CAD/CAM Dentistry.....The Way To Excellence : A Review

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Introduction

Imagine a well crafted crown in a single day.....

A very exciting development has taken place in the field of Dentistry since last two decades. Due to advanced computer technology and innovative materials, Dental procedure has led to much higher standards. Highly sophisticated chairside and laboratory CAD/CAM system have been introduced.

Using CAD/CAM technology in the dental office and laboratory was a dream 20 years ago. But today it's a reality. We now have the ability to create inlays, onlays, veneers, crowns, fixed partial dentures, implant abutments, and a full mouth construction using CAD/CAM.

History

Dr. Duret was the first to develop dental CAD/CAM in 1980's(1). From 1971, he began to fabricate crowns with an optical impression of abutment followed by designing and milling. Dr. Mormann developed CEREC system, an innovative approach to fabricate same day restorations at the chairside in the dental office(2). Dr. Anderson developed Procera system(3). This system later developed as a processing center networked with satellite digitizers around the world for the fabrication of all ceramic frameworks.(4)

Overview of CAD/CAM(5)

In-office dental CAD/CAM systems consists of a handheld scanner, a cart that houses a personal computer together with a monitor, and a milling machine.

The scanner head is placed intraorally above the tooth preparation and the resulting data appear on the monitor as a 2-dimensional (2-D) or 3-dimensional (3-D) images. Design work is done on monitor and the instructions are sent to a computer processing machine for milling.

Restorations are milled from prefabricated blocks of porcelain. Options include felspathic, leucite, or lithium disilicate materials as well as blocks of composite. After the restoration is examined and approved, it is polished and cemented using conventional bonding technique.

Advantages(5)

The use of CAD/CAM technology has numerous advantages over traditional techniques. These advantages include speed, ease of use, and quality.

1) Digital scans are faster and easier than conventional impressions.
2) Patients receive permanent restorations on the same day because of in-office milling machine.
3) No need of provisional restorations which takes time to fabricate and cement.
4) The quality of CAD/CAM restorations is extremely high because of precise measurements and fabrications.
5) CAD/CAM restorations have a natural appearance because the ceramic blocks have a translucent quality.
6) The fabricated crown or a bridge is free of internal defects.
7) All the scans can be stored on the computer whereas, standard stone models take up space and can break or chip if stored improperly.

Disadvantages(5)

1) The cost of the equipment and software is high.
2) Need of precise training for handling the equipment.
3) The scan needs to emphasize the finish line and precisely duplicate the teeth in occlusion.

CAD/CAM Systems(6)

Four CAD/CAM systems are presently available

1) CEREC AC (SironaCharlotte, NC, USA)
2) E4D Dentist (D4D Technologies, Richardson, TX, USA)
3) iTero (Cadent, Carlsdtadt, NJ, USA)
4) Lava COS (3M ESPE, St Paul, MN, USA).

The CEREC and E4D devices can be combined with in-office design and milling; whereas, the iTero and Lava COS devices are reserved for image acquisition only. In-office milling allows same-day restorations.

1) CEREC AC:-

The new CEREC AC gives Dentists the choice of implementing in-office fabrication or sending the digital images with CEREC CONNECT directly to the laboratory, where the restoration can either be milled directly or a model can be created for traditional fabrication of the restoration.

Transfer to the laboratory is only possible if the laboratory has CEREC CONNECT. The scanner operates using visible blue light eminating from light emitting diodes (LEDs) with shorter wavelengths of light than previous CEREC models, increasing the accuracy of the scan. Image acquisition is more rapid with CEREC AC than with previous models due to the continuous capturing of a series of images by the scanner once in position. The occlusion is recorded by simply scanning the arches, and digital on-screen articulating paper shows where there are contacts. Images of interdigitation of the opposing teeth also show if there is sufficient interocclusal clearance for the restoration.

After the clinician has verified that the digital preparation and interocclusal clearance are satisfactory, the system will digitally mark the margins and provide a digital version of the proposed restoration prior to its fabrication.The CEREC MC XL milling center can be used to create full contour crowns in six minutes. Alternatively, the MC L Compact Milling Unit can be used. All types of indirect restorations can be created.

CEREC AC Machine

2) E4D (D4D Technologies):-

The E4D can be used for all fixed restorations except bridges and implants, and will scan up to 16 restorations.

