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Clinical Application of Developments in CAD-CAM Technology in Dentistry

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Abstract

Technological advances have proven to be of great help in development in various fields as well as in dentistry. The development of the CAD/CAM (Computer Aided Design/Computer Aided manufacturing) technology in the 1950s brought another reality to daily clinical practice. Previously, the entire laboratory process of prosthetic work was time-consuming and purely physical, currently the manufacture of prosthetic parts requires less time due to the use of digital media. The addition of digital tools in the planning and execution of dental treatments completely changed the workflow, making the search for improvement to be constant, always seeking the best service and quality of the treatments performed. Thus, this work aims to carry out a critical review of the literature on the clinical applicability of CAD-CAM technology in dentistry.

Key Words: term, term, term, term

1. Introduction

The technological progress-taking place in various fields of science has also made it possible to apply it in the dental field. Technology combined with dental treatments aims to optimize procedures, search for treatment methods that combine aesthetics, durability, ease of execution and saving time, for both the professional and the patient, and this has been a reality for more than 30 years in dentistry (1). The CAD/CAM (Computer Aided Design/Computer Aided manufacturing) systems, developed in the 1950s, allow the modeling, design and manufacture of objects in industrial processes, but it has been used in dentistry for the manufacture of restorations inlays, onlays, crowns, laminates, fixed partial dentures and implants which represents a successful association between the evolution of information technology and engineering for the needs of dentistry.(2).

The greatest developments in CAD/CAM technology in dentistry began in the 70s and 80s by researchers François Duret, Werner Moermann and Matts Andersson, creators of the Sopha® System, CEREC® and Procera® systems respectively (3). The Sopha® System was a pioneer in the production of prosthetic restorations with occlusal morphology, but it was not successful due to its high complexity and cost (4). Currently, several companies have developed such systems with high technology, which are based on three fundamental components: dental preparation reading system, which can be intraoral or laboratory (scanning), prosthetic part design software (CAD) and milling system (CAM) (1).

At the beginning of the use of CAD/CAM technology, the ceramic systems used initially were feldspathic, leucite and lithium disilicate ceramics, composite blocks were also used (4). In the 2000s, the CEREC® 1 Ceramic reconstruction system gave way to the third generation, CEREC® 3, this system presented advances in relation to the adaptation of restorations, better attainment of the occlusal anatomy and faster wear of the ceramic block (5). It was also incorporated, the three-dimensionality in its software integrated to a computer. The scanning unit was perfected using the method of the active triangulation principle, with the optical capture of the image carried out by infrared, producing an electrical signal and generating data in three dimensions on the computer screen (4). In this way, the scanner projects a linear pattern under an active triangulation angle, allowing the light lines to not appear flat, but with smooth displacements, depending on the depth of the preparation. The milling unit was separated from the digitization and features two mounted diamond tips, one cylindrical and the other frusto-conical, considerably improving the anatomies of the restorative parts (3).

Between 2001 and 2003, there was the establishment of CEREC inLab, a laboratory system that allowed the laser digitization of the plaster model, where the infrastructure is drawn on the computer (CAD) and, later, the machining of the ceramic block and later, the covering ceramic would be applied (3). CEREC 3D, on the other hand, brought a much more illustrative technology, with easier and more intuitive manipulation of the system, allowing restorations to be evaluated on the screen, from all angles (6).

The Procera system® was developed by Dr. Matts Andersson in the early 1980s, seeking to process titanium due to technical problems during its casting (7) and therefore, in 1989, it was developed for the Procera Allceram®, in which structures were produced with high precision using densely sintered alumina (3). Currently, the company offers a complete CAD/CAM system, only for laboratory workflow, the 3Shape Dental System®, in which you have the intraoral scanning with the 3shape TRIOS® and the bench scanning the 3shape of the Ee series 3shape D1000® and D2000®.

As Duret stated in his 1991 article, concluding that CAD/CAM would bring important effects to dentistry, increase versatility, accuracy, cost-effectiveness and be part of routine dental practice in the early 21st century are currently confirmed (8). Therefore, the objective of this review is to present the current view of the applicability of the CAD/CAM technology in the manufacture of fixed prostheses in Dentistry.

2. Literature Review

To carry out this review, a search was performed in Pubmed and Scielo, where the keywords used were CAD/CAM, CEREC system, Procera system, digital impressions, and conventional impressions.

The steps of the digital workflow will be explained below.

1.1. Scanning

The first step in the process of making a work in CAD/CAM is scanning, in which three-dimensional structures are obtained. This can be done in two ways: intraoral and/or benchtop scanning (1).

With the intraoral scanner, the three-dimensional image is obtained directly from the oral environment, eliminating the conventional molding steps, consequently eliminating possible distortions of the molding materials, ensuring greater reliability and saving time in the clinical steps (9). However, the system also has some disadvantages such as the need to obtain a scanner in the office. In certain situations that the scanner should act, such as gingival creases or deeper preparations, the professional will find it more difficult to obtain these images (10).

In the bench-top scanner, the three-dimensional image is obtained outside the oral environment, and can be taken from the mold or plaster model, which would be advantageous in relation to the intraoral scanner, as the copy fidelity is greater (11).

1.2. Software

The manufacturer provides specific software, with each trademark having separate software. Such software has digital libraries, from which complete anatomical crowns, inlays, onlays, veneers, custom abutments, surgical guides, among others, can be obtained. Such pieces can still be customized according to each patient, and their shape and size can be changed (1).

1.3. Processing

Obtaining prosthetic parts through CAD technology can be done through two types of processing, subtractive, milling, and additive, 3D printing (1).

