Original Article

PROBIOTIC-BASED ADJUNCTIVE THERAPY FOR PERI-IMPLANT MUCOSITIS: INFLUENCE ON CLINICAL PARAMETERS AND MICROBIAL LOAD

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Received: 05 June 2025; **Revised:** 04 November 2025; **Accepted:** 07 November 2025 *https://doi.org/10.51847/kfZURZcPUP*

ABSTRACT

Microbial biofilm is the primary cause of peri-implant mucositis, a reversible inflammatory illness affecting the soft tissues surrounding implants. Probiotics and other adjuvant therapies are becoming viable, physiologically sound alternatives to non-surgical mechanical debridement, which is the mainstay of care. To assess topically applied probiotic gel's supplemental clinical and microbiological benefits when used in conjunction with non-surgical mechanical debridement to treat peri-implant mucositis. Forty patients with peri-implant mucositis who were otherwise healthy were included in prospective clinical research. Participants were split into two groups at random: Group 1 underwent non-surgical mechanical debridement and placebo gel, whereas Group 2 underwent non-surgical mechanical debridement and topical application of probiotic gel once daily for two weeks. At baseline and six months later, clinical parameters (Plaque Index [PI] and Gingival Index [GI]) and microbial load (CFU/mL) were measured. SPSS Version 23.0 was used for the statistical analysis, and $p < 0.05$ was used for significance. Both groups exhibited significant within-group improvements. However, the probiotic group (Group 2) showed significantly greater reductions in PI (0.42 ± 0.03 vs 1.31 ± 0.09), GI (0.46 ± 0.03 vs 1.42 ± 0.09), and microbial load ($0.64 \pm 0.04 \times 10^2$ vs $1.12 \pm 0.09 \times 10^2$ CFU/mL) compared to the control group (Group 1) at 6th month ($p < 0.05$). The clinical and microbiological results of non-surgical mechanical debridement in peri-implant mucositis are much improved by adjuvant topical probiotic treatment. This noninvasive method presents a viable supplement to evidence-based peri-implant therapy.

Key words: Mechanical debridement, Peri-implant diseases, Peri-implant health, Probiotics.

Introduction

The increasing use of dental implants has significantly transformed oral rehabilitation, offering predictable long-term outcomes in edentulous and partially dentate patients [1-7]. The process of osseointegration, in which a direct structural and functional link takes place between the surface of a load-bearing implant and living bone, is essential to the proper placement and long-term functionality of dental implants [8]. This biological phenomenon, which guarantees implant durability, is impacted by a number of systemic and local elements, such as bone quantity and quality, implant design and surface features, surgical technique, and the patient's oral hygiene habits [9, 10]. Despite the high success rates reported for implant therapy, biological complications remain a clinical challenge, with peri-implant diseases emerging as a leading cause of implant failure [11].

The initial type of peri-implant illness, known as peri-implant mucositis, is characterized by an inflammatory response that is restricted to the soft tissues surrounding the implant and does not result in bone loss. Its pathogenesis is primarily attributed to the accumulation of bacterial biofilm on implant surfaces, triggering a host-mediated inflammatory cascade [12, 13]. This interaction between microbial insult and host immune response leads to the release of pro-inflammatory mediators and clinical manifestations such as erythema, edema, and bleeding on probing. Peri-implant mucositis can develop into peri-implantitis, a more serious condition that causes gradual bone loss, if treatment is not received [14].

Mechanical debridement, utilizing ultrasonic scalers or titanium curettes, remains the cornerstone of non-surgical management for peri-implant mucositis. It facilitates biofilm disruption and reduces microbial load, contributing to inflammation control. However, its efficacy may be limited by anatomical challenges around implant threads and restricted access in deep peri-implant sulci [15]. Consequently, several adjunctive approaches have been explored to enhance therapeutic outcomes, including antiseptics, antibiotics (topical or systemic), photodynamic therapy, lasers, and recently, biological agents aimed at modulating the host response [16-19].

Probiotics—live microorganisms that exert health benefits when administered in adequate quantities—have garnered increasing attention in periodontal and peri-implant therapy. Their beneficial effects are believed to stem from competitive inhibition of pathogenic microbes, enhancement of epithelial barrier function, and immunomodulation [20, 21]. Probiotic therapy has been shown to ameliorate gingival inflammation and microbial profiles in cases of periodontitis [22, 23]. However, the data on probiotics' precise role as an adjuvant in the treatment of peri-implant mucositis is still limited and inconsistent.

This study was created to assess the adjuvant effect of a probiotic gel when paired with mechanical debridement in the treatment of peri-implant mucositis due to the paucity of clinical evidence and the need for biologically sound, non-invasive therapeutic options. The objective was to assess changes in clinical indices and microbial counts, thereby addressing the existing knowledge gap and contributing to evidence-based peri-implant care.

