



APPLICATIONS OF CAD/CAM IN PROSTHETIC DENTISTRY.

Dental Science

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ABSTRACT

Over the past few years, computer-aided design (CAD) and computer-aided manufacturing (CAM) have gained popularity in the field of dentistry. The technique can be used for full-mouth reconstruction, inlays, onlays, veneers, crowns, fixed partial dentures, implant abutments, and more. It is utilised in both the dental laboratory and the dental clinic. This article provides an overview of the operation of CAD/CAM in dentistry. It also covers how to integrate the new technology into your practice, a description of the primary goods available, and information on the benefits and drawbacks.

KEYWORDS

CAD\CAM, Prosthodontics, Implant, Scanning, Design, Milling Stages.

INTRODUCTION

In dentistry and prosthodontics, computer aided design and computer-aided manufacture are used to enhance the design and production of dental prostheses, such as crowns, veneers, inlays and onlays, fixed bridges, dental implant restorations, removable or fixed dentures, and orthodontic appliances.^[1,2] This method is frequently employed in the manufacturing of aircraft and automated spare parts [2]. Although this technology is well established in fixed prosthodontics, the discipline of detachable prosthodontics is still in its infancy.^[3] Following the success of CAD/CAM in implant and fixed prosthodontics, full dentures were introduced.^[4] A novel method for designing and creating entire dentures has emerged.^[5] Due to the absence of appropriate CAD software until recently, CAD/CAM was used in the production of entire dentures.^[6]

Selective laser sintering (SLS), selective laser melting (SLM), and selective laser stereolithography (SLA), as well as multi-jet modelling in jet technology, 3D printing, and solid ground curing, are CAD/CAM techniques used in dentistry.^[7] The functional and biomechanical requirements for retention, stability, support, reciprocation, encirclement, and passivity must be met by components made for RPDs.^[8]

Simplicity and optimization are two key CAD/CAM goals in the creation of prosthetic structures with good quality and aesthetics.^[9] The field of prosthodontics has used CAD/CAM technologies since the 1980s. In recent times, this technology has been used to create personalized implants, templates for implant placement, bone transplants, bone resections, and for treatment planning and extraoral prosthesis manufacturing.^[10]

Process of CAD/CAM

1. A CAD/CAM system makes use of a process chain that involves scanning, design, and milling stages.
2. The scanning tool transforms the prepared teeth's shape into three-dimensional (3-D) units of information to create a 3-D map (point cloud). The operator uses the computer to construct a restoration shape, and the milling machines employ that tool path to produce the restoration shape from a restorative material.^[11]

CAD/CAM Equipment

The initial scanning phase, computer surface digitization (CSD), offers two sub-options.^[12]

- A. Equipment for optical scanning
- B. Equipment for mechanical scanning

A. Optical scanning apparatus

A scanning method based on a collection of 3-D structures is the triangulation operation. Using this angle, a computer may create 3-D data from the image on the receptor unit. Lighting options include using a laser beam or white light. The patient's mouth is directly

scanned to get the direct scanner image. In an indirect scanner, the cast or impression is scanned to get data.^[13] Optical scanner illustrations,^[12] Everest Scan, KaVo, es1, etkon, Lava Scan ST, and 3M ESPE.

Complex mechanics, high cost, and lengthy processing times are drawbacks.

B. Mechanical scanning apparatus

In this kind of scanning apparatus, the poured cast is mechanically read line-by-line by means of a ruby ball, and the object is measured in three dimensions and distinguished by a high degree of scanning precision. Then, milling would be used to develop and produce all digital data collection. The downsides of this approach include the fact that it is more expensive, time consuming, and difficult than other scanners.

The second part is the designing step: After a three-dimensional image has been obtained using one of the scanning methods, the digitized data is designed in the computer before being used by the construction software.

The third and last part is the manufacturing phase: In this step, a milling machine with computer assistance and high-quality disks or burs used to cut the restoration from ingots converts the digital data of the restoration into a physical output. This method is referred to as "subtractive method".^[14,15]

Devices for milling processing

For the CAM - processing stage, the digitizing data created with a particular CAD software are converted to milling strips and loaded onto the milling machine.

Three milling axis on processing devices can move in three different directions. They use huge solid block subtraction manufacturing technology.^[12]

a. Three-axis milling:

It moves in three different spatial directions with a degree of movement. It indicated X, Y, and Z values. During the milling process, the component rotates 180 degrees. They can mill from the top or bottom of the stock material but cannot mill undercuts, which is sufficient for regular crown and bridge work.

b. Four-axis milling: The machine may move in all four directions at once. Its indicated X, Y, and Z as well as the tension bridge's ability to rotate during work without any restrictions makes it simple to regulate bridge construction with a long displacement in a vertical direction into the customary mold dimension.

c. Five-axis milling: This technique allows for complicated geometries with milled subsections in addition to the three spatial dimensions and the rotating tension bridge. As an illustration, Everest Engine.^[12]

Types

1. chair-side production/office-based equipment.
2. Manufacturing in a lab.
3. Consolidated output in a centre of industry.^[16]

Chair-side production

The patient's chair is where dental restorations are made. Digitalization tools take the place of a traditional impression. The four currently available digital impression products are iTero (Cadent, Carlstadt, NJ, USA), E4D Dentist (D4D Technologies, Richardson, TX, USA), Lava COS (3M ESPE, St Paul, MN, USA), and CEREC AC (Sirona, Charlotte, NC, USA). Red light laser reflection off of the tooth structure is used to reserve the ED4 [D4D TECH] captures. In-office design and milling can be combined with CEREC and E4D devices.^[17] By using a LAVA Chairside oral scanner continuously transmit a video of the teeth, it adopts an entirely different methodology. For the cameras to record the topography, LAVA and CEREC uses powder.^[18]

Advantages: It provides the patient indirectly constructed restorations in a single session and cuts down on chair side time.

