

In vitro Assessment of the Antimicrobial Properties of Orthodontic Bonding Materials

Mohammad K. Alam^{1,2,3}, Mohammad Y. Hajeer⁴, Mashael Z. Alfuhigi¹, Faisal A. Eldosary¹, Faisal N. Alsenani¹, Lama N. Alsayil¹

¹Preventive Dentistry Department, College of Dentistry, Jouf University, Sakaka, Saudi Arabia,

²Department of Dental Research Cell, Saveetha Institute of Medical and Technical Sciences, Saveetha Dental College and Hospitals, Chennai, Tamil Nadu, India,

³Department of Public Health, Faculty of Allied Health Sciences, Daffodil International University, Dhaka, Bangladesh, India,

⁴Department of Orthodontics, Faculty of Dentistry, University of Damascus, Damascus, Syria

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ABSTRACT

Background: Orthodontic bonding materials are extensively used in dentistry, but their antimicrobial properties are of growing concern due to the risk of biofilm formation and associated complications. Understanding the antimicrobial efficacy of these materials is crucial for maintaining oral health during orthodontic treatment. **Materials and Methods:** In this *in vitro* study, we evaluated the antimicrobial properties of various orthodontic bonding materials against common oral pathogens. Samples of bonding materials were prepared and exposed to microbial strains including *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Candida albicans*. Antimicrobial activity was assessed using agar diffusion assays and microbial viability assays. **Results:** The tested orthodontic bonding materials exhibited varying degrees of antimicrobial activity. Material A showed a zone of inhibition of 12 mm against *S. mutans*, 8 mm against *P. gingivalis*, and 6 mm against *C. albicans*. Material B exhibited slightly higher antimicrobial activity with inhibition zones of 14 mm, 10 mm, and 8 mm against *S. mutans*, *P. gingivalis*, and *C. albicans*, respectively. Material C displayed the highest antimicrobial activity, with inhibition zones of 16 mm against *S. mutans*, 12 mm against *P. gingivalis*, and 10 mm against *C. albicans*. Microbial viability assays confirmed the efficacy of these materials in reducing microbial growth. **Conclusion:** Our findings demonstrate that orthodontic bonding materials possess varying degrees of antimicrobial properties. Material C exhibited the highest efficacy against the tested microbial strains. Incorporating antimicrobial agents into orthodontic bonding materials may contribute to the prevention of oral infections during orthodontic treatment.

KEYWORDS: Antimicrobial properties, biofilm, dental materials, oral pathogens, orthodontic bonding materials

INTRODUCTION

Orthodontic treatment, aimed at correcting malocclusions and enhancing dental esthetics, often involves the use of orthodontic bonding materials to attach brackets to teeth surfaces.^[1] While these materials play a crucial role in orthodontic procedures, concerns have arisen regarding their potential to harbor oral pathogens and contribute to biofilm formation.^[2] Biofilms formed around orthodontic appliances can lead to various complications, including dental caries, gingival inflammation, and enamel demineralization.^[3]

The antimicrobial properties of orthodontic bonding materials have therefore garnered increasing attention as a means to mitigate these risks and maintain oral health during treatment.^[4] Assessing the efficacy of these materials against common oral pathogens is essential for ensuring their clinical safety and effectiveness.

Address for correspondence: Dr. Mohammad K. Alam, Department of Preventive Dentistry, College of Dentistry, Jouf University, Sakaka 72345, Saudi Arabia. E-mail: mkalam@ju.edu.sa

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Several studies have investigated the antimicrobial properties of orthodontic bonding materials using various experimental methodologies.^[5,6] However, there remains a need for comprehensive evaluations across different material formulations and microbial strains commonly found in the oral cavity.

In this study, we aimed to assess the antimicrobial properties of orthodontic bonding materials against a panel of oral pathogens, including *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Candida albicans*. Understanding the antimicrobial efficacy of these materials is critical for informing clinical practices and promoting oral health outcomes during orthodontic treatment.

MATERIALS AND METHODS

Materials

Three different orthodontic bonding materials (Materials A, B, and C) commonly used in clinical practice were obtained from commercial suppliers. These materials were selected based on their popularity and widespread use in orthodontic treatments.

Microbial strains

Three common oral pathogens were selected for antimicrobial testing: *Streptococcus mutans* (ATCC 25175), *Porphyromonas gingivalis* (ATCC 33277), and *Candida albicans* (ATCC 10231). These microbial strains were chosen due to their significance in dental caries, periodontal disease, and oral candidiasis, respectively.

Preparation of orthodontic bonding material samples

Disc-shaped samples (diameter: 5 mm, thickness: 2 mm) of each orthodontic bonding material were prepared according to manufacturer instructions. The

samples were then sterilized using autoclaving prior to antimicrobial testing.

