Case Report MedInform
DOI: 10.18044/MEDINFORM.2026132.2456 ISSUE 2, 2026

One-Year Clinical and Microbiological Follow-Up of 3D-Printed Complete Dentures: A Case Report

Ivet Dzhondrova, Ilia Liondev, Aleksandar Naydenov, Dimitar Kirov

Department of Prosthetic Dental Medicine, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria.

Abstract

The application of additive manufacturing in complete denture fabrication has expanded significantly in recent years. Despite the growing interest in this technology, evidence regarding the long-term clinical and microbiological performance of 3D-printed complete dentures remains limited. This case report presents the one-year follow-up of a healthy 75-year-old female patient rehabilitated with 3D-printed complete dentures.

The dentures were digitally designed using Exocad software and fabricated from Formlabs Denture Base Resin and Formlabs Denture Teeth Resin using a stereolithography (SLA)-printer. Microbiological samples from saliva, oral mucosa, and denture surfaces were collected before treatment and after one year of clinical service and analyzed for the presence of Candida spp.

After one year of clinical use, no fractures, repairs, or tooth debonding were observed. No Candida spp. colonization was detected at baseline or at the one-year follow-up. However, mild discoloration of the anterior denture teeth and localized plaque accumulation were evident despite adherence to a strict hygiene protocol.

The findings suggest that 3D-printed complete dentures can provide favorable short-term clinical and microbiological outcomes. Nevertheless, the observed discoloration and plaque accumulation indicate that the long-term esthetic behavior of currently available 3D-printed denture materials remains a concern and warrants further clinical investigation.

Keywords: complete dentures, additive manufacturing, 3D printing, Candida spp.

Introduction

Additive manufacturing technologies have been increasingly incorporated into removable prosthodontics because of their potential advantages in workflow efficiency, reproducibility, reduced material waste, and digital storage of patient records (1). Fully 3D-printed complete dentures have emerged as a promising alternative to conventionally fabricated prostheses. Nevertheless, limited clinical evidence is available regarding their long-term performance,

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especially concerning discoloration, plaque accumulation, and microbiological changes during routine use (2).

One of the major concerns associated with removable dentures is the development of denture stomatitis, a condition frequently associated with the colonization of denture surfaces by Candida species (3). Conflicting findings have been reported regarding microbial colonization, biofilm formation, and the risk of denture stomatitis associated with 3D printed dentures. Some authors have suggested that the layer-by-layer manufacturing process and surface characteristics of 3D-printed polymers may promote increased adhesion of Candida albicans compared with conventional heat-polymerized acrylic resins, potentially increasing the risk of denture stomatitis (4-6). In contrast, Arutyunov et al. (7) reported lower microbial adhesion on denture materials fabricated using additive manufacturing, while Fiore et al. (8) found no significant differences in microbial adhesion among 3D-printed, milled, and conventionally processed denture materials. These findings suggest that 3D-printed dentures are not associated with increased microbial colonization and that the manufacturing technique itself may not be the primary determinant of microbial adhesion.

Besides microbial colonization, color stability represents another important aspect of the long-term clinical performance of 3D-printed dentures. Surface alterations and plaque accumulation may contribute to staining and discoloration, potentially affecting the esthetic appearance of the dentures over time.

The present report describes the one-year clinical and microbiological follow-up of a fully 3D-printed complete denture fabricated for a completely edentulous patient.

Case Description

A 75-year-old female patient presented to the clinic. The patient was medically healthy and reported no systemic diseases, diabetes mellitus, xerostomia, smoking habits, or long-term medication use. She had not previously worn complete dentures.

Following clinical examination and treatment planning, maxillary and mandibular complete dentures were fabricated using a digital workflow. The clinical treatment protocol included primary and definitive impressions, jaw relation record, trial evaluation of the dentures, and subsequent delivery of the definitive dentures.

The dentures were designed using digital design software Exocad (exocad GmbH, Darmstadt, Germany). Denture bases and denture teeth were fabricated separately using an SLA-based 3D printer (Form 2, Formlabs Inc., USA). The denture bases and denture teeth were printed separately using Formlabs Denture Base Resin and Formlabs Denture Teeth Resin and were bonded according to the manufacturer's instructions.

