RESEARCH PAPER

Comparative Microbial Adhesion on Conventional Polymethyl Methacrylate and Flexible Denture Base Materials: A Systematic Review

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Abstract

Denture plaque forms mainly due to the adhesion of the microorganism to the denture base. Although polymethyl methacrylate (PMMA) is the standard restorative dental denture base material, flexible polyamide-based materials offer significant advantages due to their aesthetic properties. Nevertheless, more research is required into the biological properties of these materials. The main objective of the review was to evaluate the microbial adhesion, initial surface colonisation, and biofilm development of PMMA and Flexible denture base materials. This systematic review mainly considered randomised clinical trials as the main source. In vitro studies were added later to support the clinical evidence. According to findings from randomised controlled trials, both PMMA and Flexible Denture Base showed an increase in the number of microorganisms. Flexible dentures exhibited a higher microbial load than conventional dentures, according to all studies conducted according to the study. Furthermore, the number of biofilm bacteria on various flexible denture materials was higher than on conventional denture materials (PMMA). However, the difference was not significant
Keywords: Polymethyl methacrylate; Denture base materials; Polyamide; Flexible denture; Microbial adhesion; Biofilm; Candida albicans; Denture stomatitis; Surface roughness;
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1. Introduction

After the brushing or prophylaxis of teeth, a thin salivary film will be deposited on the denture in your mouth. The biofilm that forms on a denture could also invade many types of polymeric biomaterials used for denture construction. It is a biological process that is dynamic and sequential. It is often this process that results in a microenvironment capable of supporting the development of new species under unfavourable conditions. Initially, the first pioneer microbes, such as streptococcus, colonise, followed by a later-coloniser in a biofilm. Microorganisms multiply, aggregate, and form a polymeric matrix, ensuring irreversible adhesion and structural maturation of the biofilm.[1,2]. The yeast Candida albicans plays a central pathogenic role among many microbial components of biofilm in dentures. A critical virulence factor that enhances adhesion, biofilm stability and the invasive potential of the host mucosa is the yeast-to-hyphal transition. The surfaces of dentures to retain microbial species depend on their physicochemical properties, such as charge, hydrophilicity, and texture. The degree of colonisation may be determined by the availability of protected niches offered by surface roughness, wettability, porosity and water sorption. Such properties decrease the effectiveness of everyday hygiene practices. Due to Polymethyl methacrylate's mechanical properties, ease of processing, reparability and polishability, it remains as the gold standard. Dissolving porosities, residual monomer outflow, and surface decay during clinical service may facilitate microbial colonisation. Materials for denture bases are introduced primarily for esthetic and comfort benefits compared with PMMA-based prostheses. The chief raw material used is poly. Using drugs in vitro may provide mechanistic insight, but it does not translate well to in vivo due to the mismatch with the oral environment. Randomised clinical studies are thus the best evidence for material-based differences in microbial behaviour. This review used RCT evidence as primary evidence and included in vitro studies for biological interpretation, resulting in a clinically relevant conclusion on material composition and denture hygiene.[1,2]

2. Materials and Methods

2.1 Study Design and Protocol Registration

This approach helped in designing the research question, criteria, outcome and methodology of the study. It minimises bias and enhances transparency. This review has been performed under the PRISMA 2020 guidelines.

2.2 Eligibility

Criteria for Selection

The PICO framework has been used for selection. I would select randomised controlled trials, including the trials among denture wearers. Flexible denture bases are compared to conventional heat-polymerised PMMA denture bases as the intervention of interest. The chosen studies should provide findings that concern quantitative microbiology, i.e. results that look at bacterial or fungal colonisation, biofilm formation or counts expressed in CFU, log CFU, or any such measure. Only in vivo RCTs would be selected for inclusion, while in vitro trials, observational trials, case reports, review articles, and trials that are not two-way comparisons between flexible denture bases and conventional heat-polymerised denture bases only, will be excluded.

