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# "Investigating Polymicrobial Communities on Implant Healing Caps in Geriatric Patients : Implications for Infection Control and Healing Outcomes"

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**KEYWORDS**

Dental implants; Geriatric patients; Polymicrobial biofilm; *Enterococcus faecalis*; Implant abutments; Peri-implant infection; Microbial colonization; Healing caps; Biofilm resistance; Infection control

**ABSTRACT:**

Background:

Dental implants are a reliable treatment option for oral rehabilitation; however, geriatric patients are particularly susceptible to peri-implant infections due to systemic comorbidities, reduced salivary flow, and immune decline. Implant healing caps, being exposed to the oral cavity, are prone to microbial colonization, yet the polymicrobial dynamics in this population remain underexplored.

Aim:

To investigate the diversity and predominance of microbial flora colonizing implant abutments in geriatric patients and to evaluate their potential clinical relevance in peri-implant healing outcomes.

Materials and Methods:

This study was conducted at the Department of Implantology, Saveetha Dental College, Chennai, involving geriatric patients aged ≥65 years with functionally loaded, clinically stable implants. Thirty sterile swab samples were collected from peri-abutment regions and cultured on nutrient agar, blood agar, and MacConkey agar. Microbial identification was performed using Gram staining and microscopic evaluation.

Results:

Culture-based analysis revealed polymicrobial colonization around implant abutments, with *Enterococcus faecalis* (18,000–25,000 organisms/ml) as the most predominant organism, followed by beta-hemolytic streptococci. The microbial diversity indicated coexistence of Gram-positive and Gram-negative bacteria capable of forming resilient biofilms that may delay healing or promote peri-implant inflammation.

Conclusion:

Geriatric patients exhibit complex polymicrobial colonization around implant abutments, with *E. faecalis* as the dominant species. The findings emphasize the need for enhanced infection control measures, such as antimicrobial-coated healing caps and routine microbial monitoring. Future molecular studies are warranted to characterize microbial diversity and develop targeted prevention strategies for improving implant outcomes in the elderly population.

## 1. Introduction

Dental implants have become a widely accepted modality for oral rehabilitation, especially in geriatric populations where tooth loss is common due to age-related periodontal disease, systemic illnesses, or trauma(Thomas 2024). While implant survival rates are generally high, complications such as peri-implant mucositis and peri-implantitis remain significant concerns—particularly among elderly patients, who often present with compromised immunity, systemic comorbidities (such as diabetes and cardiovascular disease), and reduced salivary flow, all of which can alter the oral microbial environment and impair wound healing(Marko 2017).

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Implant healing caps, placed during the osseointegration or prosthetic phase, serve to guide soft tissue healing and preserve access to the implant fixture(Website ). However, their exposure to the oral cavity makes them prone to colonization by diverse microbial communities. While several studies have focused on the role of specific periopathogens in implant-related infections, increasing evidence suggests that polymicrobial biofilms, rather than individual organisms, are primarily responsible for persistent inflammation and infection in peri-implant tissues. These biofilms demonstrate complex interspecies interactions, enhanced resistance to antimicrobial agents, and the ability to modulate the host immune response("Website," n.d.).

Despite this, the microbial ecology of healing caps—especially in the vulnerable geriatric population—remains poorly characterized. Most research has examined bacterial colonization in a general population, often neglecting the unique biological and environmental factors affecting older individuals. Moreover, the impact of these polymicrobial communities on healing outcomes, inflammation, and potential implant failure is not well established.

Therefore, this study aims to investigate the diversity, structure, and clinical relevance of polymicrobial communities colonizing implant healing caps in geriatric patients. By analyzing microbial profiles and correlating them with clinical and healing outcomes, this research seeks to provide insights into infection control challenges and inform the development of more effective strategies for improving implant success in elderly patients.

## 2. Objectives

To investigate the composition, diversity, and predominance of polymicrobial communities colonizing implant healing caps in geriatric patients, and to assess the potential impact of these microbial profiles—together with systemic health factors—on peri-implant tissue healing, inflammation, and the risk of infection. This study aims to provide insights into microbial interactions around implant components in elderly individuals, who are more susceptible to compromised healing due to age-related immune decline and comorbidities, thereby informing strategies for improved implant prognosis and infection control.

## 3. Methods

Study Setting and Sample Processing

This original research was conducted in the Department of Implantology at Saveetha Dental College and Hospital, Chennai, with a focus on geriatric patients aged 65 years and above who presented with multiple implant-supported prostheses. The study aimed to analyze the polymicrobial communities present around implant abutments in this population, considering their unique susceptibility to infection due to age-related immunosenescence and systemic health factors.

