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CAD/CAM in Prosthodontics: A Review

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ABSTRACT

The evolution and development of CAD/ CAM systems have led to the production of prosthetic reconstructions by going beyond the use of traditional techniques. Precision adjustment of prosthetic elements is considered essential to ensure sustainable restoration and dental preparation. The technology does seem to offer a more streamlined and efficient means of treatment planning and delivery of care through reduced chairside time, with reported improved patient satisfaction. It has drawn comprehensive attention from dentists and has been used for dental prosthesis fabrication in a number of cases. This new digital impression technique is expected to bring about absolute digitization to the mode of prosthodontics[17].

INTRODUCTION AND BACKGROUND

Over the past 20 years, computer-aided design (CAD)/computer-aided manufacturing (CAM) has become more common in dentistry. Inlays, onlays, veneers, crowns, fixed partial dentures, implant abutments, and even full-mouth reconstruction can be done with this method. It is used in dental offices and dental laboratories. CAD/CAM is also used in orthodontics. The development of CAD/CAM technology was motivated by three challenges. The first challenge was making sure the fix was robust enough, especially for posterior teeth. The creation of restorations that seemed natural presented the second challenge. The final challenge involved making tooth repair easier, quicker, and more accurate. Due to CAD/CAM technology, patients occasionally get restorations on the same day. Dentists and laboratories may use the new technology in a variety of ways. Dentists can either perform their own internal CAD and milling, or they can build a digital image and submit it to a lab for manufacturing restorative materials. When laboratories get a digital impression, they can use the information to create a stone model, which can then either be used as is for traditional production or rescanned for milling. As an alternative, the lab can complete all of the design work online using the photos obtained. The design and production of dental restorations, particularly dental prostheses like crowns, crown lays, veneers, inlays and onlays, fixed bridges, dental implant restorations, removable or fixed dentures, and orthodontic appliances, are improved by the use of CAD/CAM in the field of dentistry. CAD and production were developed in the 1960s for use in the automobile and aerospace industries. It is conceivable to pinpoint the 1980s as the decade when CAD/CAM technology first entered the dental sector. CAD/CAM technology was introduced to dentistry in 1989 by Mormann & Brandestinni in Germany, and it was developed for the in-office fabrication of ceramic restorations specifically to enable the dentist to complete one or multiple ceramic restorations chairside, in a single appointment. These CAD/CAM technologies can be used to machine as well as precisely and accurately create various restorations and dental prostheses. Over the past 25 years, there has been a substantial increase in the utilization of CAD/CAM technology. The development of CAD/CAM technology in dentistry has significantly altered treatment plans and the production of prosthetics. In this systematic review, the history and basic operation of CAD/CAM in dentistry were covered, and we sought to confirm our initial hypotheses of whether CAD/CAM usage would enhance the quality of dental instruments/device in comparison to traditional methods that exist[2].

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ADVANTAGES OF CAD/CAM SYSTEM;

. No Traditional Impressions.

. Produce Chair-side Restorations.

. Less appointment.

. High Precision and Accuracy.

. Improve the Qualities of Restoration.

. Eliminates the Use of the Laboratory Equipments required for Conventional LOST-WAX technique.

. Speed, ease of use, and quality Digital scans.

. Faster design and fabrication.

. Natural appearance cad/cam retorations

limitations of CAD/CAM systems:

♣ Initial High Cost of CAD/CAM Systems.

♣ Time and Cost Investment to Master the technique.

CAD/CAM COMPONENTS:

Scanners: Currently, the data acquisition is either performed directly in the patient's mouth (intraoral) or indirectly after taking an impression and fabricating a master cast (extraoral. Basically there are two different scaning possibilities.

OPTICAL SCANNERS:

The basis of this type of scanner is the collection of threedimensional structures in a so-called 'triangulation procedure'. Here, the source of light (e.g.: laser) and the receptor unit are in a definite angle in their relationship to one another. Through this angle the computer can calculate a three-dimensional data set from the image on the receptor unit. Either white light projections or a laser beam as a source of elimination.

MECHANICAL SCANNERS:

In this scanner variant, the master cast is read mechanically line-by-line by means of a ruby ball and the three-dimensional structure measured. This type of scanner is distinguished by a high scanning accuracy, whereby the diameter of the ruby ball is set to the smallest grinder in the milling system, with the result that all data collected by the system can also be milled. The drawbacks of this data measurement technique are to be seen in the inordinately complicated mechanics, which make the apparatus very expensive with long processing times compared to optical systems[7].

