3.845, p < 0.001; MET: 24.58 ± 5.11 to 6.71 ± 3.22, t = -3.845, p < 0.001). Probing Depth (PD) decreased in both groups (CHX: 2.11 ± 0.65 to 1.25 ± 0.43; MET: 2.35 ± 0.73 to 1.31 ± 0.57), but the changes were not statistically significant (t=-0.381, p=0.705). These results indicate that both CHX and MET gels were effective in reducing gingival bleeding and improving oral hygiene, while reductions in PD were modest and not statistically significant (Table 3).

Table 3: Pre- and Post-Treatment Comparison of Periodontal Parameters in CHX and MET Groups

Parameter	Group	N	Baseline Mean ± SD	Endpoint Mean ± SD	t-Value	p-Value
Bleeding on Probing (BOP)	CHX	24	26.13 ± 8.14	15.38 ± 6.36	-4.496	0.001*
	MET	24	24.67 ± 3.25	8.58 ± 3.78	-4.496	0.000*
Probing Depth (PD)	CHX	24	2.11 ± 0.65	1.25 ± 0.43	-0.381	0.705
	MET	24	2.35 ± 0.73	1.31 ± 0.57	-0.381	0.705
Oral Hygiene Index (OHI)	CHX	24	22.67 ± 5.55	5.71 ± 2.90	-3.845	0.000*
	MET	24	24.58 ± 5.11	6.71 ± 3.22	-3.845	0.000*

CHX: Chlorhexidine gel, MET: Metronidazole gel
*p < 0.05 indicates statistical significance

DISCUSSIONS

Scaling and root planing (SRP) remains the standard non-surgical treatment for periodontitis, effectively removing supra- and subgingival deposits. However, in moderate to severe cases, mechanical debridement alone may not fully eliminate pathogenic microorganisms. Adjunctive therapies, such as locally applied antimicrobial agents, have therefore been explored to enhance periodontal outcomes [14]. In this study, both locally delivered chlorhexidine (CHX) and metronidazole (MET) gels, used alongside SRP, significantly reduced bleeding on probing (BOP) over 14 days, with MET demonstrating a greater proportional reduction. These findings are consistent with previous reports indicating that both CHX and MET gels effectively improve gingival inflammation when used as adjuncts to mechanical therapy. MET may offer stronger suppression of gingival inflammation due to its targeted antimicrobial activity, although clinical superiority cannot be definitively claimed, as outcomes can be influenced by gel concentration, delivery method, patient compliance, and baseline inflammation [16, 19]. While BOP and oral hygiene improved markedly, probing depth reductions were not statistically significant. This is consistent with short-duration studies, where tissue remodeling and reattachment typically lag behind reductions in bleeding and plaque burden [20]. Innovations in local drug delivery, including sustained-release CHX and MET formulations, have shown promise in maintaining effective therapeutic concentrations over time [21]. Additionally, in vitro studies suggest a potential synergistic effect between CHX and MET against periodontal pathogens [22, 23]. The study's follow-up was limited to 14 days, which may not capture the full trajectory of periodontal healing or potential relapse. Also, while MET showed a stronger BOP reduction, we cannot conclusively claim superiority in all contexts. Variation in gel concentration, delivery formulation, compliance, and baseline inflammation can modulate outcomes. Nevertheless, our results support the efficacy of locally delivered CHX and MET gels in reducing gingival bleeding in periodontitis patients over a short period, and they somewhat favor MET for bleeding suppression in our cohort. Future studies with longer observation, microbiological assays, and possibly split-mouth randomized designs would solidify comparative advantages.

CONCLUSIONS

In conclusion, both CHX and MET gels significantly reduced bleeding on probing; however, the MET group demonstrated a greater reduction, achieving a notably lower BOP value at the 14-day follow-up. Probing depth remained unchanged in both groups, and while improvements were observed in the oral hygiene index, these changes did not reach statistical significance. These findings suggest that both treatments are effective in reducing periodontal inflammation, as evidenced by the decrease in BOP, but they do not significantly impact probing depth or overall oral hygiene within the study period.

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Authors Contribution

Conceptualization: SS
Methodology: TH, IS
Formal analysis: UZ, FT
Writing review and editing: SS, SJ

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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