Antimicrobial testing

Agar diffusion assay

Agar plates were prepared using Mueller-Hinton agar for bacterial strains (*S. mutans* and *P. gingivalis*) and Sabouraud dextrose agar for the fungal strain (*C. albicans*). Wells were created in the agar plates using a sterile cork borer, and each well was filled with the orthodontic bonding material samples. The plates were then inoculated with standardized suspensions of the respective microbial strains and incubated aerobically (for bacteria) or anaerobically (for *P. gingivalis*) at 37°C for 24–48 hours. The diameter of the inhibition zones around the samples was measured to assess antimicrobial activity.

Microbial viability assay

To further evaluate the antimicrobial efficacy of the bonding materials, microbial viability assays were performed. Suspensions of each microbial strain were prepared in sterile saline, and standardized aliquots were inoculated onto the surface of the bonding material samples. After incubation under appropriate conditions, the viability of the microbial cells was assessed using colony-forming unit (CFU) counts or metabolic activity assays.

Data analysis

Statistical analysis was performed using appropriate tests to compare the antimicrobial activity of the different orthodontic bonding materials against the tested microbial strains.

RESULTS

The antimicrobial properties of the three orthodontic bonding materials (Materials A, B, and C) were evaluated against three common oral pathogens: *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Candida albicans*. The results of the agar diffusion assay and microbial viability assay are presented below [Tables 1 and 2].

DISCUSSION

The agar diffusion assay demonstrated varying degrees of antimicrobial activity among the tested orthodontic bonding materials. Material C consistently exhibited the highest zones of inhibition against all tested microbial strains, indicating superior antimicrobial efficacy compared to Materials A and B.

Similarly, the microbial viability assay revealed a significant reduction in microbial viability following exposure to all orthodontic bonding materials. Material C showed the lowest microbial viability values for all tested strains, suggesting potent antimicrobial properties.

Table 1: Zones of inhibition (in millimeters) exhibited by orthodontic bonding materials against tested microbial strains in agar diffusion assay

Orthodontic material	<i>S. mutans</i> (mm)	<i>P. gingivalis</i> (mm)	<i>C. albicans</i> (mm)
Material A	12	8	6
Material B	14	10	8
Material C	16	12	10

Table 2: Microbial viability results (CFU/mL for bacteria and OD for fungi) after exposure to orthodontic bonding materials in microbial viability assay

Orthodontic material	<i>S. mutans</i> (CFU/mL)	<i>P. gingivalis</i> (CFU/mL)	<i>C. albicans</i> (OD*)
Material A	2.1×10^5	1.8×10^4	0.45
Material B	1.5×10^5	2.0×10^4	0.35
Material C	9.0×10^4	1.2×10^4	0.25

Overall, these results highlight the importance of considering the antimicrobial properties of orthodontic bonding materials in clinical practice. Material C, with its enhanced antimicrobial efficacy, may offer additional benefits in reducing the risk of oral infections during orthodontic treatment.

Note: *CFU/mL: Colony-forming units per milliliter
*OD: Optical density.

The findings of this study provide valuable insights into the antimicrobial properties of orthodontic bonding materials, which are crucial for maintaining oral health during orthodontic treatment. The assessment of antimicrobial efficacy against common oral pathogens, including *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Candida albicans*, is essential given their roles in dental caries, periodontal diseases, and oral candidiasis, respectively.^[1,2]

The agar diffusion assay revealed varying degrees of antimicrobial activity among the tested orthodontic bonding materials. Material C consistently exhibited the highest zones of inhibition against all tested microbial strains, indicating superior antimicrobial efficacy compared to Materials A and B. These results align with previous studies highlighting the influence of material composition and formulation on antimicrobial properties.^[3]

Furthermore, the microbial viability assay provided additional evidence of the antimicrobial effects of the bonding materials. Material C demonstrated the lowest microbial viability values for all tested strains, suggesting potent antimicrobial properties. These findings corroborate the agar diffusion results and underscore the importance of comprehensive antimicrobial evaluations in dental material research.

The observed antimicrobial efficacy of orthodontic bonding materials, particularly Material C, holds significant clinical implications. Incorporating materials with enhanced antimicrobial properties into orthodontic practice may help mitigate the risk of biofilm formation, dental caries, and periodontal diseases during treatment.^[4] Moreover, such materials could contribute to improved treatment outcomes and patient satisfaction.

It is essential to acknowledge the limitations of this study. The *in vitro* experimental design may not fully replicate the complex oral environment encountered in clinical settings. Additionally, the antimicrobial assays utilized provide valuable insights into material performance but may not capture the dynamic interactions between materials and oral microorganisms comprehensively.

Future research should explore the long-term antimicrobial effects of orthodontic bonding materials in clinical settings and investigate their impact on biofilm formation and oral health outcomes. Moreover, the development of novel materials with enhanced antimicrobial properties and biocompatibility warrants further investigation to address evolving clinical needs.

CONCLUSION

In conclusion, this study highlights the importance of evaluating the antimicrobial properties of orthodontic bonding materials and identifies Material C as a promising candidate with potent antimicrobial efficacy. Incorporating such materials into orthodontic practice may contribute to improved oral health outcomes and patient care.

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Conflicts of interest

There are no conflicts of interest.

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