Adhesion of Methicillin-Resistant Staphylococcus aureus and Candida albicans to Parylene-C–Coated Polymethyl Methacrylate

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Purpose: To determine whether coating polymethyl methacrylate (PMMA) discs with Parylene-C would reduce Staphylococcus aureus and Candida albicans biofilm formation. Materials and Methods: MRSA and Candida albicans single and dual biofilms were grown for 48 hours in artificial saliva on parylene-C–coated or uncoated PMMA, and the viable biofilm colony-forming units were counted. Results: There was no significant difference in the count of viable methicillin-resistant Staphylococcus aureus or Candida albicans recovered from single- or dual-species biofilms between coated and uncoated PMMA discs. Conclusion: Parylene-C does not prevent biofilm formation on PMMA. Int J Prosthodont 2019;32:193–195. doi: 10.11607/ijp.5918

Intraoral removable prostheses, which are most commonly made using the acrylic resin polymethyl methacrylate (PMMA), are capable of acting as reservoirs for Candida albicans and methicillin-resistant Staphylococcus aureus (MRSA), opportunistic pathogens that are associated with oral and life-threatening systemic infections.1 Parylene-C, a polymer frequently used for coating medical devices, has been shown to alter PMMA surface roughness (Ra),2 a feature that could influence microbial adhesion and colonization. Parylene-N, which has a similar structure, was shown to significantly reduce adhesion of C albicans on denture resin.3 This study therefore aimed to determine whether a lower Ra, bestowed by a Parylene-C coating on PMMA, affected MRSA and C albicans single- and dual-species biofilm formation.

MATERIALS AND METHODS

Polished and heat-cured PMMA (C&J De-luxe, Chaperlin & Jacobs) discs of 10-mm diameter were coated with 10 µm of Parylene-C (Specialty Coating Systems) or left uncoated, and the Ra of the discs was measured (Proscan 1000 scanning laser profilometer). Artificial saliva was inoculated with overnight nutrient broth cultures of MRSA (EMRSA-16; NCTC 13143) and C albicans, as single- or dual-species suspensions, to optical densities of 0.5 (OD600). These suspensions (3 mL) were added to sterilized coated or uncoated PMMA discs and incubated in 5% CO₂ atmosphere at 37°C for 48 hours. Discs were dipped into sterile phosphate-buffered saline to remove planktonic bacteria and vortexed for 1 minute in 1 mL of neutralizing broth to remove the biofilm. To determine the number of viable bacteria or yeast per disc, the microbial suspensions were plated onto Columbia blood agar base supplemented with

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The results of this study show that there is no statistical difference in the number of viable organisms recovered from biofilms formed on PMMA or Parylene-C–coated PMMA. These results are in contrast to a recent study in which Parylene-N reduced adhesion of *C. albicans* to coated silicone elastomer and denture PMMA-based resins. This difference could be due to the superior penetration ability of Parylene-N compared to Parylene-C due to its unique molecular movement during deposition. However, Parylene-C fulfills International Organization for Standardization (ISO) 10993 and US Pharmacopeial Convention (USP) Class VI tests and is more appropriate for use with intraoral prostheses than Parylene-N.

**RESULTS**

There was a significant difference between the mean Ra value of the uncoated PMMA discs and the Parylene-C–coated PMMA discs (*P* = .018) (Fig 1). The mean number of viable MRSA recovered from biofilms on Parylene-C–coated PMMA discs was not significantly different from the number recovered from the uncoated discs (*P* = .168) (Fig 2a). There was also no significant difference in the number of viable *C. albicans* recovered from biofilms formed on coated compared to uncoated discs (*P* = .404) (Fig 2b). Statistical analysis of the total number of microorganisms recovered from the dual-species biofilms containing MRSA and *C. albicans* also revealed that there was no significant difference between Parylene-C–coated PMMA and uncoated PMMA (*P* = .999) (Fig 3).

