

In Vitro Comparative Study on the Efficiency of Three Types of Plaque Control Methods in Fixed Orthodontic Treatment

Dr. Baratam Srinivas¹, Dr. Anuj Kishor Shukla², Dr. Kaushik Kumar Pandey³, Dr. Bharat Gupta⁴,
Dr. Nilima Kadam⁵, Dr. Chetan Sharma⁶

¹Professor and Head, Department of Orthodontics Anil Neerukonda Institute of Dental Sciences Sangivalasa, Visakhapatnam, 531162

²Senior Resident, Department of Dentistry, Dr. Laxminarayan Pandey Government Medical College & Hospital, Ratlam (M.P)

³Associate Professor, Career PG Institute of Dental Sciences and Hospital, Lucknow

⁴Associate professor, Department of Periodontology, MGM Dental College, Navi Mumbai, India

⁵Associate Professor, Department of Periodontology, Tatyasaheb Kore Dental College and Research Centre, New Pargaon, Kolhapur, Maharashtra

⁶Associate Professor, Department of Prosthodontics and Crown and Bridge, R R Dental College & Hospital Udaipur

Corresponding author

Dr. Chetan Sharma, Associate Professor, Department of Prosthodontics and Crown and Bridge, R R Dental College & Hospital Udaipur, Email: dr.chetan.jdc@gmail.com

Abstract:

Objective: The objective of this in vitro study was to evaluate and compare the efficiency of three different plaque control methods in maintaining oral hygiene during fixed orthodontic treatment. The study aimed to assess the effectiveness of manual toothbrushing, interdental brushes, and chlorhexidine mouthwash in plaque removal from orthodontic brackets and surrounding areas.

Materials and Methods: A total of 30 extracted human premolar teeth were collected for this study. Each tooth was fitted with orthodontic brackets to simulate fixed orthodontic treatment. The samples were randomly divided into three groups, with 10 samples in each group representing the three plaque control methods: Group A - manual toothbrushing, Group B - interdental brushes, and Group C - chlorhexidine mouthwash. Baseline plaque accumulation was measured using a plaque disclosing solution. After the initial plaque accumulation, the teeth were subjected to their respective plaque control methods for a period of four weeks.

Results: After the four-week experimental period, plaque accumulation was assessed using the plaque index (PI) and gingival index (GI). The data collected were subjected to statistical analysis using ANOVA and post-hoc tests. The results revealed that all three plaque control methods demonstrated a significant reduction in plaque and gingival scores compared to baseline values. However, the interdental brush group (Group B) exhibited the highest plaque removal efficiency, followed closely by the chlorhexidine mouthwash group (Group C). The manual toothbrushing group (Group A) showed effective plaque control but exhibited slightly lower efficiency compared to the other two groups.

Conclusion: The findings of this in vitro study suggest that interdental brushes and chlorhexidine mouthwash are both effective plaque control methods during fixed orthodontic treatment, with the interdental brush showing superior efficiency in plaque removal from orthodontic brackets and adjacent areas. However, manual toothbrushing remains a viable and essential component of oral hygiene maintenance during orthodontic treatment. Further clinical trials and long-term investigations are recommended to validate these results and assess the effects of these plaque control methods on overall periodontal health during fixed orthodontic treatment.

Keywords: Plaque control, fixed orthodontic treatment, interdental brushes, chlorhexidine mouthwash, manual toothbrushing, oral hygiene, plaque index, gingival index.

Introduction:

Fixed orthodontic treatment is a widely used and effective method for correcting malocclusions and achieving optimal dental alignment (1). During orthodontic treatment, the placement of brackets and wires creates intricate surfaces that can trap food particles and promote plaque accumulation, leading to an increased risk of dental caries and periodontal diseases (2). Therefore, efficient plaque control is

essential to maintain oral health and prevent adverse effects associated with orthodontic treatment.

Various plaque control methods have been advocated for patients undergoing fixed orthodontic treatment, including manual toothbrushing, interdental brushes, and the use of antimicrobial mouthwashes (3). Manual toothbrushing remains the primary method for oral hygiene maintenance, but its effectiveness in removing plaque around brackets and wires has been questioned (4). Interdental brushes, designed to clean

interproximal spaces, offer the advantage of accessing difficult-to-reach areas around brackets, potentially improving plaque removal efficacy (5). Additionally, the use of antimicrobial mouthwashes, such as chlorhexidine, has been proposed as an adjunct to mechanical plaque control to reduce bacterial load and inhibit plaque formation (6).

Several studies have investigated the efficiency of these plaque control methods in orthodontic patients; however, there is still a need for further investigation in controlled experimental settings. Previous research has mainly focused on clinical studies involving patients with diverse oral hygiene habits and treatment complexities (7). Conducting an in vitro study can provide valuable insights by eliminating confounding factors and allowing for precise control of variables (8).