Materials and Methods

Study design

This prospective clinical study was conducted at Saveetha Dental College and Hospitals' Department of Periodontology in Chennai, India. The study included 40 patients, all between the ages of 25 and 55, who had been diagnosed with peri-implant mucositis and were proven to be in good systemic and periodontal health [24, 25]. The participants were split into two equal groups at random. Group 1 (n = 20) was the control group and was given a placebo gel in addition to mechanical debridement. Group 2 (n = 20) underwent mechanical debridement supplemented with a probiotic gel and constituted the experimental group. The Institutional Ethics Committee of Saveetha University granted ethical approval for the study protocol (IHEC/SDC/MSIMPLANT-2410/24/289). Before being enrolled, each subject gave written informed consent. G*Power software (Version 3.1.9.4) was used to determine the sample size, and prior research was consulted for expected means and standard deviations [26].

Eligibility criteria required the presence of at least one functioning dental implant accompanied by clinical signs of peri-implant mucositis. Individuals were excluded if they had a history of tobacco use, were pregnant or breastfeeding, had consumed antibiotics, medications, or nutritional supplements within the past six months, suffered from systemic illnesses, or had been previously diagnosed with periodontitis [27-29].

Intervention protocol

All participants underwent full-mouth ultrasonic scaling. Debridement around implant surfaces was performed using titanium curettes (Hu-Friedy®, Chicago, USA). In the test group (Group 2), a probiotic solution was additionally applied to the peri-implant region. This formulation was freshly prepared each day by blending 2 mL of glycerine, two drops of peppermint essential oil, and the contents of one Providac™ probiotic capsule until a uniform gel-like consistency was achieved. This preparation was applied topically to the buccal and lingual/palatal surfaces surrounding the implant once daily for 2 weeks, with each application lasting two minutes. In the control group (Group 1), a placebo gel was administered in an identical manner. Participants were instructed to refrain from eating or drinking for 30 minutes following each application. To ensure consistency, all debridement procedures were carried out by a single experienced clinician (JB). Follow-up assessments, both clinical and microbiological, were performed after three months [30-33].

Clinical assessment

The clinical parameters assessed included the Plaque Index (PI) and Gingival Index (GI). PI was measured using the Silness and Löe method, recording scores from the mesial, distal, buccal, and lingual surfaces of each implant and computing the average. GI was similarly determined using the Löe and Silness scoring criteria.

Microbiological evaluation

Aseptic collection of subgingival plaque samples from the peri-implant sulcus was performed and samples were promptly cultured on Brain Heart Infusion (BHI) agar plates. These cultures were incubated at 37°C under aerobic conditions for 24 hours. Following incubation, colony counts were recorded and results expressed in colony-forming units per millilitre (CFU/mL). All baseline and follow-up clinical and microbiological assessments were carried out by a single calibrated investigator (AR).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS, Version 23.0) was used to analyse the data. While independent t-tests evaluated differences between groups, paired t-tests were used for within-group comparisons. Using the chi-square test, gender distribution disparities were assessed. A statistically significant p-value was defined as one that was less than 0.05.

Results and Discussion

Ten males and ten females made up Group 1, with an average age of 45.12 ± 6.13 years. Group 2 consisted of ten males and ten females, with an average age of 44.36 ± 5.89 years. Regarding the distribution of age and gender, there were no statistically significant variations between the groups ($p > 0.05$).

Table 1 presents a comparative analysis of clinical (PI, GI) and microbial (total microbial load in CFU/mL) parameters between Group 1 and Group 2, both at baseline and after six months. PI ($p = 0.52$), GI ($p = 0.31$), and microbial load ($p = 0.42$) did not differ statistically significantly between the two groups at baseline, suggesting group homogeneity prior to the intervention. After six months, however, Group 2's PI (0.42 ± 0.03 vs. 1.31 ± 0.09), GI (0.46 ± 0.03 vs. 1.42 ± 0.09), and microbial load ($0.64 \pm 0.04 \times 10^2$ vs. $1.12 \pm 0.09 \times 10^2$ CFU/mL). All between-group p-values were less than 0.05, indicating that the probiotic-treated group had significantly improved. Furthermore, within-group comparisons revealed significant reductions in all three parameters from baseline to six month in both groups (p <

0.05), confirming the efficacy of mechanical debridement alone and highlighting the superior adjunctive benefit of probiotic therapy in enhancing clinical and microbiological outcomes in peri-implant mucositis management.

