Abstract

Utilization of computer-aided design/computer-aided manufacturing (CAD/CAM) increases in dental prosthetics. From single restorations and bridges, computer-aided engineering supports fabrication of partial and now complete removable dentures. Improved materials, like crosslinked poly (methyl methacrylate) (PMMA) and CAD/CAM technology permit realization of a superior quality denture in shorter time.

Keywords: CAD/CAM, Crosslinked PMMA, Digital denture

Computer-Aided Engineering (CAE) is using computer software to help in engineering analysis tasks. In the dentistry includes: computer-aided planning (CAP), computer-aided design (CAD), computer-aided analysis (CAA), and computer-aided manufacturing (CAM). Computer Aided Design - Computer Aided Manufacturing (CAD/CAM) equipment has made significant progress in dentistry since its early introduction in the 1980s [1]. Nowadays we are talking about CAD/CAM dentistry, an area of dentistry and dental prosthetics, which use CAD/CAM to improve the design and fabrication of indirect dental restorations [2] and digital dentistry, which use digital technologies or tools to perform dental procedures.

CAD/CAM has been used successfully for several years for manufacturing fixed prosthesis (inlays, onlays, crowns, bridges) [3] and implant-supported restorations [4], but data about removable complete dentures manufactured using CAD/CAM are limited.

Using CAD/CAM in construction of complete dentures has two objectives: to provide complete dentures of a better quality and to reduce the chair time.

This is possible due to improved materials and technologies, which have brought progresses to conventional materials used for production of complete dentures. The conventional material for denture base is poly (methyl methacrylate) (PMMA), which has good qualities, but also disadvantages due to remains of unreacted monomer. This residual monomer produces toxicity and low mechanical properties and residual monomer leakage may appear, followed by generation of fissures and additional structural damage of denture base that are a point of entry for various bacteria and yeasts [5].

Today, innovative materials like as high-density polymers offer remarkable possibilities for dentistry. Crosslinking, a bond that links one polymer chain to another, increases mechanical properties of linear polymers by creating a stronger and more resistant crosslinked polymer with a complex, three-dimensional network instead of a simple, linear structure. It has been experimentally observed by Min et al [6] that when crosslinked, PMMA has a characteristically more ductile response to mechanical loading than does linear PMMA.
At present, many manufacturers offer high-density polymers based on highly crosslinked PMMA acrylic resins, known as monolithic acrylic for CAD/CAM manufacturing methods. Global Dental Science, LLC introduction AvaDent™ digital dentures and provides “a patented, pre-shrunk, bacteria-resistant, polychromatic, PMMA extreme crosslinked puck for greater strength and esthetics” and a similar material is used for dentures teeth [7]. This type of crosslinked PMMA presents a decrease in the porosity and low retention of Candida albicans on the denture mucosal surface [8]. In addition, CAD/CAM dentures release less monomer than conventional ones [9] owing to use of acrylic resin polymerized under special conditions, with high pressure and temperature.

Conventionally, to provide complete dentures for dentulous patients need five appointments, if the patient approves and accepts the overall esthetics at the trial appointment before making the dentures:

1. Making of preliminary impressions,
2. Making of final impressions,
3. Jaw relationship registration,
4. Try-in of wax denture pattern,
5. Placement/insertion of complete dentures.

With the digital technology, the fabrication of complete dentures should consist in two appointments:

1. Making of impressions, jaw relationship registration, orientation of occlusal plane and tooth selection,
2. Placement of dentures.

Different studies [10, 11] describe fabrication of complete denture using AvaDent system in two appointments. In first appointment were done impressions of edentulous jaws, registration of jaw relationship, establishing of occlusal plane orientation, teeth mold and shade selection, and maxillary anterior teeth positioning record. This system used an “anatomical measuring device (AMD)” for measuring occlusal vertical dimension and registering centric relation [7]. The AMD is also used to determine the proper support for upper lip, to establish the position of the maxillary anterior teeth and orientation of the occlusal plane. It is possible to order a try-in denture to assess phonetics, function, and esthetics, and then computer made complete dentures will be completed in three appointments.

De Mendonça et al [12] presented a new workflow for complete denture fabrication in a “totally wax-free manufacturing process”, but in five appointment using digital design trays and digital design occlusal rims and two prototypes for try-in and the result is a more effective and accurate denture.

All these studies presented cases with replacement of a conventional denture with a digital denture and patients can make comparison between two type of complete dentures: conventional and digital.

Bilgin et al [13] made a review of usage of CAD/CAM technologies for removable denture fabrication and concluded that “current innovations and technological developments allow the digitally planning and manufacturing of removable dentures from start to finish.”

Kattadiyil and AlHelal [14] made a review of clinical outcomes of computer-engineered made complete dentures in comparison with conventional ones and concluded that main advantages are: reduced number of appointments, increased retention and digital achievability. Other advantages are: superior strength and fit owing to low shrinkage of acrylic base due to milling of repolymerized acrylic resin and decrease in the risk of microorganism colonization on dentures surfaces.

There are also disadvantages of CAD/CAM fabrication of dentures: engineering challenges
caused by impression taking and jaw relation recording procedures, which are similar to the procedures used in the conventional process, expensive materials and increased laboratory cost.

It is worthy to mention that CAD/CAM systems have not completely replaced traditional impression taking. Intraoral scanning of edentulous arches poses a great challenge owing to dynamic movements of the soft tissues, which influence the quality of the direct digital impression [15]. Findings reported in a study done in 2013 [16] suggested that the intra oral scanners used could not be recommended for digitizing edentulous jaws in vivo, but in 2016 a clinical report describes the use of an intraoral scanner for taking a preliminary impression in case of a patient with tight reconstructed lip [17].

At present, there are five systems are available for production of CAD/CAM dentures: AvaDent™ (Global Dental Science), Baltic Denture System™ (Merz Dental GmbH), Ceramill Full Denture System (Amann Girrbach AG), DENTCA/Whole You™ (DENTCA, Inc; Whole You, Inc), and Wieland Digital Denture™ (Ivoclar Vivadent, Inc), which provide digital fabrication of complete dentures in two or three appointments.

In conclusion, it is possible to provide complete digital denture to a better quality than conventional denture and in a shorter time, in benefits of patient and dental team. Complete digitalization of workflow will be possible when digital impressions of edentulous arches are accurate.

FINANCIAL SUPPORT AND SPONSORSHIP
Nil.

CONFLICTS OF INTEREST
There are no conflicts of interest.

REFERENCES


