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Original Research Article

CAD/CAM Digital Dentistry

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Abstract

In the present world time is money, as of with prosthodontics also. CAD /CAM had made speed and accuracy to a extent that normally it is unimaginable In the last 20 years this technology has grown without Boundss. The introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) technology. In relation to the rapid progress being made in computer-assisted processing technology in various industries since the 1970s, research and development of dental CAD/CAM systems has been actively pursued worldwide since the 1980s, including in Japanese academies. Such as all-ceramic restorations, we describe the recent history of the development of dental CAD/CAM systems for the fabrication of crowns and FPDs, based on our 20 years of experience in this. We also summarize the current state of commercial dental CAD/CAM systems that have been developed around the world, with particular focus on the of ceramic crowns and FPDs [1]. This article provides an overview of the development of various CAD/CAM systems. Operational components, methodologies, and restorative materials used with common CAD/CAM systems are discussed. Research data and clinical studies are presented to substantiate the clinical performance of these systems.

Keywords: CAD/CAM, scanning software, Traditional techniques, future trends.

INTRODUCTION

Computer-aided design (CAD) and computer-aided manufacturing (CAM) technology systems use computers to collect information, design, and manufacture a wide range of products. 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, Francois Duret, Werner Mormann, and Marco Brandestini. Young and Altschuler introduced the idea of using optical instrumentation to develop an intraoral grid surface mapping system in 1977. The commercially available dental CAD/CAM system was CEREC, developed by Mormann and Brandestini. A dental restoration must have its abutment within a 50 µm range. This requirement calls for the system to have a very accurate data collection technique, sufficient computing power to process and design complex restorations, and a very precise milling system. During the last two decades, exciting new developments have led to the success of contemporary dental CAD/CAM technology [2].

CAD/CAM systems are composed of three major parts: First, a data acquisition unit, which collects the data from the area of the preparation, adjacent and opposing structures. Then converts them to virtual impressions through intraoral scanners (in-office CAD/CAM or in-office CAD or image acquisition systems) or indirectly using a stone model generated through making a conventional impression. Second, the software used for designing virtual restorations on a virtual working cast and then computing the milling parameters. Third, a computerised milling device used for manufacturing the restoration from a solid block of restorative material or additive manufacturing [3].

The combination of materials that can be used and restoration types that can be produced by different systems vary. Some CAD/CAM systems can fabricate a final restoration with some materials (although subsequent characterization of the esthetics and/or polishing may be needed). For instance, with porcelain-based ceramics shaped using the CEREC system, acceptable strength and esthetics can be achieved without further processing. Crowns, inlays, onlays and veneers can be fabricated in a single appointment. Other ceramics, such as alumina and zirconia-based ceramics, are extremely strong but not esthetic, requiring subsequent veneering using traditional hand stacking methods to achieve acceptable esthetics [6].

MATERIALS

The ceramics currently being used for restorations are predominantly alumina- (including those subsequently infiltrated with glass), zirconia and porcelain based ceramics. Some CAD/CAM system can fabricate a final restoration with some materials (although subsequent characterization of the esthetics and/or polishing may be needed). For instances, with porcelain- based ceramics shaped using the CERAC system, acceptable strength and esthetics can be achieved (for at least some clinical indications) without further processing. Crowns, inlays, onlays and veneers can be fabricated in a single appointment. Other ceramics, such as alumina and zirconia based ceramics, are extremely strong but not esthetic, requiring subsequent veneering using traditional hand stacking methods to achieve acceptable aesthetics[4].

