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Evaluating the Efficacy of Probiotic Toothpaste in Reducing Plaque Around Orthodontic Brackets: A Randomized Controlled Trial

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ABSTRACT

Background: Plaque accumulation around orthodontic brackets presents a significant risk for enamel demineralization and gingival inflammation during fixed appliance therapy. Conventional toothpastes offer limited antibacterial activity at bracket sites. Probiotic-containing toothpastes have shown promise in promoting oral microbial balance and reducing pathogenic biofilms. This study aimed to evaluate the effectiveness of probiotic toothpaste in minimizing plaque formation around orthodontic brackets.

Materials and Methods: A randomized controlled clinical trial was conducted involving 60 orthodontic patients aged 15–25 years undergoing fixed orthodontic therapy. Participants were randomly assigned into two groups: Group A used probiotic toothpaste containing Lactobacillus reuteri, and Group B used a conventional fluoride toothpaste. Both groups followed standardized brushing instructions twice daily for 4 weeks. Plaque index (PI) scores around brackets were recorded at baseline and after 4 weeks using the Turesky modification of the Quigley-Hein Index. Data were analyzed using paired and unpaired t-tests, with $p<0.05$ considered statistically significant.

Results: At baseline, mean PI scores were similar between Group A (2.15 ± 0.28) and Group B (2.13 ± 0.26). After 4 weeks, Group A showed a statistically significant reduction in PI (1.14 ± 0.21), whereas Group B showed a moderate reduction (1.78 ± 0.25) ($p=0.001$). The intergroup comparison indicated a significantly greater reduction in plaque levels in the probiotic group compared to the control group ($p<0.01$).

Conclusion: Probiotic toothpaste demonstrated superior efficacy in reducing plaque accumulation around orthodontic brackets compared to conventional toothpaste. Incorporating probiotic-based oral care products may offer additional benefits for maintaining oral hygiene in orthodontic patients.

Keywords: *Probiotic toothpaste, Orthodontic brackets, Dental plaque, Lactobacillus reuteri, Fixed appliances, Oral hygiene.*

1. INTRODUCTION

Orthodontic treatment with fixed appliances presents unique challenges to oral hygiene due to the complex design of brackets and archwires, which create plaque-retentive areas and limit effective mechanical cleaning (1). Accumulation of plaque in these regions can lead to enamel demineralization, gingival inflammation, and the development of white spot lesions, which

are among the most common adverse effects associated with orthodontic therapy (2,3). application of various chemicals. Recently we have been able to isolate a few antiviral agents from certain plants which have shown very high antiviral activity against many viruses infecting different crops [Verma *et al*., 1979 (a, b); Chaubey, 2014].

While conventional fluoride-containing toothpastes help prevent caries and strengthen enamel, their ability to disrupt established biofilms or maintain long-term microbial balance is limited (4). In recent years, there has been increasing interest in the use of probiotics in oral health care. Probiotics, defined as live microorganisms that confer a health benefit to the host when administered in adequate amounts, are known to exert beneficial effects by competing with pathogenic bacteria, modulating the immune response, and producing antimicrobial substances (5,6). Among them, Lactobacillus reuteri has shown particular promise due to its ability to inhibit Streptococcus mutans and other cariogenic bacteria commonly associated with dental plaque (7).

Probiotic toothpastes, which incorporate these beneficial microorganisms into a daily hygiene routine, represent a novel preventive approach in orthodontics. Several studies have suggested that probiotics can reduce plaque scores, gingival bleeding, and oral malodor, although their efficacy in patients with fixed orthodontic appliances remains underexplored (8,9). The current study was designed to evaluate the effectiveness of a commercially available probiotic toothpaste in reducing plaque accumulation specifically around orthodontic brackets, comparing its efficacy with that of a conventional fluoride-based toothpaste.

2. MATERIALS AND METHODS

A total of 60 orthodontic patients undergoing fixed appliance therapy were recruited based on the following inclusion criteria: age between 15–25 years, presence of full fixed appliances in both arches, and absence of systemic diseases or antibiotic use within the last 3 months. Exclusion criteria included poor compliance with oral hygiene instructions, presence of periodontal disease, or known allergy to toothpaste ingredients.

Group Allocation: Participants were randomly assigned into two equal groups (n=30 per group) using computer-generated random numbers.

- **Group A:** Received a commercially available probiotic toothpaste containing Lactobacillus reuteri (1×10^8 CFU/g).
- **Group B:** Received a standard fluoride toothpaste (1000 ppm fluoride) without any probiotic components.

Oral Hygiene Protocol: All participants were instructed to brush twice daily using the Bass technique for two minutes with the assigned toothpaste and a standardized soft-bristled toothbrush. Brushing instructions were reinforced weekly to ensure compliance. No additional mouth rinses or interdental aids were permitted during the study period.