Inclusion and Exclusion criteria

Participants included in the study were geriatric patients aged 65 years and above, who presented with two or more implant abutments that were functionally loaded and clinically stable. Only those with no clinical signs of active peri-implantitis or mucositis, and who demonstrated satisfactory oral hygiene based on the Oral Hygiene Index-Simplified (OHI-S), were considered eligible for inclusion.

Patients were excluded if they had received antibiotic or antifungal therapy within the previous three months, or had a history of autoimmune disease, chemotherapy, or radiation therapy, which could alter their oral microbial flora. Additionally, individuals who were unable or unwilling to provide informed consent, or those with cognitive impairments that could interfere with study participation, were excluded from the study.

Sample Collection

A total of 30 sterile swab samples were collected from geriatric patients meeting the inclusion criteria. Sterile cotton swabs moistened with sterile saline were gently rubbed over and around the implant abutment surface in a circular motion, taking care not to traumatize the peri-implant tissue. Each swab was immediately placed into a sterile test tube containing phosphate-buffered saline (PBS) and transported to the microbiology laboratory under cold chain conditions.

Microbial Culture and Identification

In the laboratory, swabs were aseptically streaked in a to-and-fro motion on blood agar (for general bacterial growth) and MacConkey agar (for selective growth of

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Gram-negative organisms). The agar plates were incubated at 37°C for 24 hours under aerobic conditions. Post incubation, colony morphology was recorded, and representative colonies were subjected to Gram staining. Microscopic examination was conducted using oil immersion at 1000× magnification to identify the morphological characteristics of the bacteria. Based on colony color, hemolysis pattern, and Gram stain reaction, preliminary microbial identification was performed. Further characterization could be done using biochemical tests or molecular diagnostics in future phases of the study.

This methodology aimed to provide insight into the nature and complexity of polymicrobial flora colonizing implant abutments in geriatric patients, potentially contributing to delayed healing or increased infection risk.

## 4. Results

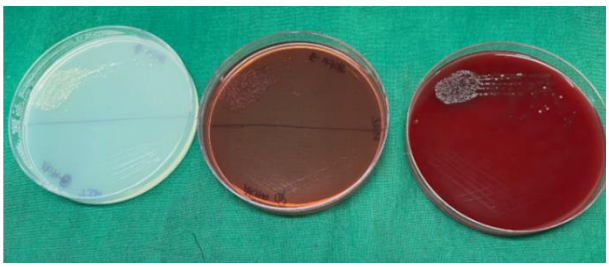

Figure 1: Represents the inoculation and zone of growth of bacteria in the agar plates

(Nutrient agar, Mckonky agar, blood agar). Inoculation was done under incubation in an incubator at 37 degree celcius Afro 24-48 hours.

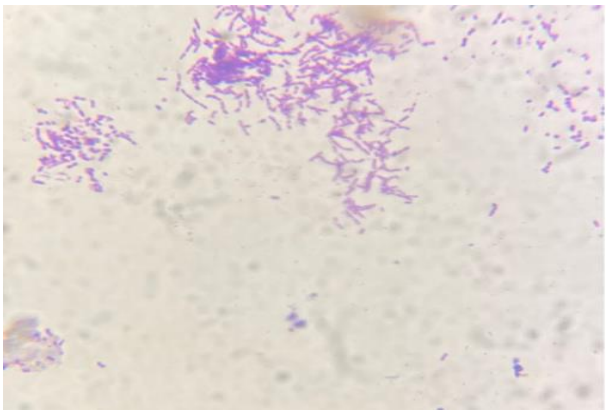

Figure 2 : microscopic appearance of Beta hemolytic streptococci. The count of enterococcus faecalis bacteria was found to be 18000 organisms/ml and was present at the minimum as the polymicrobial flora around the abutments in multiple implant cases.

