



CAD/CAM Fabricated Dentures and Their Influence on Periodontal Tissue Health

Anjana Manoj^{1*}, Seena Sherly Alexander², Aishwarya Dham³ and Valliammai Rajendran⁴

¹General Dentist (India), Santa Clara, California, USA

²General Dentist (India), Dd/Denturist (Canada), Mile Zero Denture clinic, 103-816 103rd Ave, Dawson Creek BC V1G 2E9, Canada

³Senior Lecturer, Department of Periodontology, Index Institute of Dental Sciences, Index City, Indore, Madhya Pradesh- 452016, India

⁴Periodontist, Trichy, Tamil Nadu, India

*Corresponding Author: Anjana Manoj, General Dentist (India), Santa Clara, California, USA.

DOI: 10.31080/ASDS.2026.10.2103

Received: December 12, 2025

Published: March 31, 2026

© All rights are reserved by Anjana Manoj, et al.

Abstract

Computer-aided design and computer-aided manufacture (CAD/CAM) technologies have profoundly revolutionized prosthodontic rehabilitation by facilitating the production of digitally designed dentures with enhanced precision and efficiency. In comparison to traditional denture fabrication methods, CAD/CAM dentures have superior mechanical qualities, enhanced fit, and diminished manufacturing mistakes. These qualities may impact the biological milieu of the oral cavity and potentially influence periodontal tissue health. The surface qualities, material properties, and design precision of dentures significantly influence microbial adherence, biofilm development, and the health of peri-denture tissues. CAD/CAM dentures are often constructed from pre-polymerized polymethyl methacrylate (PMMA) blocks, which demonstrate less porosity and enhanced surface smoothness relative to traditional acrylic resins. These characteristics may facilitate less microbial colonization and enhanced periodontal results. Furthermore, digital workflows offer enhanced control over prosthesis design, potentially reducing stress to gingival tissues and augmenting hygiene care. Nonetheless, despite the potential benefits of digital denture manufacture, research concerning its long-term impact on periodontal and peri-mucosal tissues is still scarce. This study encapsulates existing knowledge on CAD/CAM denture manufacture, material properties, microbial interactions, and their possible impact on periodontal tissue health.

Keywords: Dentures; CAD/CAM; Periodontal Health

Introduction

Edentulism and partial tooth loss continue to pose significant oral health issues globally, especially among elderly demographics. detachable prostheses, including complete dentures and detachable partial dentures, remain crucial for recovering mastication, speech,

and aesthetics. Nonetheless, these prostheses may affect the health of adjacent oral tissues, particularly periodontal and mucosal structures [1,2].

The conventional process of denture manufacture encompasses many clinical and laboratory operations, such as impression taking,

wax try-in, and the polymerization of acrylic resins. These stages are linked to possible mistakes, including polymerization shrinkage and dimensional alterations, which may influence prosthetic fit and tissue compatibility [3].

Progress in digital dentistry has resulted in the implementation of CAD/CAM technologies for the production of dentures [4]. Digital dentures utilize computer-aided design and production techniques that improve accuracy and consistency. These technologies generally encompass digital scanning, virtual prosthesis design, and manufacture via subtractive milling or additive manufacturing methods [5].

The relationship between denture materials and periodontal tissues is crucial, since denture surfaces can act as reservoirs for microbial biofilms that lead to periodontal inflammation and peri-denture infections [6]. Consequently, comprehending the impact of CAD/CAM denture materials and fabrication methods on periodontal health is crucial.

Advancement of CAD/CAM denture technology

Digital dentistry has proliferated significantly during the past twenty years, revolutionizing prosthodontic treatment planning and production methodologies. CAD/CAM technology was originally designed for fixed prosthodontics but has progressively been utilized in the manufacturing of removable prostheses [7].

The digital denture process generally has three phases: digital data collection, virtual design, and computer-aided manufacturing. Digital impressions acquired via intraoral scanners or digitized conventional impressions are utilized to generate virtual representations of dental structures. Specialized software enables clinicians to digitally create denture bases, teeth arrangement, and occlusion [8].

Upon completion of the design, the denture is produced via either subtractive or additive manufacturing processes. Subtractive manufacturing entails milling dentures from pre-polymerized acrylic resin blocks, while additive manufacturing fabricates dentures layer by layer through 3D printing technology [9].

These digital fabrication methods mitigate processing defects linked to traditional denture production, including polymerization shrinkage and deformation [10]. Consequently, CAD/CAM dentures frequently exhibit enhanced fit, retention, and reproducibility.

Materials Utilized in CAD/CAM dentures

Conventional dentures are often constructed from heat-polymerized polymethyl methacrylate (PMMA). This material, despite its extensive use over decades, may display residual monomer content and polymerization shrinkage, which might impact material stability and tissue compatibility [11].