Common ceramic materials used in earlier dental CAD/ CAM restorations have been machinable glass ceramics such as Dicor (Dentsply Caulk, Milford, DE 19963) or Vita Mark II (Vident, Bera, CA 92821). Although monochromatic, these ceramic materials offer excellent esthetics, biocompatibility, great color stability, low thermal conductivity, and excellent wear resistance. To overcome esthetic disadvantages of a monochromatic restoration and to imitate optical effects of natural teeth, a multicoloured ceramic block (Vita TriLuxe Block VITA Zahnfabrik) was designed to create a 3 dimensional layered structure. The inner third has a dark opaque base layer, while the middle third has a neutral zone comparable to the standard block, and the outer third is more translucent. CERAC software allows the operator to have some visual control over the alignment of the restoration within the multilayered block [5].

Cad/cam production concepts in dentistry

Depending on the location of the components of the CAD/CAM systems, in dentistry three different productions [6].

Concepts are available

- Chairside production.
- Laboratory production.
- Centralised fabrication in a production centre.

a) Chairside production

All components of the CAD/CAM system are used in the dental restoration. Fabrication of dental restorations can thus take place at chairside without a laboratory procedure. The digitalisation instrument is an intra-oral camera, which replaces a conventional impression in most clinical situations. This saves time and offers the patient indirectly fabricated restorations one appointment. At present, only the Cerec® System (Sirona) offers this possibility. Other producers also plan to introduce chairside CAD/CAM systems to the market. Since the Cerec® system functions with water-cooling, a variety of materials can be processed, from glass-ceramic to high performance oxide ceramic.

b) Laboratory production.

This variant of production is the equivalent to the traditional working sequence between the dentist and the laboratory. The dentist sent the impression to the laboratory where a master cast is fabricated first. The remaining CAD/CAM production steps are carried out completely in the laboratory. With the assistance of a scanner, three-dimensional data are produced on the basis of the master die. These data are processed by means of dental design software. After the CAD-process the data will be sent to a special milling device that produces the real geometry in the dental laboratory. Finally the exact fit of the framework can be evaluated and, if necessary, corrected on the basis of the master cast. The ceramist carries out the veneering of the frameworks in a powder layering or overpressing technique.

c) Centralised production

The third option of computer-assisted production of dental prostheses is centralised 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. As a result, the configiguration of the prosthesis remains in the hands of the dental technician.

The benefit of outsourcing CAM production is to be found in the small investment requirement, since only the digitalisation tool and software have to be purchased, still having access to a high quality production process. In An additional simplification in CAD/ CAM production consists of intraoral data collection (optical impression). This means a digitalisation of what is now only an 'analogue' step in the production process. This could lead to additional improvement in quality and cost reduction. New software developments will make it possible to directly judge the quality of the preparation intraorally, before data are finally sent to the dental laboratory or production centre.

IMAGE AQUATION

The following optical scanners are available [7].

- Lava scan ST(3M ESPE, white light projections)
- Everest Scan (KaVo, white light projections)
- Es1 (etkon, laser beam)

Each system uses a different method to acquire the images. The first system introduced was the CEREC 1 in 1986. Then evolution continous in 1994 CEREC2 evolved followed by CEREC 3 system (Sirona Dental)in 2000, All of them have used a still camera to take multiple pictures that are stitched together with software. The E4D (D4D Tech) takes several images, using a red light laser to reflect off from the tooth structure and only requires the use of powder in some limited circumstances. The application of powder to the tooth is quick and simple, taking only seconds, and the powder is easily removed afterwards with air and water.

The iTero system uses a camera that takes several views, (still) and uses a strobe effect as well as a small probe that touches the tooth to give an optimal focal length this system does not require the use of powder. The LAVA Chair side Oral Scanner (LAVA COS, 3M ESPE) takes a completely different approach using a continuous video stream of the teeth (Fig.1). CEREC and LAVA currently require the use of powder for the cameras to register the topography.