**DISCUSSION**

The results of this study show that there is no statistical difference in the number of viable organisms recovered from biofilms formed on PMMA or Parylene-C–coated PMMA. These results are in contrast to a recent study in which Parylene-N reduced adhesion of *C. albicans* to coated silicone elastomer and denture PMMA-based resins. However, Parylene-C fulfills International Organization for Standardization (ISO) 10993 and US Pharmacopeial Convention (USP) Class VI tests and is more appropriate for use with intraoral prostheses than Parylene-N.

5% horse blood, amphotericin B, and/or Sabouraud agar containing vancomycin and incubated for 24 to 48 hours at 37°C in a 5% CO₂ atmosphere. Statistical significance was determined using a paired-samples *t* test and SPSS software (Version 24, IBM) with a 5% level of statistical significance.

**Fig 1** Graph showing the roughness (Ra) values (µm) of Parylene-C–coated polymethyl methacrylate (PMMA) discs and uncoated PMMA discs. Error bars represent 1.5 interquartile range. The line represents the median, and the square represents the mean. *P* < .05.

**Fig 2** Single-species biofilm formation in colony-forming units (CFU/mL) of (a) methicillin-resistant *Staphylococcus aureus* (MRSA) and (b) *Candida albicans*. The results are shown as the mean of at least three biologic repeats, within which three technical repeats were done. Error bars represent standard deviations.

**Fig 3** Dual-species biofilm formation of *Staphylococcus aureus* (MRSA) and *Candida albicans* (CFU/mL) on Parylene-C–coated and uncoated PMMA discs. (a) Total viable counts of MRSA and *C. albicans*. (b) Viable counts of MRSA within dual-species biofilms. (c) Viable counts of *C. albicans* within dual-species biofilms. The results are shown as the mean of at least three biologic repeats, within which three technical repeats were done. Error bars represent standard deviations.
A surface roughness of 0.2 μm is thought to be the limit to which gingival plaque microbes can adhere. The PMMA discs in this study were sanded to a target Ra value of 3.0 μm, comparable to the Ra values obtained by Bourlidi et al. To achieve the lowest possible Ra values with the Parylene-C coating, the discs were coated with 10 μm of Parylene-C. Despite the mean Ra of the Parylene-C-coated discs (1.45 μm) being significantly lower than the uncoated (2.95 μm) PMMA discs (P = .018), the reduced Ra did not result in a significant reduction in biofilm formation by MRSA or C. albicans.

CONCLUSIONS

Coating PMMA discs with Parylene-C does not lead to a significant difference in biofilm formation by the opportunistic pathogens C. albicans and MRSA, despite the significant reduction in Ra.

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REFERENCES


Literature Abstract


The aim of this study was to evaluate the influence of the location and length of root pieces on buccal peri-implant bone width and socket preservation in the socket shield technique. A total of 48 dental implants (24 narrow- and 24 regular-platform internal hex implants) were placed in six dogs. The clinical crowns of teeth P2, P3, P4, and M1 were detached horizontally and removed from the underlying roots. Then the mesial root of each tooth was extracted, and the distal root was degraded using a high-speed handpiece with round bur, creating a concave shell of dentin cementum and periodontal ligament (PDL) connected to the buccal aspect of the socket. Remaining root fragments of different lengths were created: coronal (1/3); middle and coronal (2/3); and full length (3/3). These were positioned all around the bone crest. Implants were placed at the center of the root sockets, 1 to 3 mm deeper than the original root apex. Resonance frequency analysis and histologic evaluations were made at 4 and 12 weeks. Data underwent statistical analyses, with P < .05 considered significant. All 48 implants osseointegrated satisfactorily. On both the buccal and lingual sides, the coronal (1/3) radicular fragment was attached to the buccal bone plate by a physiologic PDL with less crestal bone resorption compared to the middle (2/3) and whole (3/3) root groups for narrow and standard implants. Within the limitations of this study, the results demonstrate that a small piece of root in the coronal part of the alveolus can protect the buccal, mesial, and distal bone crest following the immediate placement of narrow or standard internal hex implants. The thickness of the peri-implant bone and the remaining root fragment together will provide a total thickness of > 2 mm. This technique appears to be highly predictable, maintaining bone volume and reducing the risk of crestal bone resorption.