1.1.1 Milling

Milling corresponds to the last phase of the CAD/CAM system, which would be the making of the prosthetic part itself. For this, there are two ways of obtaining it, through chairside production, laboratory and outsourcing (1).

Chairside production is carried out in the dentist's office, that is, the indirect restoration is produced and cemented in a single session. The types of restorations made in this way are; inlays, onlays, overlays, crowns and veneers it has as a disadvantage the fact that these restorations are machined from blocks of prefabricated restorative materials, in which the color is unique or with varying saturation and translucency, impairing the esthetics of anterior teeth; in addition, ceramics are generally not glazed, but polished (4).

In laboratory production, prosthetic parts are milled in laboratories. Initially, the digitalization of the preparation to obtain the virtual model is performed, and it can be done in two ways: optical impression, with an intraoral scanner, or conventional impression, plaster modeling and digitization, with an extraoral scanner. In both cases, the dentist sends the data or impression/modeling to the prosthetic laboratory, which is able to produce the most varied types of prosthetic parts, from inlays, onlays and single crowns, to 14-element infrastructures, customized abutments for implants, restorations temporary acrylic, infrastructure for removable dentures, etc. (1). The advantage of this type of production is the possibility of extrinsic characterization and glazing in ceramic materials (4).

The type of outsourcing production is carried out in production centers affiliated with companies that supply the CAD/CAM system, such as, for example: LAVA (3M ESPE®), ETKON (Straumann®) and PROCERA (Nobel Biocare®). In this possibility, both dentists and laboratories, who choose not to purchase CAD/CAM systems, send their work to these highly structured locations. These centers have more complex and technologically advanced equipment, with which it is possible to produce different types of structures (4).

1.1.1 3D printing

3D printing currently makes use of two techniques, digital light processing and polyjet printing. Digital light processing printing is done using a conventional light source, liquid crystal panel, or projection source to polymerize the surface layer of a light-curing resin vat into a shape predefined by the digital model. Polyjet printing is performed with jet heads that spray or inject resin into the desired areas. As the jet heads make subsequent passes, each sprayed layer is polymerized with an ultraviolet light source (12).

3. Discussion

Digital dentistry is increasingly present in dental offices and laboratories and, therefore, most dental treatments can or are planned and executed from beginning to end digitally. Technologies such as digital radiography, cone bean tomography, intraoral cameras, digital photography, microscope and mouth scanners help in planning and equipment such as milling machines, 3D printers, bench-top scanners guided the technical laboratory work (13).

In order to be successful in treatments conducted with the aid of digital dentistry, it is borne in mind that there are two distinct fields, the digital world and the physical world. Patients (physical) need to be scanned (digital) to perform the treatment. In the future, actions in the mouth will be increasingly smaller and the digital models of the patients will provide enough information for the planning and application of the treatment. It is even possible to think that, in the future, the direct labor of the dentist could be replaced by a robot, in order to obtain greater precision. the dentist will specialize and qualify for handling equipment and diagnosing oral problems "leaving aside" the practical dental applications (13), therefore, a digital clinical work protocol should be created to perform the procedures, such as digital image capture and processing: digital, intraoral and camcorder cameras, intraoral or bench-top scanners and image exams such as tomography and digital radiographs will be used to obtain the digital version of the patient. (13) Carrying out a virtual planning, after capturing the information, these will be analyzed through software and all treatment will be conducted with this information from planning to application. Thus, the professional should spend more time in front of digital equipment than in front of the patient (1).

Once the planning is done and the last step will be the process of making by milling or 3D printing, from the virtual planning the manufacturing will be executed, thus returning to the physical world, transforming the digital planning into fixed, removable, partial and total dental prostheses, surgical guides , dental aligners, bruxism plates, among others. Through two basic techniques, milling (subtractive form) or 3D printing (additive form), the works that will be destined to the rehabilitation of patients are created.

Commercially available intraoral cameras come in two forms: single-image cameras that record individual images, namely, iTero (Align Technology), Planscan (Planmeca), CS 3500 (Carestream Dental LLC) and Trios (3 Shape), and video cameras, which are used by the True Definition scanner (Lava Chairside oral scanner), Apollo DI (Sirona) and OmniCam system (Sirona) systems. Single-image cameras record only one section, and the software needs to overlay images to generate a three-dimensional complete arcade model (1).

Among the CAD/CAM systems available for dental offices we have CEREC and E4D, and one of the advantages of the E4D system over CEREC is the elimination of one of the steps, in this case, the application of a layer of titanium dioxide. As for complete laboratory systems, we have Sirona CEREC inLab, Degudent Cercon, Kavo Everest and Wieland Zeno. Each system has its peculiarities, whether in relation to the steps required completing the restorations, the type of material available and the degree of difficulty in using it (14).

With the use of such technology, prosthetic treatments are increasingly better adapted and with a much shorter treatment time, but the uses of prosthetic parts made in a traditional way, through molding techniques, still present good marginal adaptation and longevity (9). Studies indicate that full crowns made by CAD/CAM present a 49μm mismatch, whereas the crowns produced through molding such mismatch level is 71 μm, but clinically acceptable (15).

4. Conclusion

With constant advances, it is evident that the use of these technologies is already a reality in the daily clinical routine of professionals in different areas of dentistry. The use of CAD/CAM technology for making fixed prostheses has proved to be advantageous both for financial reasons and for the practicality and agility of treatment; enabling dentists to perform more effective treatments, with greater precision and less time. Therefore, it is up to us to define how important our inclusion in this digital workflow is, analyzing our area of expertise and the market in which we operate. In this way, regardless of the choice of workflow, analog or digital, we will be aware of the constant search for the best service.

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