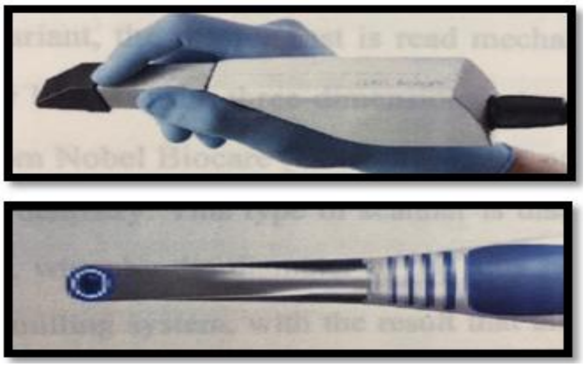
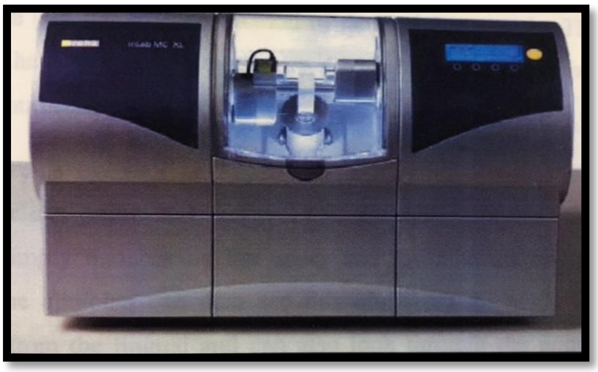


Fig-1: CEREC (upper image) and LAVA COS (lower image)

CAD/CAM Technology [8]

CEREC

CEREC using an optical scan a couple charged device camera and a 3D digital image can use for prepared tooth scan. The restoration is then designed and milled. With the newer CEREC 3D, the operator can take multiple images for clinicians to prepare multiple teeth in the same quadrant and create a virtual cast for the entire quadrant. The designed restoration that can transmitted to a remote milling unit for fabrication. One of the advantages of this system is that the software can virtually seat the restoration back into the virtual cast to provide the adjacent contact. While designing the next restoration.



Lava

This system introduced in 2002, which includes a laser optical system which can scan the digital information of the multiple abutment margins and edentulous ridge. The Lava CAD software automatically finds the margin and suggests a pontic. It is reported framework and is designed larger to compensate for sintering shrinkage. Using this system, the semisintered zirconia block can properly size and then select for milling. Milled frameworks then undergo sintering to attain theirfinal dimensions, and strength. The systemhas numerous shades to color the framework for maximum esthetics.

Procera

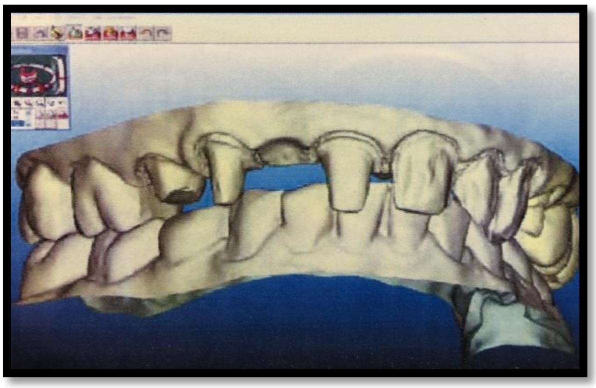
Introduced in 1987, designed by Anderson and developed by Bobelpharma. The Procera system (Nobelpharma Inc. Goteborg, Sweden) combined pantographic reproduction with electrical discharge (spark-erosion) machining. It allows the production of titanium copings, which are subsequently veneered with compatible porcelain (Ti-Ceram) or composite to form crowns or bridges, the latter requiring laser welding of the individual titanium units.

I Terio

The iTero system offers two options – transmissionof the digital image to an iTero laboratory wherea model is milled using the image and can then be used in a traditional manner to create the restorationin CAD/CAM and non CAD/CAM laboratories like, thereby transforming the software image into a physical model alternatively, the digital image can be used to create the restoration using CAD/ CAM.