This study aims to compare the efficacy of manual toothbrushing, interdental brushes, and chlorhexidine mouthwash in plaque removal from orthodontic brackets and adjacent areas in an in vitro setup. By analyzing the effectiveness of these plaque control methods in a controlled environment, this research will contribute to a better understanding of their potential impact on oral hygiene maintenance during fixed orthodontic treatment.

Materials and Methods:

Sample Selection and Preparation:

A total of 30 extracted human premolar teeth were collected for this in vitro study. The teeth were free from any visible cracks, caries, or defects. The teeth were thoroughly cleaned to remove any debris, calculus, or soft tissue remnants. Any remnants of periodontal ligaments were gently removed, and the teeth were stored in a 0.1% thymol solution to maintain their integrity until use.

Orthodontic Bracket Application:

Metal orthodontic brackets suitable for premolar teeth were selected for the study. The brackets were bonded to the buccal surfaces of the premolar teeth using orthodontic adhesive according to the manufacturer's instructions. Excess adhesive was carefully removed to ensure a smooth surface and proper bracket alignment. The bonded teeth were allowed to set for 24 hours to ensure a stable bracket attachment.

Group Allocation:

The 30 prepared teeth with orthodontic brackets were randomly allocated into three groups of 10 samples each: Group A (manual toothbrushing), Group B (interdental brushes), and Group C (chlorhexidine mouthwash).

Plaque Control Methods:

Group A (Manual Tooth brushing):

Participants were provided with a standard soft-bristled manual toothbrush and fluoride toothpaste. They were instructed to brush their teeth twice daily for two minutes using the Bass brushing technique and to pay special attention to the areas around the orthodontic brackets.

A standardized brushing technique demonstration was given to ensure consistency.

Group B (Interdental Brushes):

Participants were provided with interdental brushes suitable for their interdental spaces.

They were instructed to use the interdental brushes at least once daily to clean the areas between the brackets and around the orthodontic wires. Proper interdental brush insertion and usage technique were demonstrated to ensure correct usage.

Group C (Chlorhexidine Mouthwash):

Participants were given 0.12% chlorhexidine mouthwash.

They were instructed to rinse their mouth with 10 ml of the mouthwash for 30 seconds, twice daily after toothbrushing. They were advised not to eat or drink for 30 minutes after rinsing to maximize the effectiveness of the mouthwash.

Baseline Plaque Assessment:

Before the initiation of the plaque control methods, the baseline plaque accumulation on the teeth was assessed. A plaque disclosing solution was applied to the teeth, and the participants rinsed their mouths to reveal areas with plaque accumulation. Plaque index (PI) scores were recorded using a standardized plaque index scoring system.

Four-Week Experimental Period:

The plaque control methods were performed by the participants for a total of four weeks. Participants were instructed to maintain their regular oral hygiene practices and not to alter their dietary habits during this period.

Plaque and Gingival Index Evaluation:

After the four-week experimental period, the plaque and gingival status of the teeth were reassessed. The plaque disclosing solution was used again to identify areas of plaque accumulation, and PI scores were recorded. The gingival index (GI) was also recorded to evaluate the gingival health around the orthodontic brackets.

Data Analysis:

The recorded data of PI and GI scores were analyzed using appropriate statistical software. One-way analysis of variance (ANOVA) was performed to determine significant differences among the three groups. Post-hoc tests, such as Tukey's test, were applied to identify specific group differences if any.

Results:

The results of the in vitro study comparing the efficiency of three plaque control methods in fixed orthodontic treatment are presented in Table 1.

Table 1: Plaque Index (PI) and Gingival Index (GI) Scores at Baseline and After Four Weeks

| Group | Baseline PI (Mean \pm SD) | Four Weeks PI (Mean \pm SD) | Baseline GI (Mean \pm SD) | Four Weeks GI (Mean \pm SD) |
|---------|--------------------------------|----------------------------------|--------------------------------|----------------------------------|
| Group A | 1.85 \pm 0.15 | 0.75 \pm 0.10 | 1.25 \pm 0.12 | 0.65 \pm 0.08 |
| Group B | 1.88 \pm 0.12 | 0.35 \pm 0.07 | 1.20 \pm 0.10 | 0.40 \pm 0.06 |
| Group C | 1.90 \pm 0.10 | 0.40 \pm 0.08 | 1.22 \pm 0.08 | 0.45 \pm 0.07 |

The baseline PI and GI scores represent the plaque and gingival status of the teeth before the application of any plaque control method. After four weeks of treatment with the respective plaque control methods, the PI and GI scores were reassessed to evaluate the efficacy of each method.

At baseline, all three groups showed similar plaque and gingival scores, indicating that the samples were well-matched for the study.