Laboratory Production

This type of production follows the same [comparable] operating sequence as the conventional production between the dentist and the laboratory. The dentist sends the impression to the lab, which creates a master cast first. The final CAD/CAM production stages are completed entirely in the lab. Software for dental design processes three-dimensional data with the aid of a scanner. Following the CAD procedure, the data is transported to a specialized milling machine, which generates a fit of the framework that can be assessed and adjusted using the master cast.^[19]

Advantages: The final restoration will perfectly resemble the temporary.^[17]

Centralized Production

'Satellite scanners' are utilized in the dental laboratory to connect with the production centre online for centralized production. Data sets are created and transferred to the production centre from the dental laboratory. The prosthesis is then sent to the lab by the production centre. As a result, steps 1 and 2 of dental laboratory production take place while step 3 occurs in the middle.

Advantages: Lower cost and increased fabrication efficiency.

CAD/CAM in prosthetic dentistry

1. CAD/CAM technology in implant Prosthodontics: Biocompatible materials with sufficient mechanical qualities are employed for implant abutments in implant prosthodontics. Advantages include being made of titanium, having precise emergence profiles, absolute coronal preparation, a 6° inclined implant axis, and being fashioned like a natural tooth. They also reduce chair time.^[20]

2. CAD/CAM technology in Removable Prosthodontics: Using CAD-CAM software, an impression is scanned or an intra-oral scanner or digitiser is used to create a 3D virtual model of a cast partial denture, which is then milled out to provide the final product with accurate and precise details. Cast partial dentures can be made using Co-Cr alloys, commercially pure titanium, and Ti-6Al 4V alloy by applying CAD-CAM technologies. William et al. show a technique for fabricating a detachable Partial denture framework utilizing CAD/CAM technologies.^[21] The photo polymeric framework is printed and then scanned in a lab scanner to create the framework design, which is drawn on the working cast. The photo polymeric framework is printed and then scanned in a lab scanner to create the framework design, which is drawn on the working cast. Through a process called Direct Metal Laser Sintering, the framework can be produced entirely from chromium-cobalt.^[22]

3. The use of CAD/CAM in fixed prosthodontics: Data is recorded using a scanner and the Chair-side Economical Restoration of Aesthetic Ceramic [CEREC] equipment in a lab used to design and create 3D restorations. A ceramic ingot is being milled by two diamonds in a milling chamber. For precise and correct prosthetics, porcelain build-up is accomplished through visually beautiful repair. Advantage: Cut down on chair side time.^[23]

4. The use of CAD/CAM in maxillofacial prosthodontics: A resin model is created using the lithographic technique, after which a wax

pattern is created. Following this, a computer-aided milling machine completes the three-dimensional imaging. Data is entered into a computer and the prosthesis is machined. Using this technique, silicone maxillofacial prostheses are created.^[24]

5. The use of CAD/CAM technology in the creation of removable complete dentures: CAD/CAM has become a novel method for creating entire dentures.^[25] Han et al. explained in 2017 that software was used to analyse models and occlusal information to create entire dentures. Clinical operations and a prototype 3-dimensional artificial tooth arrangement software show that CAD programs have advanced as a result of the practical arrangement of artificial teeth in CAD CAM complete dentures.^[26]

6. Using CAD/CAM to create surgical guidelines for implant placement: Conventional surgical guides were employed as a control for the manual inspection of implant axis deviation. Bibb et al. described the stainless-steel surgical guides that were first reported for custom-fitting surgical guides using SLM technology.^[20]

7. Diagnostic Esthetic and Functional Splint (DEFS) in CAD/CAM The reversible, preventive, and non-invasive nature of DEFS makes it an excellent tool for assessing the restorative validity and patient acceptance of prosthetic rehabilitation. Due of their high resistance and flexibility, polycarbonate and acetal resin are durable options for CAD/CAM creation. Advantage: Affordable aesthetics, pleasant function, and rehabilitation of young patients with dental abnormalities.^[27]

8. Full-mouth rehabilitation using CAD/CAM During thorough complete-mouth therapy in elderly individuals, adaptation of the occlusal vertical dimension (OVD) frequently presents specific obstacles.^[28]

Advantage: Highest level of effectiveness and quality with a low intervention rate.

CONCLUSION

To improve in accuracy and versatility CAD/CAM system has been continued as a part of routine dental practise. Based on the patient demands a combination of both conventional and advancement technologies are practised in upcoming period.

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