Each unit has its own method of determining centric. The LAVA COS and iTero have the ability to capturea bite from the buccal with the patient closed in total contact and occlusion. There is no wax or impressionmaterial between the teeth and the practitioner and canguide and easily see if the patient is closed correctly. The software simply matches up the upper and lower scans and places them in centric. The clinician can then see this bite from all angles on the screen, including from the lingual and can also look through the upperto the lower occlusal planes to examine points of contact.

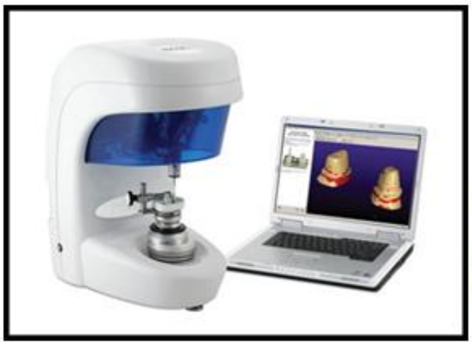
ITero has a feature that tells the clinician (on the screen as well as actually“talking”) if there is enough occlusal clearance for the planned restoration. The CEREC 3D (2003) software currently available allows you to see the preparation and restoration from all angles and also has a built-in occlusal feature. After the virtual restoration has been seated on the digital impression, the occlusal contacts. Are visualized using virtual articulation paper. This process ensures that minimal chairside adjustments are necessary once the restoration has been seated.

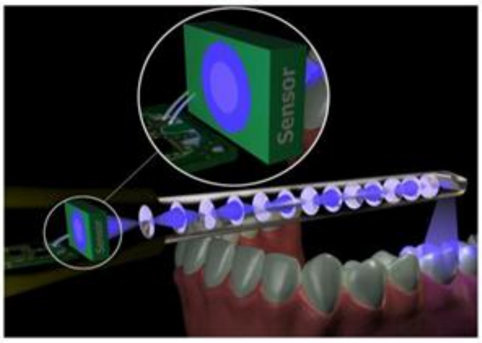


Benefits of Digital Impression and CAD/CAM Systems

Digital impression and CAD/CAM systems offer a number of benefits over traditional Methods. In the case of a complete CAD/CAM system used to scan preparations and create restorations in-office, this eliminates a second visit for the patient (CEREC, Sirona DentalSystems; E4D, D4D Tech). With both complete systems and chairside scanning systems, accuracy benefits exist. CAD/CAM restorations have been found to have good longevity and a fit meeting.

Accepted clinical parameters. Scanning an imageand viewing it on a computer screen allows theclinician to review the preparation and impression, and make immediate adjustments to the preparationand/or retake the impression if necessary, prior to its being sent to the milling unit or a laboratory. This ensures no calls from a laboratory that a (physical) impression is defective - no missing margins, pulls or voids in the impression or steps between two viscosities used that are errors seen in physical impressions. This review, as well as seeing a preparation multiple times its normal size on a screen, can result in improved preparations.





Advantages and disadvantages of digital impressions

Disadvantage

- Digital equipment is very expensive.
- Digital equipment is complex and trained operator is required to operate and maintain the device.
- Good and up-to- date laboratory support is required.
- Those with small mouth may have difficulty with this procedure.

Advantage

- Application of new materials,
- Reduced labor,
- Cost-effectiveness, and quality control.
- This has led to the application of CAD/CAM processing, especially in a large machining center facility.

CONCLUSIONS

CAD/CAM technology currently includes a number of systems that fall into two basic genres – in-office and laboratory fabrication of restorations after digital scanning of images. CAD/CAM has been found to be accurate and offer a number of benefits over traditional in-office and laboratory techniques. It can be anticipated that CAD/CAM technology in dentistry will continue to develop. Having been a CAD/CAM user for several years, our office and patients have enjoyed the benefits of one-visit dentistry. Patients appreciate the convenience of no provisional restorations and not having a second visit for the definitive restoration. The latest technology results in highly accurate restorations that will allow users to have a minimal learning curve and fabricate restorations with ease.

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