Post-processing included washing in 95% isopropyl alcohol using Form Wash (Formlabs Inc., Somerville, MA, USA) followed by additional polymerization in Form Cure (Formlabs Inc., Somerville, MA, USA) for 30 minutes at 80°C under ultraviolet light (405 nm).

After post-processing, the dentures were finished, polished, and assembled according to the manufacturer's recommendations (Fig, 1(A),(B)).

The patient received detailed instructions regarding denture hygiene. Denture maintenance consisted of cleaning the dentures twice a day using a soft denture brush and neutral soap,

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combined with the daily use of denture cleansing tablets. The patient was specifically instructed to avoid the use of toothpaste because of its abrasive properties and potential to increase surface roughness. According to the patient's report, these hygiene measures were consistently followed during the entire follow-up period. The patient demonstrated excellent compliance throughout the observation period.

Figure 1. Fully 3D-printed complete dentures at different stages: (A) denture base and denture teeth immediately after printing and prior to bonding, finishing, and polishing; (B) completed dentures at delivery; (C) dentures after one year of clinical use.

Microbiological Investigation

Microbiological samples were collected before denture delivery (baseline), six months after and one year after function. Samples were obtained from saliva, oral mucosa, and denture surfaces and were analyzed for the presence of Candida spp. Unstimulated saliva was collected in sterile containers according to the standardized saliva collection protocol. The patient was instructed not to eat, smoke, or rinse with antiseptic mouthwashes for at least two hours before sample collection.

Samples from the oral mucosa and denture surfaces were obtained using sterile cotton swabs. During follow-up visits, one sterile swab was used to sample the intaglio surface of the denture, while a second swab was used to collect a sample from the mucosa in direct contact with the denture base. Following collection, the swabs were immediately transferred into AMIES transport medium (AMIES 300290, Ekomet-90 Ltd., Bulgaria) and transported to the microbiological laboratory at 4°C in a refrigerated container.

All collected materials were plated on chromogenic agar for isolation and identification of Candida spp. The plated materials were cultured for 48 hours at 35-37°C under aerobic conditions. Identification of Candida species was performed by direct evaluation of chromogenic agar, where Candida albicans was recognized by its characteristic green coloration, while all non-albicans species were further identified through individual slide inoculation followed by spectrophotometric analysis using the VITEK MS system. Candida counts were reported as colony-forming units per milliliter (CFU/ml). Values below 10^3 CFU/ml were considered normal, values between $\geq 10^3$ and $<10^4$ CFU/ml were considered low, values between $\geq 10^4$ and $<10^5$ CFU/ml were considered moderate, and values above 10^5 CFU/ml were considered significant.

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One-Year Follow-Up

The patient was recalled one year after denture delivery. According to the patient's subjective assessment, the dentures remained comfortable and functional during the follow-up period, with no reported difficulties related to chewing, speech, or denture stability. Clinical examination revealed no denture fractures, tooth debonding, repairs, or relining procedures. The dentures maintained stable occlusion, satisfactory retention and stability, and the oral mucosa appeared healthy, with no signs of inflammation or denture stomatitis.

Visual examination of the dentures revealed mild discoloration of the anterior denture teeth and localized plaque accumulation in the posterior regions (Fig. 1(C))(Fig. 2). Despite the presence of visible deposits, no clinical signs of mucosal irritation or fungal infection were observed.

Microbiological analysis demonstrated the absence of Candida spp. in saliva, on the oral mucosa, and on denture surfaces at baseline, six months, and one year after denture delivery.

Figure 2. Surface alterations observed after one year of clinical use: (A) discoloration of the denture teeth; (B) localized plaque deposits on the denture surface.

Discussion

Long-term clinical evidence regarding fully 3D-printed complete dentures remains limited. Therefore, the present report contributes additional clinical and microbiological data regarding the performance of additively manufactured complete dentures after one year of function.

The dentures demonstrated satisfactory clinical performance throughout the observation period. No fractures, tooth debonding, repairs, or relining procedures were required, and acceptable retention, stability, and occlusion were maintained.

A notable finding of the present case was the absence of Candida spp. colonization throughout the observation period. No Candida spp. were detected in saliva, oral mucosa, or denture surface samples, and no clinical signs of denture stomatitis were observed. These findings are in agreement with previous investigations reporting that 3D-printed denture materials do not necessarily exhibit increased microbial colonization compared with conventional heat-polymerized acrylic resins. (7, 8) Similarly, Elsarrif et al. demonstrated significantly lower microbial counts on 3D-printed dentures than on conventional dentures during a randomized crossover clinical trial, further supporting the favorable biological performance of additively manufactured dentures (9). Teama

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et al. reported detectable levels of Candida albicans on both denture surfaces and palatal mucosa during an 18-month clinical evaluation of 3D-printed dentures, highlighting the complex relationship between denture materials and microbial colonization (10).