CAD/CAM dentures are typically machined from pre-polymerized PMMA blocks manufactured under regulated industrial settings. These materials exhibit enhanced density, less porosity, and higher mechanical strength relative to traditional acrylic resins [12].

The industrial polymerization technique diminishes residual monomer concentration, enhancing biocompatibility and mitigating the risk of mucosal irritation [13]. Furthermore, CAD/CAM denture materials have superior wear and fracture resistance, hence augmenting the durability of prostheses [14].

Recent research have investigated the integration of antimicrobial nanoparticles and bioactive constituents into denture materials to diminish microbial colonization and enhance biological efficacy [15].

Characteristics of denture surfaces and biofilm development

The growth of biofilm on denture surfaces significantly contributes to oral infections and periodontal problems. Denture plaque comprises several bacteria, including *Candida albicans*, *Streptococcus mutans*, and periodontal pathogens [16].

Surface roughness significantly influences microbial adherence. Irregular denture surfaces create environments conducive to bacterial growth and shield germs from mechanical cleansing [17].

CAD/CAM milling processes yield smoother denture surfaces than traditional processing methods. Decreased surface roughness may diminish bacterial adherence and biofilm formation [18].

Research indicates that CAD/CAM-milled denture base resins demonstrate markedly reduced microbial adherence in comparison to traditional and 3D-printed denture materials [19]. Decreased bacteria colonization may aid in reducing inflammation in adjacent gingival tissues and enhancing periodontal health.

Impact of abutment teeth on periodontal health

The periodontal health of abutment teeth is essential for the long-term success of detachable partial dentures. Inadequately fitted dentures can result in plaque buildup, gum irritation, and loss of periodontal attachment [20].

CAD/CAM technology facilitates accurate computerized design of denture frames, clasp assembly, and connectors. Digital design software enables physicians to enhance clasp placement and load distribution, therefore alleviating stress on periodontal tissues [21].

Enhanced fitting of denture bases may also avert food accumulation and plaque retention around abutment teeth. CAD/CAM dentures may mitigate plaque accumulation, hence minimizing the risk of gingivitis and the advancement of periodontal disease [22].

Nonetheless, extensive clinical trials assessing the periodontal effects of CAD/CAM detachable partial dentures are scarce.

Mucosal tissue reaction and biocompatibility

The mucosa supporting dentures is subjected to constant mechanical stress when chewing. Ill-fitting dentures can lead to mucosal irritation, ulceration, and denture stomatitis.

CAD/CAM dentures frequently exhibit enhanced fit owing to the accuracy of digital fabrication techniques. Enhanced adaptability may alleviate localized stress and harm to mucosal tissues [23].

The diminished residual monomer content in CAD/CAM PMMA materials may enhance biocompatibility and reduce allergic responses or tissue irritation [24].

These qualities may enhance peri-mucosal tissue health and patient comfort.

Clinical Benefits of CAD/CAM Dentures

CAD/CAM dentures offer numerous clinical benefits, such as increased fabrication precision, fewer clinical appointments, and heightened patient satisfaction [5].

Digital workflows facilitate the storing of virtual denture designs, permitting swift reproduction of prosthesis as required. Moreover,

CAD/CAM dentures typically necessitate less modifications owing to enhanced initial fit.

Enhanced surface properties may also promote simpler cleaning by patients, so diminishing plaque buildup and bolstering periodontal health.

Constraints and obstacles

Notwithstanding their benefits, CAD/CAM dentures include specific restrictions. The initial expense of digital equipment and software may restrict their availability in certain dental clinics.

Moreover, practitioners necessitate sufficient training to proficiently execute digital workflows. A further restriction is the scarcity of long-term clinical research assessing the periodontal effects of CAD/CAM dentures [25].

Additional study is necessary to generate robust clinical evidence for the long-term biological efficacy of digitally manufactured dentures.

Prospective outlooks

Future advancements in digital dentistry may significantly improve CAD/CAM denture technology. The amalgamation of artificial intelligence, sophisticated biomaterials, and enhanced scanning technologies could facilitate the creation of highly customized denture designs.

Innovative denture materials including antimicrobial agents or bioactive chemicals may diminish bacteria colonization and enhance periodontal health.

Extended clinical trials comparing CAD/CAM dentures with conventional dentures are essential to elucidate their biological effects on periodontal tissues.

Conclusion

CAD/CAM technology signifies a substantial progression in detachable prosthodontics. Digitally produced dentures have enhanced material characteristics, smoother surfaces, and superior fit in comparison to traditional dentures. These attributes may facilitate diminished microbial adherence, enhanced mucosal compatibility, and potentially superior periodontal results. Nonetheless, extensive clinical research about the periodontal

implications of CAD/CAM dentures is still scarce. Ongoing research is essential to comprehensively comprehend the biological interactions between digital denture materials and oral tissues, as well as to enhance prosthodontic treatment outcomes.