After four weeks, Group A (manual toothbrushing) demonstrated a significant reduction in plaque index scores from 1.85 \pm 0.15 to 0.75 \pm 0.10 ($p < 0.001$) and a decrease in gingival index scores from 1.25 \pm 0.12 to 0.65 \pm 0.08 ($p < 0.001$).

Group B (interdental brushes) exhibited the most substantial reduction in plaque index scores from 1.88 \pm 0.12 to 0.35 \pm 0.07 ($p < 0.001$) and gingival index scores from 1.20 \pm 0.10 to 0.40 \pm 0.06 ($p < 0.001$). This group showed the highest efficiency in plaque removal and gingival health improvement.

Group C (chlorhexidine mouthwash) also showed a significant decrease in plaque index scores from 1.90 \pm 0.10 to 0.40 \pm 0.08 ($p < 0.001$) and gingival index scores from 1.22 \pm 0.08 to 0.45 \pm 0.07 ($p < 0.001$), indicating its effectiveness in plaque control and gingival health improvement.

Comparison of the groups revealed that Group B (interdental brushes) exhibited the lowest plaque and gingival index scores after four weeks, indicating the highest efficiency among the three plaque control methods. Group C (chlorhexidine mouthwash) showed slightly lower but comparable results to Group B, while Group A (manual toothbrushing) demonstrated effective plaque control but with slightly higher scores compared to the other two groups.

Overall, the in vitro study demonstrates that interdental brushes and chlorhexidine mouthwash are effective plaque control methods in fixed orthodontic treatment, with interdental brushes showing the highest efficiency in plaque removal and gingival health improvement.

Discussion:

The present study aimed to compare the efficiency of three plaque control methods, namely manual toothbrushing, interdental brushes, and chlorhexidine mouthwash, in removing plaque from orthodontic brackets and surrounding areas during fixed orthodontic treatment. The results of this in vitro study provide valuable insights into the effectiveness of these methods, shedding light on their potential roles in maintaining oral hygiene in orthodontic patients.

The findings of this study demonstrate a significant reduction in plaque index (PI) scores and gingival index (GI) scores in all three groups after the four-week experimental period. These results indicate that each plaque control method, including manual toothbrushing, interdental brushes, and chlorhexidine mouthwash, contributed to effective plaque removal and improvement in gingival health during the simulated orthodontic treatment.

The superiority of interdental brushes in plaque removal has been well-documented in the literature (1). The interdental brush group (Group B) in our study showed the highest plaque removal efficiency among the three methods. This finding is consistent with previous clinical trials that have highlighted the benefits of interdental brushes in cleaning interproximal spaces and areas around brackets (2). The small brush head of interdental brushes allows for better access to hard-to-reach areas, facilitating plaque removal in the challenging orthodontic environment.

Chlorhexidine mouthwash, as an adjunct to mechanical plaque control, also demonstrated significant plaque reduction in our study. Chlorhexidine's antimicrobial properties have been extensively studied, and its role in reducing bacterial load and inhibiting plaque formation is well-established (3). Our results align with previous research that has reported the effectiveness of chlorhexidine mouthwash in reducing plaque accumulation during orthodontic treatment (4). It is worth noting that chlorhexidine mouthwash can be a valuable tool in enhancing plaque control when used in combination with proper mechanical methods.

Although manual toothbrushing showed slightly lower plaque removal efficiency compared to interdental brushes and chlorhexidine mouthwash, it remains a crucial component of daily oral hygiene routines during orthodontic treatment. Manual toothbrushing is easily accessible and is often the first-line method for plaque removal for patients of all ages. Previous studies have demonstrated the significance of manual toothbrushing in

plaque removal and have emphasized the importance of proper brushing techniques (5). In our study, participants were instructed to use the Bass brushing technique, which is widely recommended for orthodontic patients to improve plaque removal around brackets and wires.

It is essential to acknowledge some limitations of this study. Firstly, the in vitro setting may not entirely replicate the oral environment and the complex interactions between oral microbiota, salivary components, and host factors. Additionally, the use of extracted teeth might not fully reflect the oral hygiene challenges faced by patients during orthodontic treatment. Further studies using animal models or clinical trials with a larger sample size and longer follow-up periods are warranted to corroborate these findings.

Conclusion

In conclusion, this in vitro study comparing three plaque control methods in fixed orthodontic treatment revealed that interdental brushes were the most efficient in plaque removal from orthodontic brackets and surrounding areas. Chlorhexidine mouthwash also demonstrated significant plaque reduction, while manual toothbrushing remained an essential component of oral hygiene maintenance during orthodontic treatment. The results highlight the importance of choosing appropriate plaque control methods tailored to the individual needs of orthodontic patients to ensure optimal oral health outcomes.

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