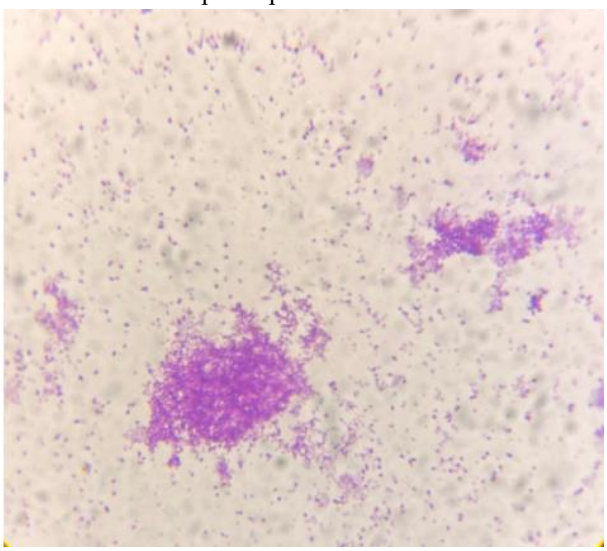

Figure 3 : microscopic appearance of Enterococcus Faecalis

The count of enterococcus faecalis bacteria was found to be 25000 organisms/ml and was present at the maximum as the polymicrobial flora around the abutments in multiple implant cases.

## 5. Discussion

This study investigated the presence and characteristics of polymicrobial flora around implant abutments in geriatric patients with multiple implants. The findings indicate a diverse microbial profile colonizing the peri-abutment region, with Enterococcus faecalis identified as the most predominant species.

The in vitro culture analysis, represented in Figure 1, confirmed robust microbial growth on nutrient agar, MacConkey agar, and blood agar after 24–48 hours of incubation at 37°C. The successful growth on multiple selective and non-selective media suggests a heterogeneous mix of Gram-positive and Gram-negative bacteria commonly associated with oral biofilms. The use of different agar types also enhanced detection of both fastidious and facultative anaerobes.

Microscopic analysis revealed the presence of beta-hemolytic streptococci, typically associated with early-stage colonization and mucosal inflammation (Figure 2). These organisms are known to release hemolysins, which can contribute to tissue irritation and delayed soft tissue healing around implants, particularly in elderly patients

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with compromised immune responses or comorbidities such as diabetes and xerostomia.

Most notably, Enterococcus faecalis was consistently observed in all samples, with a microbial load ranging from 18,000 to 25,000 organisms/ml (Figure 3). This organism is clinically significant due to its ability to survive harsh environments, form resilient biofilms, and exhibit intrinsic resistance to many commonly used antibiotics. Its prevalence in the peri-abutment area in elderly patients may be attributed to prior antibiotic exposure, poor salivary clearance, or systemic alterations in immune function. The dominance of *E. faecalis* raises concerns, as it is often implicated in chronic low-grade infections and has the potential to transition from a commensal to a pathogenic state under favorable conditions.

The identification of polymicrobial flora, with *E. faecalis* as the dominant species and beta-hemolytic streptococci as a secondary colonizer, underscores the complex microbial interactions around implant healing caps. These interactions can potentiate biofilm formation and inflammatory responses, ultimately affecting the quality and speed of peri-implant soft tissue healing. In the geriatric population, where tissue regenerative capacity is reduced, even subclinical biofilm-related inflammation can impair healing outcomes or predispose patients to peri-implant mucositis.

Clinically, these findings advocate for increased vigilance in infection control during the prosthetic phase of implant treatment in elderly patients. Strategies may include using antimicrobial-coated healing caps, chlorhexidine disinfection prior to second-stage surgery, or routine microbial monitoring for high-risk patients. Given the high resistance potential of *E. faecalis*, empirical use of antibiotics must be approached cautiously, and culture-specific treatment protocols may be more appropriate in persistent or recurrent peri-implant inflammation.

This study is limited by its culture-based approach, which, while effective in identifying predominant species, may not capture the full spectrum of anaerobes or uncultivable organisms within the polymicrobial community. Future studies using molecular techniques like 16S rRNA sequencing or metagenomics would help in better characterizing the microbial diversity and their functional contributions to peri-implant health in geriatric patients.

## Conclusion

This study highlights the presence of diverse polymicrobial communities colonizing implant abutments in geriatric patients, with Enterococcus faecalis emerging as the most dominant organism, followed by beta-hemolytic streptococci. The microbial load and composition observed suggest that elderly individuals, due to age-associated immune decline and systemic factors, may be particularly vulnerable to microbial colonization and biofilm persistence around implant components.

The presence of high-count, resilient species such as *E. faecalis* underscores the need for enhanced infection control measures, particularly during the healing phase. These may include the use of antimicrobial-coated healing caps, stricter disinfection protocols, and patient-specific microbial risk assessments.

Given the implications of persistent biofilm formation on delayed healing and potential peri-implant complications, early identification and management of microbial colonization are critical in improving implant prognosis in the geriatric population. Future studies incorporating molecular diagnostics are recommended to further characterize the microbial profiles and develop targeted preventive strategies.

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