2.3 Information Sources and Search Strategy

An extensive electronic search using different databases was conducted from inception to the date of the final search. The keywords associated with denture base with microbial adhesion were "PMMA", "Flexible denture", "Polyamide", "Thermoplastic Resin", "Biofilm", "Microbial adhesion", "Candida", "Streptococcus ", and so on. A manual search of the reference section of the included studies was done to get more trials.

2.4 Study Selection

After deleting duplicative references, all references were imported into reference management software. To check for relevance, titles and abstracts were searched individually by two authors. The full-text of potentially relevant articles was then evaluated independently based on pre-defined criteria. All parties agreed, and decisions were made via discussion.

2.5 Data Extraction

The studies were assessed for similarity, and clinical data were extracted from study articles using an information-procuring form for duplicate authors who have not taken the same study. The information procurement form included study design, sample size, sample details, denture base types, duration of observation, means of collecting microbes, outcomes, and findings. When necessary, various data values were converted from their respective units for a qualitative comparison of MICROBE.

2.6 Data Synthesis

There were substantial differences in the outcome variables for the studies and also in the sampling strategies and follow up duration.A narrative synthesis was carried out for this purpose. The main analysis did not include in vitro studies but was instead used for the interpretation of clinical data.

2.7 Microbial Sampling and Outcome Measurement

Sterile swabs were used to take microbial samples from the denture tissue contact surface. The samples were inoculated on selective agar for bacteria and fungi identification. The colony-forming units were quantified and expressed as either CFU or log CFU. The samples were taken at the baseline and designated follow-ups.

2.8 Statistical Analysis

CFU values were changed into log terms to increase the normality of microbial counts. When the p-value was less than 0.05, it was considered significant. The statistical analysis plan included paired and unpaired t-tests, analysis of variance and appropriate non-parametric tests.

3. Results

PICO Framework

Population (P): Completely or partially edentulous patients
Intervention (I): Flexible polyamide-based denture base materials
Comparison (C): Conventional polymethyl methacrylate denture base
Outcome (O): Primary outcomes included microbial adhesion, early microbial colonisation, and biofilm accumulation expressed quantitatively as CFU counts and log CFU values.

PRISMA

Fig 1

Risk of Bias Assessment

The quality of randomised clinical trials will be evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool, which considers bias arising from randomisation, deviations from intended interventions, missing outcome data, measurement of outcome, as well as reporting.

Figure 2
Figure 3

. Results

4.1 Study Selection and Characteristics

A total of four randomised or controlled clinical trials concerning microbial adhesion and colonisation on denture base materials under clinical conditions were included in the systematic review. Every study presented quantitative microbiological results using one of the methods below, likely to present a clearer picture. Follow-up time ranged from 1 week to 30 days, which are the important periods that broadly involve initial microbial attachment and biofilm maturation. Table 1 shows characteristics of the study.

Table 1

4.2 Overall Microbial Colonisation Patterns

After studying the results, it could be analysed that there was more microbial penetration in PMMA and flexible denture bases. However, both dentures had differences in extent and rate of penetration. Saimbi et al. observed that flexible dentures had more residual microbial counts. A randomised controlled crossover trial found that the total count was greater with flexible acrylic. Abd-Alreheim et al. conducted a three-month randomised study on 20 healthy subjects to assess the microbial colonisation on both materials. The two had a low baseline colonisation. Bacterial colonisation on flexible dentures was greater at 1 month. At 3 months, flexible dentures exhibited increases of 1.5 to 2.3 log CFU for several bacteria, whereas post-polymerisation PMMA dentures showed only 0.7 to 1.4 log CFU increases. Flexible materials required much less time to form biofilm. Concerning overall aerobic plate counts, Streptococcus mutans, and Lactobacillus. The investigation contained 30 adults with controlled Type II diabetes. They discovered that Candida albicans attached differently to the polyamide dentures. In addition, one week post-denture insertion, the difference from the PMMA was highly significant. Due to their immunosuppressed state, this population is prone to infections. Additionally, there are changes in the consistency of the saliva. The extent of the difference was even greater than in healthy subjects. This signifies a synergy. In the study by Olms and colleagues (subsequent studies), 20 subjects were examined, and a significantly higher bacterial adhesion on the flexible dentures (Bre-flex) than on the PMMA was observed at 24 h and one week. The microbial load as well as the biofilm architecture were found to be higher on the flexible materials, as evidenced by scanning electron microscopy. Biofilms developed multilayers on the flexible materials at 24 h and showed multilineage features of the onset of matrix formation. In a study by Ahmad et al., 19 old subjects were investigated, and they found that after 1 week of insertion, the microbial loads on the T-crystal flexible denture were more than those on the PMMA. The participants also underwent a hygiene phase, rinsing with 0.2% chlorhexidine gluconate mouthrinse twice a day for 1 week. The microbial load of all the materials was reduced in the hygiene phase. Yet, the flexible materials nevertheless maintain 0.5 to 0.8-log CFU higher microbial loads; chemical cleaning is insufficient to negate their vulnerability.