However, fungal adhesion to denture surfaces is influenced by numerous factors including material composition, surface characteristics, oral hygiene practices, and host-related conditions. Current recommendations for the maintenance of removable dentures generally include cleaning with a soft brush, the use of non-abrasive cleansing agents, and regular application of denture cleansing tablets (11). The patient in the present case adhered to such a protocol, cleaning the dentures twice daily with a soft brush and neutral soap while additionally using denture cleansing tablets. Therefore, the observed plaque accumulation cannot be readily attributed to inadequate denture hygiene.

Despite the favorable microbiological findings, visible plaque accumulation and discoloration of the anterior denture teeth were observed after one year. This finding may be related to the surface characteristics of additively manufactured polymers. Increased surface roughness may facilitate plaque retention and staining, even in patients with satisfactory hygiene habits (12). Previous investigations, including our own laboratory study, have demonstrated significantly greater surface roughness of 3D-printed denture materials compared with conventional heat-polymerized PMMA (13-16).

The observed discoloration is consistent with previous studies investigating the color stability of 3D-printed denture materials. Koh et al. demonstrated that 3D-printed denture teeth are susceptible to color changes following exposure to staining agents, although the reported values remained within clinically acceptable limits (17). Similarly, Gad et al. reported lower color stability of 3D-printed denture base resins compared with CAD/CAM-milled and conventionally processed materials after artificial aging procedures (18). Sharma et al. also identified limited polishability and reduced color stability among the most commonly reported shortcomings of currently available 3D-printed denture materials (19). Interestingly, these findings contrast with those reported by Alfouzan et al., who observed lower color changes in 3D-printed denture resins compared with conventional PMMA following simulated aging and staining procedures (20). Such discrepancies may reflect differences in material composition, printing technologies, post-processing protocols, and the inability of laboratory simulations to fully reproduce the complex oral environment. The present case suggests that clinically detectable discoloration may develop even in the absence of major staining habits such as smoking or excessive consumption of coffee, tea, or red wine.

Although no microbiological colonization by Candida spp. was detected, the presence of plaque accumulation and discoloration indicates that favorable biological performance does not necessarily correspond to optimal esthetic behavior. The present findings suggest that current 3D-printed denture materials may provide satisfactory short-term functional and microbiological outcomes while still presenting limitations related to surface properties and long-term esthetic stability.

The main limitation of this report is its single-patient design, which limits the generalizability of the findings. In addition, no quantitative assessment of plaque accumulation or color change was performed, and surface roughness was not evaluated after clinical use. Although the follow-up period of one year provides valuable clinical information, longer observation periods are necessary to assess the long-term behavior of 3D-printed denture materials.

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Conclusion

This case report demonstrated that fully 3D-printed complete dentures remained clinically functional after one year, with no fractures or tooth debonding. Microbiological evaluation revealed no Candida spp. colonization of the saliva, oral mucosa, or denture surfaces throughout the observation period, indicating satisfactory biological compatibility of the evaluated materials.
However, visible discoloration of the anterior denture teeth and localized plaque accumulation were observed after one year of use. These findings indicate that the long-term esthetic properties of 3D-printed denture materials represent a challenge. While current 3D-printed denture materials may provide acceptable short-term clinical results, their color stability and susceptibility to plaque accumulation remain areas of concern.
Further long-term clinical studies involving larger patient cohorts are needed to evaluate the overall clinical performance of 3D-printed dentures compared with conventional heat-polymerized PMMA dentures.

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Corresponding author:

Ivet Dzhondrova
Faculty of Dental Medicine, Medical University Sofia
Georgi Sofiiski 1, 1000, Sofia
Email: i.dzhondrova@fdm.mu-sofia.bg

Dzhondrova I, Liondev I, Naydenov A, Kirov D. One-Year Clinical and Microbiological Follow-Up of 3D-Printed Complete Dentures: A Case Report. J. Med. Dent. Pract, 2026; 13(2):2456-2462.