E4D Machine

The E4D has separate scanning and milling units within a cart, with automated interunit communication. The scanner reflects light from directly above the tooth, using a red light laser

oscillating at 20,000 cycles per second to capture the series of images and create a 3-D model. This technology requires that the scanner be held at a specific distance above the tooth, aided by rubber stops on the scanner head, and that the area be centered for imaging (aided by a bull's-eye on-screen guide). There is no requirement to scan the opposing arch, as the occlusion and occlusal height of milled restorations are assessed from the preparation's arch and an image of a physical registration bite. The Dentist has the opportunity to examine the preparation from different aspects for accuracy and to view the proposed restoration prior to milling. The milling component includes a touch-screen panel that provides guidance during the process. The digital scan is transferred to the milling machine (with wireless or wired transmission), and the restoration milled from both sides simultaneously.

The E4D does not offer the opportunity to scan and digitally transfer the images to a laboratory. The E4D scanner can also be used to scan a traditional impression for chairside milling of the restoration.

3)iTero

The iTero chairside digital impression scanner utilizes parallel confocal imaging to capture a 3D digital impression of the tooth surface, contours and gingival structure. It captures 100,000 points of laser light and has perfect focus images of more than 300 focal depths. The system captures 3.5 milliondata points for each arch. The scanner has the ability to capture preparations for crowns, bridges, inlays, and onlays. Parallel light emission from the scanner, which does not need to be held a set distance from the tooth and will also scan when touching the teeth, enables the detection of angled contours. During scanning, a series of visual and verbal prompts are given that are customized for the patient being treated and guide the clinician through the scanning process. For each preparation, a facial, lingual, mesio-proximal and disto-proximal view is recorded in around 15 to 20 seconds, after which the adjacent teeth are scanned from the facial and lingual aspect.

iTero machine

The occlusion is captured by taking two interocclusal views with the patient in centric, after which the Dentist can view the image within 30 seconds and ascertain that the interocclusal clearance is sufficient for the planned restoration prior to the patient leaving. No bite registration material is required.

The iTero system only allows scanning to begin after the prescription charting for the restoration (the “lab slip”) has been completed in the program, ensuring that the prescription is fully entered, with the option to scan either arch first, letting the clinician choose depending on the procedure.

A process flow can be viewed on-screen. After the images have been captured, the digital impression is transmitted to the manufacturer's facility and to the selected dental laboratory. There are no restrictions on the Dentist's choice of dental laboratory.

The manufacturer mills the models on a 5-axis milling machine, using a proprietary resin material. Simultaneously, the dental laboratory technician can export the digital impression file to his or her CAD/CAM system and begin fabrication of copings and/or full coverage restorations.

With the iTero CAD workstation, the dental laboratory technician may also digitally trim the virtual dies where there is evidence of soft-tissue impinging on the margin.

The resin model can also be used for a traditional laboratory technique.

4) Lava C.O.S

The Lava C.O.S. system is used for chairside digital impression making.

Lava C.O.S machine

The Lava C.O.S. scanner contains 192 LEDs and 22 lens systems with a pulsating blue light and uses continuous video to capture the data that appears on the computer touch screen during scanning. Almost 2,400 data sets are captured per arch.

After scanning the tooth preparation, the Dentist is able to rotate and magnify the view on the screen and can also switch from the 3-D image to a 2-D view. The full arch is scanned after the preparation imaging is complete, followed by the opposing quadrant, and the occlusion is assessed by scanning from the buccal aspect with the teeth in occlusion and viewing the arches digitally. The laboratory information is completed after scanning.

The images can be transmitted directly to an authorized laboratory where the laboratory technician digitally marks the margins and sections the virtual model prior to sending this digitally to the manufacturer. The model is then virtually ditched, articulated and sent to the model fabrication center for stereolithography (SLA) to create acrylic models.

These models can then be used for conventional laboratory techniques for CAD/CAM restorations. The Lava C.O.S. lab machine is also available to create CAD/CAM copings (substructures).

Summary

CAD/CAM systems in Dentistry allow for the creation of accurate and precise laboratory models and restorations, involve less chairside time, and achieve fine esthetics that are difficult or time consuming chairside. In-office CAD/CAM allows clinicians to provide same visit fixed partial restorations with precise fit and esthetically pleasing.

CAD/CAM dentistry is changing the way in which clinicians provide indirect restorations to patients with fabrication of highly precise, accurate models and restorations, increased chair side productivity, and improved clinic laboratory communication.

Over the next decades, as prices come down and dentist become more comfortable with new technology we can expect increased use of CAD/CAM in dentistry. Same day restorations will become more popular and will likely expand to fixed partial and removable denture.

References

References are available on request at **editor@healtalkht.com**