4.3 Summary of Microbial Findings Across All Studies

Table 2 shows the changes in colonisation over time and differences between materials by all four trials.

All four clinical trials show a similar trend. Microbes routinely proliferate across both PMMA and flexible bases. (15 words). The early period, which is up to a week, shows slight differences. Microbes were always found in larger numbers in flexible materials than in PMMA during longer periods of observation (4 weeks to 3 months). The increase in the number of microbes ranged from 0.5 to 2.0 logs CFU. This numerical value depends on the kind of microbes, the patients and the hygiene standard. When utilising chlorhexidine, there appear to be similar antibacterial levels for both materials. However, the flexible bases tend to be colonised to a slightly higher level.

DISCUSSION

This systematic review looked at four randomised clinical trials and six in vitro studies that evaluated the pattern of microbial colonisation on the conventional polymethyl methacrylate (PMMA) and flexible polyamide denture base materials. According to clinical evidence, both materials show evidence of progressive biofilm development. However, higher log values and remaining counts following chemical disinfection have been recorded for flexible materials for higher microbial loads. According to in vitro studies, differences between the materials are due at least in part to surface roughness, water sorption and polishability.

5.1 Surface Roughness and Initial Adhesion

The formation of biofilm was less material-dependent at a previous stage. Bacterial colonisation has indeed increased from 104 to 105-106 CFU/cm2 over the observation period of 1 month for PMMA and polyamide, with no significant difference between the groups. However, substantial differences emerged during subsequent maturation of biofilm formation. Paliwal et al. reported significantly greater adhesion of Candida albicans on flexible materials in vitro (13.67 × 104 versus 10.9 × 104 CFU/mm2 in PMMA; $P < 0.01$) [43]. 14.89. It was mentioned that surface roughness (Ra) is the most important factor. The literature indicates that surface roughness values above 0.2 µm will exhibit clinically relevant microbial retention [4,5]. In a study conducted by Abuzar et al, they observed that the post-polishing Ra values of polyamide were 0.25-0.35 µm compared to <0.2 µm for PMMA [6]. According to Subbarao et al., when conventional PMMA is used, smoothness improves by more than a factor of 20 (0.995→0.046 µm), whereas for polyamide, only a factor of 7 (1.111 → 0.146 µm) increase in smoothness can be obtained. Sultana et al stated that injection moulded PMMA(0.0669µm) exhibited.

5.2 Biofilm Maturation and Population-Specific Responses

Species-specific patterns were found in a long-term follow-up with host factors creating an unexpected synergy between PMMA and nylon-based dentures having fungi. Ahmed and his colleagues conducted a study where they controlled type II diabetes in patients and found PMMA to have significant higher fungal colonization (97.3 ± 1.6 CFU/sample) than versacryl (22.4 ± 1.3) and nylon (c12.9 ± 1.7) after three months, an absolute increase of 52.4, 9.6 and 4.7 CFU respectively [9] In contrast to healthy populations, who have been found to have a consistently higher microbial load on the flexible material [1,12]. Alterations in saliva composition, including a decreased flow rate and an elevated glucose concentration due to diabetes, were suggested to facilitate fungal growth on acrylic materials [9,10]. The release of monomers creating a microenvironment that favours Candida [11] and differences in hygiene compliance are the other proposed mechanisms. Conversely, Abd-Alreheim et al. found that total aerobic plate counts for the flexible dentures were significantly higher after four weeks in immunocompetent edentulous patients [12]. Different types of Candida and Streptococcus. as well as Staphylococcus spp. Flexible materials showed a greater prevalence of all these practices, thus confirming controlled in vitro studies. These studies eliminate distractions like.

