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Review Article

CAD CAM IN RESTORATIVE DENTISTRY: A REVIEW

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ABSTRACT

Dental CAD/CAM technology has been used to replace the laborious and time-consuming conventional lost-wax technique for efficient fabrication of restorations.
This technology enables dentists to produce complex shapes of ceramic prostheses under the computer-controlled manufacturing conditions directly from the simply shaped blocks of materials within 1 hour

INTRODUCTION

Restorative dentistry has significantly metamorphosed over recent years. An ongoing trend that has greatly affected the field's evolution has been the ability of both clinicians and laboratory technologists to embrace and incorporate emerging technologies into their everyday work flows.[1]

The term 'CAD/CAM' in dental technology is currently used as a synonym for prostheses produced by 'milling technology'. This is not entirely correct. CAD is the abbreviation for 'computer-aided design' and CAM stands for 'computer aided manufacturing'. The term 'CAD/CAM' does not provide any information on the method of fabrication[3]

Over the past 25 years, computer-aided design (CAD) and computer-aided manufacturing (CAM) have become increasingly popular parts of dentistry.[1]

Dental CAD/CAM technology has been used to replace the laborious and time-consuming conventional lost-wax technique for efficient fabrication of restorations.

This technology enables dentists to produce complex shapes of ceramic prostheses under the computer-controlled manufacturing conditions directly from the simply shaped blocks of materials within 1 hour.[1]

It is expected that a ceramic restoration should have a high longevity.

With the CAD/CAM systems, restorations can be produced quicker, which eliminates the need for temporary restorations.

History of CAD CAM

Computer-aided design (CAD) and computer-aided manufacturing (CAM) technology systems use computers to collect information, design, and manufacture a wide range of products. [5]These systems have been in general use in industry for many years, but dental CAD/CAM applications were not available until the 1980s. The earliest attempt to apply CAD/CAM technology to dentistry began in the 1970s with Bruce Altschuler, DDS,[6] in the United States, Francois Duret, DDS, MD, in France, and We r n e r Mormann, BMD, DDS, and Marco Brandestini, PhD, in Switzerland. Young and Altschuler first introduced the idea of using optical instrumentation to develop an intraoral grid surface mapping system in 1977[6]

In 1984, Duret developed the Duret system, which was later marketed as the SophaBioconceptsystema, demonstrating the ability of CAD/CAM to generate single-unit, full-coverage restorations. However, this system was not successful in the dental market because of its complexity and cost. [7]The first commercially available dental CAD/CAM system was CERECb, developed by Mormann and Brandestini[1,2]

Applications of CAD/CAM Technology In Dentistry:[3]

- Inlays
- Onlays
- Conventional Crowns
- Endo Crowns
- Veneers
- Fixed partial dentures

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- Implant abutments
- Surgical guides
- Partial dentures
- Complete Dentures
- Maxillofacial prosthesis

CAD CAM Components:[3,4,5]

CAD/CAM Systems: All CAD/CAM systems consist of three components:

1. A digitalization tool/scanner that transforms geometry into digital data that can be processed by the computer.
2. 2. Software that processes data and, depending on the application, produces a data set for the product to be fabricated. 3. A production technology that transforms the data set into the desired product.

Depending on the location of the components of the CAD/CAM systems, in dentistry three different production concepts are available:

- Chairside production (Office System)
- Laboratory production
- Centralized fabrication in a production centre.

Review of Common Cad/Cam Systems

CAD/CAM systems may be categorized as either in-office or laboratory systems.

Among all dental CAD/CAM systems, CEREC is the only manufacturer that provides both in office and laboratory modalities. Similar to CEREC is the Evolution D4D. Laboratory CAD/CAM systems have increased significantly during the last 10 years and include DCS Precident, Procera, CEREC in Lab, and Lava.[1]

Cercon is a laboratory system that possesses only CAM capabilities without the design stage. Several of the more common dental CAD/CAM systems are described below. [1]