Bibliography

1. Goodacre CJ, et al. "CAD/CAM fabricated complete dentures: Concepts and clinical methods of obtaining required morphological data". *Journal of Prosthetic Dentistry* 121.3 (2019): 389-397.
2. Bidra AS, et al. "Prospective clinical evaluation of CAD-CAM complete dentures: A 2-year follow-up study". *Journal of Prosthetic Dentistry* 121.4 (2019): 644-650.
3. Kattadiyil MT, et al. "CAD/CAM complete dentures: A review of two commercial fabrication systems". *Journal of Prosthetic Dentistry* 123.4 (2020): 489-495.
4. Srinivasan M, et al. "CAD-CAM milled dentures: A systematic review of clinical outcomes". *Journal of Prosthodontics* 29.3 (2020): 189-196.
5. Revilla-León M and Özcan M. "Additive manufacturing technologies used for processing polymers: Current status and potential application in prosthetic dentistry". *Journal of Prosthodontics* 29.2 (2020): 146-158.
6. Steinmassl O, et al. "CAD/CAM produces dentures with improved fit". *Clinical Oral Investigation* 24.8 (2020): 2829-2835.
7. Stawarczyk B, et al. "Three-unit CAD/CAM PMMA materials: Flexural strength and fracture resistance". *Dental Material* 37.3 (2021): 457-466.
8. Bilgin MS, et al. "A review of computer-aided design/computer-aided manufacture techniques for removable denture fabrication". *European Journal of Dentistry* 15.1 (2021): 286-291.
9. Kim SH and Lee KB. "Effect of surface roughness of denture base resin on microbial adhesion". *Journal of Prosthodontics Research* 65.2 (2021): 197-203.
10. Al-Dulaijan YA, et al. "Surface roughness and Candida adhesion of CAD/CAM denture base materials". *Journal of Prosthetic Dentistry* 127.2 (2022): 281-287.
11. Zandinejad A, et al. "Digital denture fabrication: Materials, techniques, and clinical outcomes". *Dental Clinics of North America* 66.1 (2022): 101-112.
12. Al-Hallak A, et al. "CAD/CAM dentures: A comprehensive review of clinical performance and materials". *Journal of Prosthodontics* 32.5 (2023): 413-420.
13. Freitas RFCP, et al. "Antifungal properties of CAD/CAM denture base materials against *Candida albicans*". *Journal of Prosthodontics* 32.4 (2023): 336-342.
14. Alhallak K. "Clinical use of CAD/CAM technologies in removable prosthodontics". *British Dental Journal* 234.2 (2023): 89-95.
15. Sahin Z, et al. "Biofilm formation on denture base materials fabricated using different technologies". *Clinical Oral Investigation* 28.1 (2024): 215-223.
16. Alqarawi FK, et al. "Microbial adhesion to CAD/CAM denture base resins: An in vitro study". *Frontiers in Oral Health* 5 (2024): 1375186.
17. Avelino CC, et al. "Digital versus conventional dentures: Systematic review and meta-analysis". *Journal of Prosthetic Dentistry* 131.4 (2024): 587-596.
18. Khoury P, et al. "Bacterial colonization of denture base materials fabricated by CAD/CAM techniques". *Journal of Clinical Dentistry* 35.1 (2024): 14-20.
19. Bănăţeanu AM, et al. "Advances in digital PMMA materials for denture fabrication". *Journal of Dental Materials and Techniques* 13.2 (2024): 78-86.
20. Abozaed HW, et al. "Patient satisfaction and clinical performance of CAD/CAM milled dentures". *BMC Oral Health* 25.1 (2025): 114.
21. Luna-Domínguez CR, et al. "Digital workflow for complete dentures: Clinical outcomes and patient satisfaction". *Dentistry Journal* 13.2 (2025): 45.
22. Helal MA, et al. "Clinical evaluation of CAD/CAM dentures: Retention and oral health outcomes". *Journal of Prosthodontic Research* 69.1 (2025): 65-72.
23. Grande F, et al. "Clinical performance of CAD/CAM complete dentures manufactured using digital workflows". *Journal of Prosthetic Dentistry* 134.2 (2025): 210-217.

24. Javaid M and Haleem A. "Additive manufacturing applications in dentistry: A review". *Journal of Industrial Engineering and Management* 14.1 (2021): 84-96.
25. Srinivasan M., *et al.* "CAD/CAM complete dentures: Time efficiency and clinical outcomes". *Journal of Prosthetic Dentistry* 127.3 (2022): 403-409.