Review Article

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Precision Fit with a Click: Use of Computer Aided Design/ Computer Aided Manufacture Techniques for Removable Denture Fabrication: A Review

Vishwas Kharsan[1*] Vaibhav Bandgar[2] Pravin Raipure[3] Vaibhav Jain[4]

[1]Associate Professor, Department of Prosthodontics, Nair Hospital Dental College, Mumbai, Maharashtra, India.
[2]Assistant Professor, Department of Prosthodontics, Government Dental College and Hospital, Mumbai, Maharashtra, India.
[3]Assistant Professor, Department of Prosthodontics, Nair Hospital Dental College, Mumbai, Maharashtra, India.
[4]Associate Professor, Department of Conservative Dentistry and Endodontics, Chhattisgarh Dental College and Research Institute, Rajnandgaon, India.

ABSTRACT

Background: Since their introduction, RPDs have been made by laboratory waxing and casting of the metal frame, with technological and scientific advances limited to this technique. Several attempts to modernize and improve the preparation of these metal frames, but few advances have been observed. New processing techniques for RP have been evaluated, such as stereolithography (SLA), selective laser sintering (SLS), selective laser melting (SLM), selective deposition modeling (SDM), 3D printing, and direct inkjet printing. This review aims to highlight the use of CAD/CAM and rapid prototyping (RP) in the manufacture of RPDs.

Keywords: Computer-aided design; Computer-aided machining; Critically appraised topic (CAT); Removable partial denture.

INTRODUCTION

Over the last two decades, however, developments in dental technology have led dentists and dental technicians to use computer-aided design/computer-aided manufacture (CAD/CAM) such as milling and rapid prototyping (RP) technologies for removable denture fabrication. This article reports the results of literature review the historical background, development, and use of dental CAD/CAM technologies for milling and RP, including maxillomandibular relationship (MMR) transfer devices, for the fabrication of removable complete and partial dentures [1]. Dental laboratory technicians and clinicians are using software to design RPD frameworks from digital impressions obtained from both intraoral and laboratory-based digital scanning strategies. The primary obstacle preventing the broad application of a complete RPD digital workflow has been the difficulty and expense associated with producing the metal frameworks [2].

MATERIALS AND METHODOLOGY

The articles used in this review were found in MEDLINEPubMed), Google Scholar, Science Direct, and Cochrane database using the Keywords:

1.“additive manufacturing” and “removable partial denture”
2. “rapid prototyping” and “removable partial denture”
3. “ removable prosthesis design,” “removable partial denture framework”
4. “CAD/CAM and removable partial dentures (RPDs)”

Articles published in English from 2001 up to and including 2018 were selected. All articles about RPDs fabricated by Rapid prototyping were included, including laboratory and clinical reports. Articles published in non-English languages that included identified search terms in the title or abstract were excluded. The search process was

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***Correspondence Dr. Vishwas Kharsan.**
Department of Prosthodontics, Nair Hospital Dental College, Mumbai, Maharashtra, India.
Email: Not Disclosed

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executed in three phases as searching of titles, analysis of abstracts, and identification of full-text articles. A total of 124 potentially relevant articles were found. 19 full text articles were selected for the review after final evaluation.

LITERATURE REVIEW

Digital dentistry using CAD-CAM technology, high-precision 3D printers and scanners, and industrial casting and production techniques can be expected to improve the fit, esthetics, and functional components of RPDs while reducing costs and labor, thus increasing efficiency and manufacturing outcomes [1].

Bilgin MS [1] et al investigated the usage of computer-aided design/computer-aided manufacture (CAD/CAM) such as milling and rapid prototyping (RP) technologies for removable denture fabrication. They concluded that current innovations and technological developments of CAD/CAM and RP allow the digitally planning and manufacturing of removable dentures from start to finish. **Lima JM et al** [3] conducted a review on the use of CAD/CAM and RP in the manufacture of removable partial dentures. They concluded that such technologies can achieve better reproducibility and adaptation of prosthetic devices, besides eliminating the errors inherent in steps like waxing, casting, and coating; however, many advances in this area still need to be made so that appropriate equipment and software can be developed and the high costs of production reduced.

William RJ et al [4] presented a report on the first patient-fitted chromium cobalt removable partial denture framework produced by computer-assisted design, computer-assisted manufacture and rapid prototype technologies. The technique involved scanning of the dental cast, virtual surveying and designing of the framework on a 3-dimensional computer model. A rapid prototype machine was used for direct fabrication of the alloy framework. Traditional finishing techniques were applied, the framework was assessed by a clinician in a conventional manner, fitted to the patient, and judged to be satisfactory by both the patient and clinician. They concluded that the framework showed an accuracy of fit judged to be at least comparable to the results obtained by traditional casting methods. **Arnold C et al** [5] in vitro study was to evaluate the fit of RPD clasps fabricated by means of 4 different CAD-CAM-systems and to compare those fittings with that of the conventional lost-wax casting technique (LWT). They concluded that milling techniques enabled fabrication of RPDs with comparable or better fit. However, RPDs fabricated with rapid prototyping techniques showed distinct fitting irregularities.

Han J et al [6] described a method to digitally survey and build virtual patterns for removable partial denture (RPD) frameworks using a new three-dimensional (3D) computer-aided design/computer-assisted manufacturing (CAD/CAM) software package developed specifically for RPD design. The procedure included obtaining 3D data from partially dentate casts, deciding on the path of insertion, and modeling the shape of the components of the frameworks digitally. The completed model data were stored as stereolithography (STL) files, which are commonly used in transferring CAD/CAM models to rapid prototyping technologies. Finally, metal RPD frameworks were fabricated using a selective laser melting technique.

Bibb et al [7] **and Ye H et al** [8] reported a clinical case in which a metal frame was produced by CAD/CAM and RP. The die model was scanned and a 3D image was obtained, where the design of the metal frame of the mandibular partial denture was made. From this design, a prototype epoxy resin was obtained by RP. This prototype, which replaced the waxing manually done by the prosthetic technician, was included in a coating material, and the metal frame was obtained as in the conventional method. This frame provided adequate adaptation to both hard and soft tissues and was considered clinically acceptable, indicating that the resin pattern obtained by SLA had accuracy similar to that of the standard traditionally used in wax. According to the authors, the necessary adjustments required to adapt the metal frame were fewer than in the conventional technique, but the distribution and extent of these adjustments were similar between the two techniques. **Jiang Wu et al** [9] **and D Eggbeer et al** [10] explored the application of computer-aided design and manufacture (CAD/CAM) to the process of electronically surveying a scanned dental cast as a prior stage to producing a sacrificial pattern for a removable partial denture (RPD) metal alloy

framework. CAD software was used to design the framework and generate a standard triangulation language (STL) file in preparation for its manufacture using rapid prototyping (RP) methods. They concluded that RP-produced patterns may be successfully cast using conventional methods and that the resulting frameworks can provide a satisfactory fit

CONCLUSION

Computer aided designing/ Computer aided milling (Rapid Prototying) is promising and offers new possibilities in the field of prosthodontics, though its application is still limited. An understanding of these limitations and of developments in material science is crucial prior to considering it as an acceptable method for the fabrication of dental prostheses.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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