CEREC

With CEREC 1 and CEREC 2, an optical scan of the prepared tooth is made with a couple charged device (CCD) camera, and a 3-dimensional digital image is generated on the monitor. The restoration is then designed and milled. With the newer CEREC 3D, the operator records multiple images within seconds, enabling clinicians to prepare multiple teeth in the same quadrant and create a virtual cast for the entire quadrant. The restoration is then designed and transmitted to a remote milling unit for fabrication. While the system is milling the first restoration, the software can virtually seat the restoration back into the virtual cast to provide the adjacent contact while designing the next restoration. [1,2]

CEREC in Lab is a laboratory system in which working dies are laser-scanned and a digital image of the virtual model is displayed on a laptop screen. After designing the coping or framework, the laboratory technician inserts the appropriate VITA In-Ceram block into the CEREC in Lab machine for milling. The technician then verifies the fit of the milled coping or framework. The coping or framework is glass infiltrated and veneering porcelain is added [2]

DCS Precident

The DCS Precident system is comprised of a Preciscan laser scanner and Precimill CAM multitool milling center. The DCS Dent form software automatically suggests connector sizes and pontic forms for bridges. It can scan 14 dies simultaneously and mill up to 30 framework units in 1 fully automated operation. Materials used with DCS include porcelain, glass ceramic, In Ceram, dense zirconia, metals, and fiber- r e in forced composites. This system is one of the few CAD/CAM systems that can mill titanium and fully dense sintered zirconia.[1]

Procera

Procera/All Ceram was introduced in 1994 and according to company data, has produced 3 million units as of May 2004. Procera uses an innovative concept for generating its alumina and zirconia copings. First, a scanning stylus acquires 3D images of the master dies that are sent to the processing center via modem. The processing center then generates enlarged dies designed to compensate for the shrinkage of the ceramic material.

The complete procedure for Procera coping fabrication is very technique-sensitive because the degree of die enlargement must precisely match the shrinkage produced by sintering the alumina or zirconia. [1]

Lava

Introduced in 2002, Lava uses a laser optical system to digitize information from multiple abutment margins and the edentulous ridge. The Lava CAD software automatically finds the margin and suggests a pontic. The framework is designed to be 20% larger to compensate for sintering shrinkage. After the design is complete, aproperly sized semisintered zirconia block is selected for milling. The block is bar coded to register the special design of the block. The comp u t e r-controlled precision milling unit can mill out 21 copings or bridge frameworks without supervision or manual intervention. Milled frameworks then undergo sintering to attain their final dimensions, density, and strength. The system also has 8 different shades to color the framework for maximum esthetics. [1,5]

Everest

Marketed in 2002, the Everest system consists of scan, engine, and thermal components. In the scanning unit, a reflection-free gypsum cast is fixed to the turntable and scanned by a CCD camera in a 1:1 ratio with an accuracy of measurement of 20 μm. A digital 3D model is generated by computing 15 point photographs. The restoration is then designed on the virtual 3D model with Windows-based software. Its machining unit has 5-axis movement that is capable of producing detailed morphology and precise margins from a variety of materials including leucite-reinforced glass ceramics, partially and fully sintered zirconia, and titanium. Partially sintered zirconia frameworks require additional heat processing in its furnace. [1,5]

Cercon

The Cercon System is commonly referred to as a CAM system because it does not have a CAD component. In this system, a wax pattern (coping and pontic) with a minimum thickness of 0.4 mm is made. The system scans the wax pattern and mills a zirconia bridge coping from presintered zirconia blanks. The coping is then sintered in the Cercon heat furnace (1,350oC) for 6 to 8 hours. A low-fusing, leucite-free Cercon Ceram S veneering porcelain is used to provide the esthetic contour.[1]

CONCLUSION

CAD/CAM systems have dramatically enhanced dentistry by providing high-quality restorations. The evolution of current systems and the introduction of new systems demonstrate increasing user friendliness, expanded capabilities, and improved quality, and range in complexity and application. New materials also are more esthetic, wear more nearly like enamel, and are strong enough for full crowns and bridges.[1] Dental CAD/CAM technology is successful today because of the vision of many great pioneers. As Duret concluded in his article in 1991, "The systems will continue to improve in versatility, accuracy, and cost effectiveness, and will be a part of routine dental practice by the beginning of the 21st century.[7]

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