Table 1. Comparison of Clinical and Microbial Parameters Between and Within Groups

Parameter	Timeline	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	Between-group p-value[#]	Within-group p-value[$] (Group 1)	Within-group p-value[$] (Group 2)
PI	Baseline	2.77±0.06	2.75±0.08	0.52	0.00*	0.00*
	6 Months	1.31±0.09	0.42±0.03	0.00*		
GI	Baseline	2.87±0.11	2.81±0.17	0.31	0.00*	0.00*
	6 Months	1.42±0.09	0.46±0.03	0.00*		
Total Microbial Load (CFU/mL)	Baseline	1.88±0.23 (10^6)	1.82±0.18 (10^6)	0.42	0.00*	0.00*
	6 Months	1.12±0.09 (10^2)	0.64±0.04 (10^2)	0.00*		

[#]Independent t test; [$]Paired t test; *Statistically significant at $p < 0.05$
PI = Plaque Index; GI = Gingival Index; CFU/mL = Colony-Forming Units per Milliliter

This clinical trial assessed the efficacy of non-surgical mechanical debridement in conjunction with topical probiotic administration as an adjuvant for the treatment of peri-implant mucositis [34-37]. The results demonstrated that the local delivery of probiotics significantly improved clinical indices such as PI and GI, while also producing a marked reduction in total bacterial load. These findings underscore the therapeutic potential of topical probiotics in modulating the peri-implant microenvironment and enhancing overall mucosal health.

Our results are in alignment with Peña *et al*. [38] who observed enhanced clinical outcomes with adjunct *Lactobacillus reuteri* therapy combined with mechanical debridement and chlorhexidine. Although their approach involved systemic application, the overall clinical trends mirror our findings, indicating the added value of probiotic support in peri-implant care. In a randomized controlled experiment, Hallström *et al*. [39] also found that probiotics given via lozenges improved plaque index scores, bleeding scores, and probing depth values. Despite both placebo and test groups showing benefit, the probiotic group consistently demonstrated superior outcomes, emphasizing the role of probiotic supplementation regardless of the mode of delivery.

Topical application has the advantage of targeted action, allowing direct interaction with the peri-implant biofilm. Galofré *et al*. [40] showed that *L. reuteri* lozenges used adjunctively with mechanical therapy improved both clinical and microbiological parameters, particularly in reducing *P. gingivalis* load [41-44]. Our findings corroborate this antimicrobial activity, as evidenced by a significant decline in total CFUs following probiotic use. This is further supported by Mulla *et al*. [45] who demonstrated the inhibitory effects of *Lactobacillus salivarius* against key periopathogens like *P. gingivalis* and *S. aureus* in vitro.

Additional support for probiotic efficacy comes from Alqahtani *et al*. [46] who demonstrated that adjunctive probiotic therapy offered better short-term results than mechanical debridement alone, especially in non-smokers. Their comparison between probiotics and antibiotics also revealed superior outcomes with probiotics over time. Similarly, Kumararama *et al*. [47] reported that while antibiotics produced quicker reductions in probing depth and bleeding on probing, probiotics provided more sustained improvement in plaque control and inflammation over three months.

Additionally, Arbildo-Vega *et al*. [48] confirmed that L. reuteri is therapeutically effective in lowering probing depths and plaque scores by a comprehensive review and meta-analysis. Di Spirito *et al*. [49] also emphasized that although mechanical or surgical interventions reduce pathogen burden, complete eradication is rare, reinforcing the importance of adjunctive modalities like probiotics to enhance treatment success.

While these findings are encouraging, the study has limitations. The brief follow-up period limits the assessment of topical probiotics' long-term benefits. The study also did not assess species-specific microbial shifts, which could provide more detailed insights into probiotic mechanisms. Nevertheless, the topical application method used here offers a non-invasive, patient-friendly, and localized strategy with minimal systemic risks, which is a notable strength [50, 51].

In conclusion, the use of topically applied probiotics in conjunction with mechanical debridement greatly enhanced the microbiological and clinical results of peri-implant mucositis. These results lend credence to the idea that probiotics can be used in place of or in addition to conventional antibacterial medicines [52-55]. Future research should aim to explore optimal formulations, application protocols, and long-term outcomes in larger, multi-center trials. The integration of probiotic therapy into routine peri-implant maintenance regimens could represent a meaningful advancement in the non-invasive management of peri-implant diseases.

Conclusion

The results of this study show that probiotics applied topically as an adjuvant to non-surgical mechanical debridement provide notable microbiological and clinical advantages in the treatment of peri-implant mucositis. Notably, improvements in plaque control, gingival inflammation, and bacterial load reduction were observed, highlighting the potential of probiotics to modulate the peri-implant environment. This method offers a promising noninvasive supplement to traditional therapy, which calls for more research in extensive, long-term clinical trials to confirm its effectiveness and improve application procedures.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: The study protocol was approved by Institutional Ethics Committee, Saveetha Dental College and Hospitals, Chennai, India (IHEC/SDC/MSIMPLANT-2410/24/289).

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