5.3 Water Sorption, Wettability, and Recolonisation Dynamics

Polyamide materials have a hydrophilic feature, which helps the growth of the micro-organism in various ways. More flexible materials have higher water sorption values (31.5 vs. 29.7 µg/mm³ for PMMA). This supports both hydration of the surface and retention of nutrients [13]. Thermocycling increased the water sorption of both materials ($<0.2\%$ for heat-cured polyamide and poly(methylmethacrylate) (PMMA)) while still meeting the ISO 20795-1 standards. By contact angle analysis, polyamide was more hydrophilic [14]. Assistance can be provided by the enhanced wettability. Al-Fatyan and colleagues demonstrated that the application of chlorhexidine resulted in comparable log reductions with each type of material. However, the Candida counts remained significantly elevated for the flexible denture, 4.28 ± 0.33 vs. 3.41 ± 0.28 log CFU/cm2, $p < 0.05$ [13]. The higher water sorption values could help with a rapid re-colonisation after a chemical treatment. Alternatively, the current hygiene measures in place may not be effective in conquering the material susceptibility. Elkholy and Lofty confirmed this further when they showed that the surface treatment has no effect on the highly hydrophilic soft liner material, unlike PMMA, which has.

5.4 Effects of Ageing and Long-Term Microbial Retention

The impact of material ageing enhanced colonisation variability. The effects of thermocycling (10,000 cycles equivalent to 1-year usage) were shown to increase the surface roughness of polyamide while decreasing the surface roughness of PMMA, showing a material-specific degradation pattern [14]. The authors Patil et al. presented additional details on the mechanisms of colonisation, showing enhanced Candida biofilm formation of flexible materials even when abraded to a surface roughness similar to PMMA [7]. The porosity of polyamide, coupled with its lack of polishability, results in a microbe housing that cleaning does not help.

5.5 Clinical Implications

Research has suggested that flexible materials are more likely to experience microbial attachment, with the attachment rate depending on the patient. The general public, especially vulnerable populations such as the elderly, diabetics, and immunocompromised, continues to prefer PMMA [13]. A flexible material should be limited to cases where an esthetic demand exists, anatomical undercuts and hypersensitivity to PMMA. The short-term efficacy of chlorhexidine was comparable, but the flexible denture's persistent residual colonisation shows that chemical cleaning alone is not sufficient. Most of the chemical disinfectants affect implanted tissues and often lead to rapid repopulation of bacteria. Hence, there is a need for implementation of a multimodal approach which will incorporate mechanical debridement, regular chemical disinfection and professional maintenance.

Strengths and Limitations

Here are the advantages of a systematic review. First of all, they have conducted randomised clinical trials. It assures that the results are not confined to imagined situations of laboratory conditions; they have essential clinical significance. Secondary studies on the mechanisms were developed by means of in vitro experiments. Studies of biological response must be associated with material properties. Afterwards, these studies can be used to improve the material. The patient groups include healthy adults, diabetics and elderly patients. Besides, the dental group consisted of removable denture wearers. When findings apply to other populations, they are more generalizable. It also highlights the need for physical materials. The system review has limitations, naturally. Due to different measures of outcome (CFU, log CFU, and TAPC), a meta-analysis was not possible, so a narrative was made rather than a systematic review. The follow-up periods from one week to three months may likely not be enough to represent the long-term colonisation pattern or material degradation. The subgroup analysis from this meta-analysis will have reduced statistical power because the sample size (n = 10-40 per study) is relatively small. Additionally, the studies did not control for confounding variables, such as denture age, night wear, salivary flow rate and compliance to instructions. The previously mentioned studies employed flexible materials like Valplast, Deflex, Versacryl, Bre-flex, and T-crystal, which are all different and have different chemical, physical properties.