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Design software:

Software that can turn the captured images into a digital model to produce and design the prosthesis. Special software is provided by the manufacturers for the design of various kinds of dental restorations. The software of CAD/CAM systems presently available on the market is being continuously improved. The latest construction possibilities are continuously available to the user by means of updates. The data of the construction can be stored in various data formats. The basis therefore is often standard transformation language (STL) data. Many manufacturers, however, use their own data formats, specific to that particular manufacturer, with the result that data of the construction programs are not compatible with each other[6].

Digital fabrication process tools:

The last phase of the dental CAD/CAM process involves developing a restoration from a CAD model into a physical part that undergoes processing, finishing, and polishing before being inserted into the patient's mouth. The two primary methods used to fabricate these restorations may be subtractive (milling and grinding) or additive manufacturing (Rapid Prototype, RP or 3D printing). Milling/machining technology is a type of restoration fabrication that utilizes subtraction manufacturing technology from large solid blocks. The milling units are categorized into two classifications: (A) dry/wet/milling and grinding in which some milling materials need dry milling and others need wet milling (B) number of axes (3 axes or 4 axes or 5 axes) in which both the 4 axes and 5 axes move linearly up and down through different axes (X, Y, Z). Additive manufacturing is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer. Once the CAD design is finalized, it is segmented into multislice images. For each millimeter of material, there are 5–20 layers in which the machine lays down successive layers of liquid or powder material that are fused to create the final shape. This is followed by furtherrefinement to remove the excess material and supporting frame. The main problem with this type of manufacturing is that it can cause differences in the final model production because of shrinkage during building, postcuring, and minimal thickness of the layers. There are several techniques that can be involved in the additive technology including Direct Metal Laser Sintering (DMLS), Stereo Lithogr Aphy (SLA), Scan, Spin and Selectively Photo curing (3SP), Poly Jet, and Direct Light Projection (DLP). The primary difference is related to developing the z-plane, which represents the vertical components of the restorations[8].

CAD/CAM systems in dentistry:

Depending on the location of the components of the CAD/CAM systems, in dentistry three different production concepts are available: 1. Chairside Production/Office-Based Devices 2. Laboratory Production 3. Centralized fabrication in a production center.

Centralized production:

The third option of computer-assisted production of dental prostheses is centralized production in a milling centre. In this variation, it is possible for 'satellite scanners' in the dental laboratory to be connected with a production centre via the Internet. Data sets produced in the dental laboratory are sent to the production centre for the restorations to be produced with a CAD/CAM device. Finally, the production centre sends the prosthesis to the responsible laboratory. Thus, production steps 1 and 2 take place in the dental laboratory, while the third step takes place in the centre. This production modal minimizes the cost to the labortary and has the potential to improve fabiration efficiencies.

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CAD/CAM IN DIFFERENT FIELDS OF PROSTHETIC DENTISTRY

CAD/CAM REMOVAL PROSTHODONTICS:

In recent years, CAD/CAM systems have been successfully introduced into restorative dentistry and maxillofacial technology. Moreover, they have been applied to removable prostheses. Regarding the removable partial denture, the framework design is drawn on the working cast and then scanned using a laboratory scanner. The framework is always fabricated by printing a photo polymeric framework and then cast with chromium cobalt, or the framework can be printed directly from chromium cobalt through Direct Metal Laser sintering.

CAD/CAM technology in implant prosthodontics:

CAD/CAM allows simplified production of precise and durable implant components. The precision of fit has been proven in several laboratory experiments and has been attributed to the design of implants. Milling also facilitates component fabrication from durable and aesthetic materials. The CAD component virtually designs the 3D contour of the final implant component. The CAM system produces the actual implant component according to the virtual design. In implant dentistry, the implant abutments and frameworks are produced by milling at a central production facility. Examples of these systems are Procera (Nobel Biocare), Etkon (Straumann), CAMStructure (Biomet 3i), and Atlantis (Astra Tech). Custom CAD/CAM abutments combine most of the advantages of stock and cast custom abutments[10].

CAD/CAM technology in maxillofacial prosthodontics:

CAD/CAM is widely used for the fabrication of maxillofacial prostheses, extraoral radiation devices, individual respiratory masks and facial protection devices etc. Three dimensional surfaces imaging is done by using CAD software. This 3-D surface image aids in the fabrication of resin model with Lithographic technique and then wax pattern is made. Of this completed wax pattern, once again computer assisted three dimensional imaging is done. Data is entered in computer and prosthesis is milled by computer aided milling machine. Thus, a silicone maxillofacial prosthesis is fabricated using CAD/CAM technology[11].

CONCLUSION

CAD/CAM systems, though costly in the initial phase however the accuracy and the quality of restoration definitely outweighs its economic factor and undoubtedly the future of prosthodontics will be led by these CAD/CAM technologies.

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