DIGITAL TECHNOLOGIES FOR COMPLETE DENTURES REALIZATION

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Abstract

Full dentures are not technologically difficult to make, but involve a large number of clinical and technological steps, which can lead to an increased risk of errors. With the development of digital technologies, subtractive and additive methods, the working flow was considerably reduced and the precision of the prosthetic devices was greatly increased. These technologies use industrially produced materials, with physical, chemical and mechanical properties superior to the conventional materials. The main motivations for accepting or rejecting a new technology include the relative advantages they offer compared to the classical methods, and these can be represented by time saving, financial advantages, and clinical benefits. The present study aims to analyze the advantages and disadvantages of complete denture made by digital methods.

Key words: complete denture, CAD-CAM technologies, 3D Printing methods

INTRODUCTION

The therapeutic solutions used to rehabilitate a complete edentulous oral cavity are represented by: multiple: implant supported fixed prostheses, implant supported partial dentures or conventional full dentures. Complete dentures are relatively economical, easy to fabricate and repair, and provide a level of esthetics and function acceptable to many patients.

Acrylic resins remain the materials of choice for removable complete dentures, due to their indisputable qualities: easy to make and repair, good physical properties, acceptable aesthetics, good thermal conductivity, low permeability to oral fluids, color stability, low water sorption, low solubility, very accurate in reproducing surface detail, low weigh and a low cost [1,2,3].

But these materials also have a number of disadvantages, such as: poor mechanical properties, high coefficient of thermal expansion, low modulus of elasticity, increased risk of fracture, mucosal irritation caused by the release of methyl methacrylate or bacterial colonization, due to their porosity [4]. Denture porosity could potentially result in increased oral biofilm accumulation and microorganisms that cause denture stomatitis. Extensive researches have been done to eliminate these disadvantages and to improve the properties of acrylic resins; these studies aimed to develop alternative materials [5], to modify and to optimize the structure of polymers or to increase the mechanical strength of methyl poly-methacrylate.

Frequent complains of full denture wearers include lack of denture retention and loss of the masticatory ability. The edentulous ridge undergoes continuous resorption over the years, ultimately compromising the fit and stability of dentures. Only 13% of denture wearers seek annual dental care; dental implant supported dentures may provide more functional capacity than less costly conventional dentures, but not every patient is an implant candidate [6].

Also, an important issue that specialists faced was the mucosal irritation caused by microbial adhesion to inner denture surface. Epidemiological studies report that approximately 70% of removable denture wearers suffer from denture stomatitis. *Candida albicans* adhesion and biofilm formation are regarded as essential prerequisites for denture stomatitis. [7,8,9,10]. Another problem related to denture stomatitis is that some elderly patients present difficulties on keeping the denture clean, due to their reduced motor dexterity, memory loss, and cognitive impairment [11]. The classic treatment of denture stomatitis is based on topical or systemic antifungal drugs, [12], but this infection is often persistent, since antifungal resistance has been reported in *Candida albicans* biofilms [13]. The prophylaxis of dental stomatitis still represent a challenge for dentistry and more studies are needed to find the optimal prevention method. To provide antibacterial properties, in the last years more attention has directed toward the incorporation of AgNps into acrylic resins. AgNPs incorporation aims to avoid or at least to decrease the microbial colonization over dental materials, increasing oral health parameters and improving life quality [14,15,16].

Full dentures are not technologically difficult to make, but involve a large number of clinical and technological steps, so there is an increased risk of errors. With the development of digital technologies, subtractive and later additive methods, the

working flow was considerably reduced and the precision of the prosthetic devices was greatly increased. These technologies use industrially produced materials, with physical, chemical and mechanical properties superior to the conventional materials. The main motivations for accepting or rejecting a new technology include the relative advantages they offer compared to the classical method, and these can be represented by time saving, financial advantages, and clinical benefits [17].

The present study analyzed the advantages and disadvantages of complete dentures made by digital methods.

I. COMPUTER-AIDED DESIGN/COMPUTER-AIDED MANUFACTURE SUBTRACTIVE TECHNOLOGIES

Computer-aided design/computer-aided manufacture (CAD/CAM) technology has become more popular in dentistry, especially in the fabrication of fixed prostheses. The methods of fabricating full dentures are laborious and requires a lot steps; therefore, researchers have tried to adapt digital technologies to make this category of removable prostheses. Recently, CAD/CAM technologies for fabricating complete dentures have become more well-known and commercially available, and the methods and materials are more and more efficient, allowing to obtain complete dentures according to the highest requirements. These procedures offers significant advantages to the dental practitioner, dental technician and also to the patients. CAD/CAM technology have three important steps (17): data acquisition, by using intraoral scanners or by scanning a stone model from a conventional impression, designing virtual devices in order to generate data for the future restorations, and computerized realization of the full denture, using state-of-the-art materials.

For full dentures, the resins used in computerized technologies are industrially produced, have a high resistance to impact and distortion, resistance to blanching, color stability and dimensional stability. The pre-polymerized acrylic resin are produced under high pressure and heat and polymerization shrinkage does not occur, porosity is decreased, and the adherence of *Candida albicans* to the denture base is decreased. The lack of polymerization shrinkage associated with milled dentures results in a highly accurate denture fit and improved retention [18,19].