Future Research Directions

In future randomised controlled trials. We recommend conducting longer follow-ups of at least a year for all the test subjects with regard to evaluating material durability. Moreover, ageing and colonisation patterns should also be looked into.

Conclusion

In conclusion, conventional PMMA and flexible denture base materials allow colonisation of microbes in a time-dependent manner. Nonetheless, the flexible materials are always showing greater absolute loads, log scales, and elevated residual counts after the hygiene phase. Due to enhanced surface roughness, lesser polishability and higher water sorption of this polyamide-based material. In most clinical scenarios, PMMA remains the more biologically predictable option. It enables lower and more controllable levels of associated microorganisms generally. The use of a flexible material should be limited to selected cases with clear clinical indications. It is advisable for patients to be more educated regarding stringent hygiene control.

References

1.Singh JP, Dhiman RK, Bedi RPS, Girish SH. Flexible denture base material: a viable alternative to conventional acrylic denture base material. **Contemp ClinDent.** 2011;2(4):313-7.

2.Soygun K, Bolayir G, Boztug A. Mechanical and thermal properties of polyamide versus reinforced PMMA denture base materials. **J Adv Prosthodont.** 2013;5:153-60.

3. Budtz-Jorgensen EJ. The significance of Candida albicans in denture stomatitis.

4.Nikawa H, Mikihira S, Egusa H, Fukushima H, Kawabata R, Hamada T, et al. *Candida* adherence and biofilm formation on oral surfaces. **Nippon Shishubyo Gakkai Zasshi.** 2005;46:233-242.

5.Coulter WA, Strawbridge JL, Clifford TJ. Denture-induced changes in palatal plaque microflora. In: **Microbial ecology in health and disease.** Vol. 3. 1990. p.77-85.

6.Couthwaite L, Verran J. Denture plaque: a neglected biofilm. In: Allison DG, Verran J, Spratt DA, Upton M, editors. **Biofilms: persistence and ubiquity.** Manchester: Biofilm Club; 2005. p.311-322.

7.Abd-Alreheim SA, Sadawy A, Gaber M, Ali MA. Flexible Denture Induced Changes in Palatal Micro Flora versus Conventional Complete Denture. Al-Azhar Assiut Dental Journal. 2018 Oct 1;1(1):1-7.

8. Olms C, Yahiaoui-Doktor M, Remmerbach TW, Stingu CS. Bacterial colonization and tissue compatibility of denture base resins. Dentistry journal. 2018 Jun 15;6(2):20.

9. Ahmed EM, Esmat AM, Hassan HG. Candida albicans colonization on different polymeric denture base materials in controlled type II diabetic patients. Journal of The Arab Society for Medical Research. 2019 Jul 1;14(2):95-101.

10. Ahmed N, Pasha MF, Rahman S. Clinical and microbiological evaluation of polyamide versus PMMA denture base materials in complete denture wearers. **Bull Stomatol Maxillofac Surg.** 2025;21(10):533–540.

11. Paliwal J, Dadarwal A. Adherence of Candida albicans on different denture base material as heat cure acrylic denture base material flexible denture base material and cobalt chromium alloy: an in vitro study. Nat Res Denticon.. 2021;10:12-22.

12. Abuzar MA, Bellur S, Duong N, Kim BB, Lu P, Palfreyman N, Surendran D, Tran VT. Evaluating surface roughness of a polyamide denture base material in comparison with poly (methyl methacrylate). Journal of oral science. 2010;52(4):577-81.

13. Elkholy S, Lofty W. Candida adherence and different denture bases. **Res Rev J Dent.** 2018;9(1):23–28.

14. Sultana N, Ahmed S, Nandini VV, Lathief J, Boruah S. An in vitro comparison of microbial adhesion on three different denture base materials and its relation to surface roughness. Cureus. 2023 Apr 3;15(4).