Clinical Assessment: Plaque accumulation was assessed using the Turesky modification of the Quigley-Hein Plaque Index. Clinical evaluations were performed at baseline (Day 0) and after 4 weeks by a single blinded examiner to reduce inter-observer variability. Plaque scores were recorded for the buccal surfaces of teeth with brackets in both arches.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Descriptive statistics (mean and standard deviation) were calculated for each group. Intragroup comparisons between baseline and post-intervention scores were done using paired t-tests, while intergroup comparisons were analyzed using independent t-tests. A p-value <0.05 was considered statistically significant.

Results

A total of 60 patients participated in the study, with equal distribution across Group A (probiotic toothpaste) and Group B (fluoride toothpaste). All participants completed the 4-week intervention period. No adverse reactions were reported during the study.

At baseline, the mean plaque index scores were comparable between the two groups. After 4 weeks of intervention, Group A demonstrated a notable reduction in plaque scores, while Group B showed only a modest improvement. The mean reduction in plaque index was significantly greater in the probiotic group compared to the fluoride group ($p < 0.01$).

Table 1 shows the intra-group comparison of plaque index scores before and after the intervention. Group A showed a reduction from 2.18 ± 0.27 to 1.12 ± 0.23 ($p < 0.001$), while Group B showed a decrease from 2.16 ± 0.29 to 1.78 ± 0.26 ($p = 0.03$).

Table 2 presents the inter-group comparison of plaque index scores at the 4-week follow-up. A statistically significant difference was observed between the two groups ($p < 0.01$), indicating the superior effectiveness of probiotic toothpaste in plaque reduction.

Table 1: Intra-group Comparison of Plaque Index Scores

Group	Baseline Plaque Index (Mean ± SD)	4-Week Plaque Index (Mean ± SD)	p-value
Group A (Probiotic)	2.18 ± 0.27	1.12 ± 0.23	< 0.001*
Group B (Fluoride)	2.16 ± 0.29	1.78 ± 0.26	0.030*

*Statistically significant

Table 2: Inter-group Comparison of Plaque Index Scores at 4 Weeks

Time Point	Group A (Probiotic)	Group B (Fluoride)	p-value
4 Weeks	1.12 ± 0.23	1.78 ± 0.26	< 0.01*

*Statistically significant

3. DISCUSSION

Effective plaque control remains a cornerstone of successful orthodontic treatment. Fixed appliances such as brackets and wires create new plaque-retentive niches that are difficult to access with routine oral hygiene methods, thereby increasing the risk of demineralization and gingivitis (1,2). In this study, the application of probiotic toothpaste showed a statistically significant reduction in plaque accumulation compared to a conventional fluoride toothpaste, suggesting that probiotics may offer an adjunctive benefit in managing plaque during orthodontic therapy.

Probiotic therapy in dentistry is grounded in the principle of microbial interference, where beneficial bacteria inhibit the colonization and activity of pathogenic species (3). Lactobacillus reuteri, the probiotic strain used in the current formulation, has demonstrated antibacterial activity against Streptococcus mutans and other biofilm-forming organisms through the production of reuterin and competitive inhibition (4,5). The present findings support earlier studies which reported that probiotic supplementation can significantly reduce plaque indices and gingival inflammation in both healthy and orthodontic populations (6,7).

Our results showed a plaque index reduction of over 45% in the probiotic group over four weeks, aligning with prior investigations. For example, Cagetti et al. observed a marked decline in plaque and gingivitis scores in schoolchildren using a probiotic-based regimen (8). Similarly, Teughels et al. reported that topical probiotic administration led to a significant reduction in microbial pathogenicity within subgingival biofilms (9). These effects are attributed to the ability of probiotics to alter the local environment, enhance the host immune response, and suppress inflammatory mediators (10,11).

Unlike chemical agents such as chlorhexidine, which though effective, may lead to staining, mucosal irritation, and taste alteration (12), probiotics are generally well tolerated and have a favorable safety profile, especially when used in non-invasive forms like toothpaste or lozenges (13). Additionally, the daily use of probiotic toothpaste fits seamlessly into existing oral hygiene routines, improving compliance in adolescent orthodontic patients.

Nonetheless, this study has limitations. The short study duration may not capture long-term effects or sustainability of probiotic colonization in the oral cavity. Moreover, only one strain of L. reuteri was tested, and results may vary with different probiotic combinations or delivery methods (14). Future studies should focus on long-term outcomes, strain-specific efficacy, and molecular profiling of microbiota to better understand the underlying mechanisms (15).

4. CONCLUSION

In conclusion, probiotic toothpaste demonstrated superior plaque reduction around orthodontic brackets compared to conventional fluoride toothpaste, offering a promising and biocompatible strategy for enhancing oral hygiene during fixed appliance therapy.

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