

The Role of Soft Tissue Former Material in Microbial Colonization of the Peri-Implant Zone

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Annotation: Implant-supported prosthetics is currently one of the leading approaches in prosthetic dentistry for the treatment of partial and complete edentulism. The use of dental implants provides high functional efficiency, improves aesthetic outcomes, and enhances patients' quality of life compared to removable prostheses, which are often associated with prolonged adaptation periods, insufficient stability, and reduced masticatory efficiency. During the formation of the soft tissue contour around the implant, the choice of the healing abutment (soft tissue former) and its material plays a critical role. The surface properties and chemical composition of the material can influence the degree of microbial adhesion and the intensity of biofilm formation in the peri-implant region. Therefore, strict requirements are imposed on the materials used for soft tissue formers, including mechanical strength, biological inertness, absence of toxic effects, and hypoallergenic properties. Optimizing the selection of material helps reduce the risk of inflammatory complications and contributes to the formation of a stable soft tissue barrier around the implant.

Keywords: healing abutment, dental materials, titanium, PMMA resin, PEEK polymer

Introduction

The presence of various prosthetic constructions in the oral cavity affects the microbial composition of the oral environment and may lead to alterations in the established biofilm community. During prosthetic treatment, it is important to consider the ability of the resident oral microbiota to adhere to and colonize the surfaces of different dental materials [1, 2, 7]. Increased microbial contamination of prosthetic components can trigger and sustain inflammatory changes in the peri-implant suprastructure [3, 4].

One of the key factors for achieving stable functional and aesthetic outcomes in implant therapy is the maintenance of healthy soft tissues in the peri-implant region. Individual healing abutments (soft tissue formers) are used to shape the anatomically correct soft tissue profile, preparing the tissues for abutment and prosthetic placement. These formers facilitate the formation of an adequate gingival contour, provide mechanical stability for the implant, and create a barrier that limits the penetration of pathogenic microorganisms [5, 6].

According to both domestic and international studies, the intensity of microbial adhesion to artificial crowns, healing abutments, and other prosthetic components depends on the properties of the material used. Surface microtopography, degree of polishing, and physicochemical and mechanical characteristics of the material play a significant role [8, 9]. Nevertheless, there are currently no clear clinical guidelines for selecting the optimal material for individual healing abutments in patients with dental implants [10].

Objective: To perform a comparative analysis of microbial colonization on the surfaces of different materials used for shaping the soft tissue contour around dental implants.

METHODS

The study included 36 patients aged 24–65 years who underwent implant-supported prosthetic rehabilitation and received individual healing abutments. All patients were divided into three equal groups of 12 subjects each:

- Group 1: healing abutments made of titanium;
- Group 2: healing abutments made of polymethyl methacrylate (PMMA);
- Group 3: healing abutments made of polyetheretherketone (PEEK).

Microbiological analysis was performed at two time points: 7 days after placement (baseline) and 4 weeks after abutment installation. The qualitative and quantitative composition of facultative and opportunistic microorganisms adhering to the surfaces of the formers was assessed.

After removal, each healing abutment was placed in a sterile Petri dish. Microbial biofilm was collected using an adhesive film, which was then transferred to phosphate buffer solution and homogenized. Serial tenfold dilutions were prepared from the suspension and plated on the following culture media: blood agar, egg-yolk salt agar, MRS agar, Sabouraud agar, and chromogenic agar for primary identification and colony counting.

Incubation was carried out in a thermostat at 37 °C for 24–48 hours under microaerophilic conditions. Microbial counts were expressed as colony-forming units (CFU) and presented as logarithms per 1 cm² of the surface (lg/cm²).

RESULTS AND DISCUSSION

Baseline microbiological analysis showed that the spectrum of microorganisms adhering to the surface of individual healing abutments was predominantly facultative flora. Most of the isolated strains belonged to representatives of the normal oral microbiome.

The highest degree of microbial colonization was observed on polymethyl methacrylate (PMMA) abutments. The proportion of enterococci, yeast-like fungi of the genus *Candida*, and actinomycetes on this material exceeded 40%. The lowest contamination levels were recorded for titanium abutments, while polyetheretherketone (PEEK) abutments showed intermediate levels of microbial adhesion.

The most pronounced differences between materials were observed for *Candida* and actinomycetes. For PMMA, *Candida* was detected in 43.8% of cases and actinomycetes in 42.9%. For titanium, the corresponding values were 18.8% and 23.8%, respectively. PEEK abutments showed 37.5% colonization by *Candida* and 33.3% by actinomycetes.

Notably, potentially pathogenic and transient microorganisms — including *Pseudomonas spp.*, *Klebsiella spp.*, and *Escherichia coli* — were exclusively isolated from the surface of PMMA abutments. These microorganisms are not typical components of the oral microbiome and are usually eliminated by antagonistic interactions with the resident flora or removed through ingestion. The porous structure of PMMA likely facilitates their adhesion and retention on the surface of the abutments.

Quantitative analysis at 7 days after placement showed that streptococci were the predominant microorganisms. The most frequently isolated species were *Streptococcus mitis*, *S. salivarius*, *S. milleri*, and *S. mutans*, with concentrations not exceeding lg 3.4 CFU/cm².

Overall, quantitative microbial counts at 7 days showed minor differences among the materials. The most significant difference was observed between PMMA and titanium. For *Candida*, concentrations were lg 2.4 CFU/cm² on PMMA and lg 0.8 CFU/cm² on titanium. PEEK exhibited intermediate values, slightly lower than PMMA and slightly higher than titanium.

Repeated microbiological analysis at 4 weeks post-installation revealed no substantial changes in the percentage composition of the microbiota compared to baseline. Streptococci remained dominant, accounting for approximately 33.3% of the total isolated microorganisms and demonstrating comparable colonization levels across all materials.

Further analysis indicated that *Candida* colonization occurred in 50% of PMMA abutments, 30% of PEEK, and 20% of titanium abutments. Similar trends were observed for lactobacilli and staphylococci: the highest frequencies were recorded on PMMA, the lowest on titanium, and PEEK exhibited intermediate levels.

Quantitative analysis (CFU, lg/cm²) at 4 weeks showed notable changes compared to initial values. PMMA abutments demonstrated the highest microbial load, while titanium had the lowest. PEEK exhibited intermediate colonization levels, showing better microbial resistance compared to PMMA.

Conclusion and Recommendations

These results indicate that PMMA exhibits the highest potential for microbial adhesion and accumulation, including non-typical oral microbiome species. In contrast, PEEK abutments showed only slightly higher microbial colonization compared to titanium, supporting their suitability for soft tissue contouring around dental implants.

The observed differences suggest that the PEEK polymer can be considered a promising material for shaping the soft tissue contour around dental implants, given its satisfactory microbial resistance.

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