15. Patil R, Sharma H, Gupta D. Comparative evaluation of biofilm development of candida albicans on abraded surfaces of heat cure PMMA and flexi denture material": an in vitro study. Journal of Dental and Medical Sciences. 2016;15(9):130-3.

16. Ağan H. Effects of Thermocycling on Some Properties of Polyamide Resins in Comparison with Polymethyl Metacrylate. GEVHER NESİBE JOURNAL OF MEDİCAL&HEALTH SCIENCES. 2022;7(21).

17. Shah J, Bulbule N, Kulkarni S, Shah R, Kakade D. Comparative evaluation of sorption, solubility and microhardness of heat cure polymethylmethacrylate denture base resin & flexible denture base resin. Journal of clinical and diagnostic research: JCDR. 2014 Aug 20;8(8):ZF01.

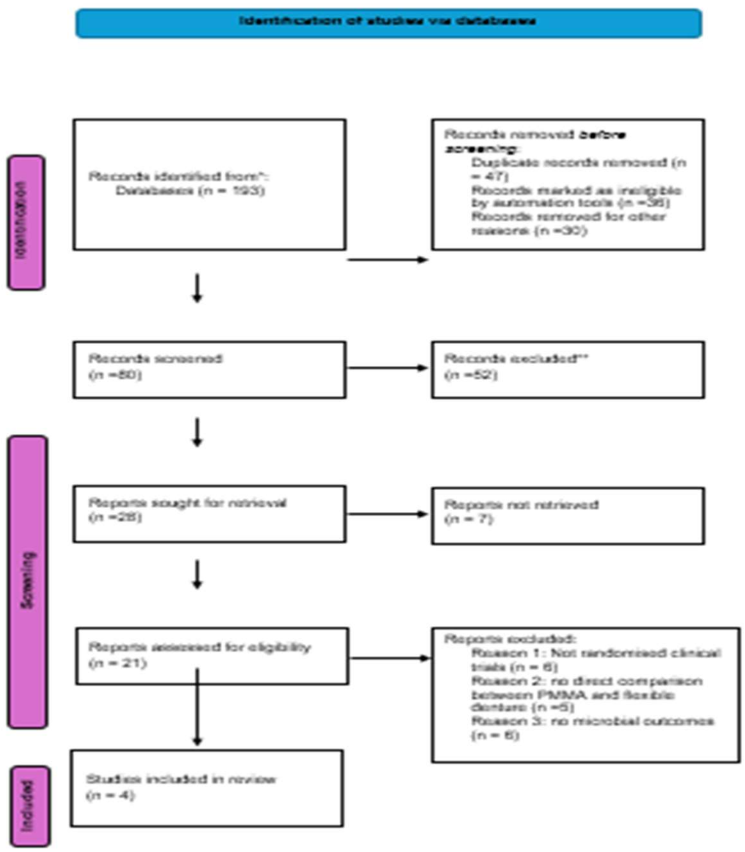
18. Kumar BS, Pacharne AP, Sadafule N, Singh K. Flexible denture base material: A viable alternative for conventional denture base material. International Journal of Health Sciences. 2022(II):11096-105.

19. SANDU SA. Assessment of Flexible and Conventional Resins as Denture Bases. Materiale Plastice. 2025 Sep 1;62(3).

20. Akinyamoju CA, Ogunrinde TJ, Taiwo JO, Dosumu OO. Comparison of patient satisfaction with acrylic and flexible partial dentures. Nigerian Postgraduate Medical Journal. 2017 Jul 1;24(3):143-9.

21. Le Bars P, Kouadio AA, Amouriq Y, Bodic F, Blery P, Bandiaky ON. Different polymers for the base of removable dentures? Part II: A narrative review of the dynamics of microbial plaque formation on dentures. Polymers. 2023 Dec 21;16(1):40.