Also, the CAD/CAM denture base milled from poly-methyl methacrylate discs, polymerized on high temperature and pressure have been reduced the risk of residual

monomer. The residual monomer is responsible for toxicity, low mechanical properties of acrylic resins [20] and low water absorption [21, 22]; also, methyl methacrylate is associated with immune hypersensitivity reactions in the gingiva and mucosa, and systemic reactions due to the small size of the molecules, which can diffuse throughout the body [23]

The advantage of using of pre-polymerized resins is that there is a higher degree of monomer conversion which leads to the formation of longer polymer chains; also, the polymerization shrinkage has already being realized, the accuracy of the denture can be expected to be improved.

Not only the base of the prosthesis can be made by digital methods, but also the artificial teeth, being able to get artificial arches with an individualized morphology and with superior strength and aesthetics.

Some methods perform the base, the saddles and the artificial arch in to a single stage, while other technologies recommend to make the base and the saddles in one step and the artificial teeth, prefabricated or digitally milled, to be fixed at a later step.

Of course, there are also limitations and disadvantages of these CAD/CAM technologies:: intermaxillary relation, lip support, and maxillary incisal edge position are challenging, the optimal assessment of vertical dimension, establishing the mandibular occlusal plane is difficult, the opportunity for the patient to participate during the procedure is minimal, current material and laboratory costs are still more expensive in comparison to the fabrication by conventional techniques [23].

II. ADDITIVE MANUFACTURING TECHNOLOGIES-3 D PRINTING

3D printing technologies represent another possibility of realizing complete dentures by computerized methods. Additive manufacturing technologies are essentially a method of getting devices with complex spatial geometry through additive processes. Additive manufacturing is gaining rapid potential in nearly all dental fields and it is different in comparison to the formative and subtractive manufacturing, in the additive manufacturing process the device being printed by adding the material layer by layer [23]. Compared to the subtractive CAD-CAM technology for the elaboration of prosthetic appliances based on computer-controlled milling, 3D printing offers the advantage of unlimited design flexibility, the elaboration of the prosthetic device being realized in a few single steps.

The main stages of the prosthetic construction are:

-resin layers depositions in a horizontal direction and their successively polymerization, in a vertical orientation
-removing the structures necessary to support the device during the realization; these rods also avoid deformation before the complete polymerization
-removing the rest of the non-polymerized material and finishing the printed device

The clinical-technological flow of making the complete prosthesis involves several stages: scanning, designing, STL file output, printing and post processing, assembly, final post cure and finishing.

First, an impression of the patient's oral anatomy or of the model is registered. The best available method for creating a digital file for edentulous patients is to scan the fully articulated poured model and wax rim with a desktop laboratory scanner.

The teeth area is selected for the digital denture, depending on the desired morphology, size and color; also, the shape and color of the false gingiva will be chosen. Then, it was selected the option to produce the base and teeth as separate manufacturing files, because this is ideal for 3D printing full dentures.

After STL File Output, follows the stage of printing and Post processing. Once the STL files for denture design are exported, it can be imported the file into the software that contains files for printing and the material for printing denture Teeth or denture base can be selected.

After the resin is inserted in to a resin tank, printing can be started. 3D printing consists in inserting a platform for making the proposed prosthetic works in a bath with light-curable liquid resin, on which a uniform layer of micrometric-sized resin is deposited, according to the CAD program 3D design. Once this first layer of material has been polymerized, the procedure is continued by the successive layered deposition and polymerization of fluid resin until the final form of the prosthetic appliance is realized. The 3D printed device is connected to the manufacturing platform by some support elements of the same type of resin; thus, the post-processing stage follows, which involves washing under running water and removing the support structures.

In the subsequent assembly step, the teeth are inserted and bonded into the saddles. At this point, the denture is ready for the final post-cure, at 80 ° C for 30 minutes. After post-curing is complete, the finishing step follows; this stage is performed in the same way as for a conventional denture, by polishing at low speeds using a rag wheel on a lathe with pumice.

3D printing has several advantages compared to conventional technology -

superior accuracy, developed thanks to additive technology which, compared to subtractive techniques, allows superior reproduction of details; also, the increase of the work efficiency, being able, to elaborate, simultaneously, several prosthetic works, the reduction of the consumption of dental materials and of the working time.

The disadvantages are: the high costs of digital processing programs and printers themselves, the more limited accessibility of materials for this technology, the flawless design of the future prosthesis [23].

CONCLUSIONS

Digital technologies have improved the quality of prostheses in dentistry and found a way to standardize the production process. The CAD-CAM software solutions are designed for the creation, processing, analysis and management of 3D data for application in complex manufacturing processes.

The quality and durability is comparable to those of conventionally produced dentures, often even superior, because these technologies allow the use of modern materials, with optimized mechanical and biological characteristics.

Digital denture process represents an opportunity in the digital design and manufacture of complete removable dentures; is mandatory to know the stages of realization and the advantages of conventional prostheses, but, at the same time, it is necessary to know the benefits of modern technologies, in order to adapt the therapeutic solutions to the particularities of each clinical situation.

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