22. Wei X, Gao L, Wu K, Pan Y, Jiang L, Lin H, Wang Y, Cheng H. In vitro study of surface properties and microbial adhesion of various dental polymers fabricated by different manufacturing techniques after thermocycling. Clinical oral investigations. 2022 Dec;26(12):7287-



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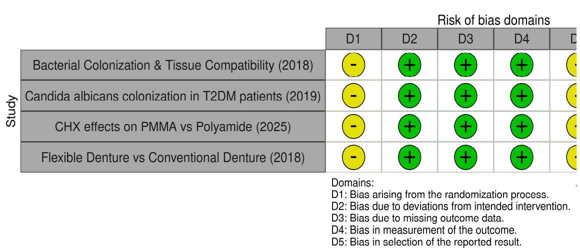

Figure 3

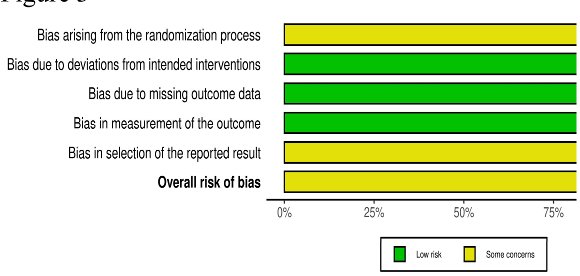

Table 1

Study	Design & Sample	Materials	Follow-up	Microbial Outcome	Key Findings
Olms et al., 2018	Split-mouth RCT n = 10 (young adults, 20–30 years)	PMMA vs Polyamide	4 weeks	Total bacteria (CFU/cm²), species diversity	No significant difference in bacterial counts or diversity. Both ≈10^4–10^6

					CFU/cm²
Ahmed et al., 2019	Parallel RCT n = 30 (controlled type II diabetic patients)	PMMA vs Versacryl vs Nylon	1 month, 3 months	Candida albicans (CFU/sample)	PMMA >> Flexible materials at 1 & 3 months ($p<0.05$)
Al-Fatyan et al., 2025	Parallel RCT n = 40 (edentulous adults)	PMMA vs Polyamide (with 0.12% CHX)	14 days	Candida ($\log_{10}$ CFU/cm²), plaque index, Newton's classification	Both materials showed significant reductions with CHX. No inter-group difference ($p>0.05$)
Abd-Alreheim et al., 2018	Parallel trial n = 20 (edentulous patients)	PMMA vs Flexible thermoplastic	0, 1 week, 4 weeks	TAPC, Streptococci, Staphylococci, Candida	Flexible showed significant time-dependent increase ($p=0.002$). PMMA stable ($p=0.819$)

Table 2

Study	Material	Baseline	Final	Absolute Change	p-value
Olms et al., 2018 (4 weeks)	PMMA Polyamide	≈10^4 CFU/cm² ≈10^4 CFU/cm²	≈10^5–10^6 CFU/cm² ≈10^5–10^6 CFU/cm²	+1–2 log units +1–2 log units	NS
Ahmed et al., 2019 (1 month)	PMMA Versacryl Nylon	— — —	44.9 ±2.3 CFU 12.8 ±1.5 CFU 8.2± 0.7 CFU	— — —	<0.05*
Ahmed et al., 2019 (3 months)	PMMA Versacryl Nylon	44.9 ±2.3 CFU 12.8 ±1.5 CFU 8.2± 0.7 CFU	97.3 ±1.6 CFU 22.4 ±1.3 CFU 12.9 ±1.7 CFU	+52.4 CFU +9.6 CFU +4.7 CFU	<0.05*
Al-Fatyan et al., 2025 (14d	PMMA Polyamide	4.12 ±0.38 log CFU/cm² 4.08 ±0.4	3.07 ±0.29 log CFU/cm² 2.96 ±0.3	−1.05 log units −1.12 log units	0.77

CHX)		1 log CFU /cm²	3 log CFU /cm²		
Abd-Alreheim et al., 2018 (TAPC)	PMMA Flexible	4.99 ±0.37 (0 wk) 4.89 ±0.45 (0 wk)	4.98 ±0.42 (4 wk) 5.44 ±0.53 (4 wk)	−0.01 (NS) +0.55**	0.050