Review Article

Digital Impression System –Virtually Becoming a Reality

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Abstract
Digital impression has been integrated into dentistry since the1980s. It offers the clinician the ability to offer patients fixed restorations of all types. The new technology has become easier to use for the clinician as well as more precise, and offers technological advances over earlier versions. There are different types of lights used to capture image. Diode lasers, which produce invisible near infrared wavelengths ranging from 805 nm to 1,064 nm, are for soft tissues only. After image acquisition, the final image is either stored in the system and used for chairside fabrication or digitally transmitted to a laboratory for use or the image can be send to milling unit for fabrication of prosthesis. Different system has their own method of determing centric. There is no wax or impression material between the teeth and the practitioner can guide and easily see if the patient is closed correctly. There are many advantages in using this advance technology. The overall goal of this article is to provide the clinician with information on digital impression in dentistry and the clinical application of the technology.
Key words: Digital scanner, Camera, Software,
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Introduction

"Impression" has different meaning in life but in dentistry, impression is negative form of teeth or other tissues of the oral cavity. Impression has it's importance in various aspects of dentistry especially in prosthodontic dentistry, to perform various procedure like inlays, onlays, crowns, veeners impression has to be made using different materials and techniques.

Earlier impression plaster was used to make impressions, but with time it was replaced by reversible and irreversible hydrocolloid and then elastomeric impression materials. Still, there is lack of some accuracy in making impressions. So, to overcome the inaccuracy digital impression were introduced using scanner and prosthesis are fabricated using software and milling machine. The first digital scanner was introduced in 1980s for dental impressions since then, development engineers at a number of companies have enhanced the technologies and created in-office scanners that are increasingly user-friendly and producing precisely fitting dental restorations. These systems are capable of capturing three-dimensional (3D) virtual images of tooth preparations from which restorations may be directly fabricated

(CAD/CAM systems) or can be used to create accurate master models for the restorations in a dental laboratory (dedicated impression scanning systems). The use of these products presents a paradigm shift in the way the dental impressions are made.[1]. The advent of highly innovative and accurate impressioning systems are poised to revolutionize the way in which dental professionals already are and will continue making impressions for indirect restorative dentistry.

The first system for the dental office was CEREC 1 in 1986. The system was developed by Prof. Dr. Werner Moermann in Switzerland and was eventually licensed to what today is Sirona Dental Systems[2]. The Cerec 2 and subsequent Cerec 3 as well as the eventual the Cerec 3D system replaced the original technology in 1994,2000 and 2003 respectively.[2,3] The Lava™ Chairside Oral Scanner (C.O.S.) was created at Brontes Technologies in Lexington, Massachusetts, and was acquired by 3M ESPE (St. Paul, MN) in October 2006. The product was officially launched in February 2008. iTero In early 2007, the Cadent iTero (Cadent, Carlstadt, NJ) digital impression system came into the market. The E4D Dentist system, introduced by D4D Technologies LLC (Richardson, TX) in early 2008.[1] CEREC AC was introduced in January 2009. Each evolution in the imaging technology led to more indications that the unit could fabricate, as well as a decreased learning curve as the software evolved.[2]

Several of the leading 3D dental digital scanning systems are presented and discussed in this article.

Various systems available in market

1. Cerec systems
2. E4D denist system(D4D Technologies)
3. iTero system
4. The Lava™ Chairside Oral Scanner (C.O.S.)

Pre-requisite of digital imagining

1. Digital camera.
2. Software to create image using CAD/CAM system.
3. Connection to export the image
4. Milling unit to fabricate the prosthesis (in house or in lab).

Figure1: Digital scanner

Steps in digital impression (Figure2)

Types of light sources:

Dental laser technology is based on specific wavelengths that determine the tissues (eg, hard or soft) on which a particular device can be used. Diode lasers, which produce invisible near infrared wavelengths ranging from 805 nm to 1,064 nm, are for soft tissues only. One exception is caries detection lasers (eg, DIAGNOdent, KaVo Dental) which has a visible red wavelength of 655 nm. Pohlhaus says that like other soft-tissue lasers, diode lasers are effective for gingivectomies, biopsies, impression troughing, and frenectomies.[4]

Figure 2: steps in Digital Impression

Different system uses a different method to acquire the images. The earlier versions of Cerec® employed an acquisition camera that depended on an infrared laser light source, advancements in the performance of blue light-emitting diodes (LEDs) in parameters that are relevant for 3D acquisition cameras have now surpassed the quality of the longer-wavelength infrared light source. The shorter-wavelength intense blue light projected by the blue LEDs allows for greater precision of the resultant optical image. The camera projects a changing pattern of blue light onto the object (Figure 3) and then reads it back at a slightly different angle, referred to as "active triangulation technique."

Figure 3: Cerec AC bluecam camera captures an image of teeth using shorter wavelength blue

It uses a telecentric beam, which permits the capture of essential information from all of the prepared tooth's surfaces in a single view. The entire area being impressed needs to be coated completely with a layer of biocompatible titanium dioxide powder to enable the camera to register all of the tissues. The powder is easily removed afterwards with air and water.[1]

The E4D (D4D TECHNOLOGIES), a complete powder free chair side CAD/CAM system, takes several images using a red light laser to reflect off of the tooth structure.

The iTero system uses parallel confocal imaging to quickly capture the digital impression. Parallel confocal imaging uses laser and optical scanning to digitally capture the surface and contours of the tooth and gum structure. The Cadent iTero scanner captures 100,000 points of red laser light and has perfect focus images of more than 300 focal depths of the tooth structure. All of these focal depth images are spaced approximately 50 µm apart. This system does not require the use of powder.[1]

The LAVA Chairside Oral Scanner (LAVA COS, 3M ESPE) takes a completely different approach using a continuous blue light LED video stream of the teeth. It consists of a mobile cart containing a CPU, a touch screen display, and a scanning wand, which has a 13.2-mm wide tip and weighs 14 ounces. The camera at the tip of the wand contains 192 blue LED cells and complex optical system comprised of multiple lens. Thus, this system is able to capture approximately 20 3D data sets per second, or close to 2,400 data sets per arch, for an accurate and high-speed scan.[5]

CEREC and LAVA currently require the use of powder for the cameras to register the topography. Each system uses a system-specific handheld device to scan the site. (Figure 4).

Figure 4: cerec handheld device, and lava COS handheld device.

The cerec 1 was an integrated acquisition and milling unit that was moved from operatory to operatory. The teeth were powdered with an opaquing medium and images were taken with the camera[2]. One study found that the average camera angulation error by clinicians

was just under two degrees. The impression process necessitates achieving adequate visualization of the margins of the tooth preparation by proper tissue retraction or troughing and hemostasis.[1,6]

Bluecam uses blue-light light emitting diodes (LEDs) to create highly detailed digital impressions using shorter wavelengths of light than earlier systems.

Software

Following image acquisition, the final image is either stored in the system and used for chairside fabrication or digitally transmitted to a laboratory for use. Cerec and E4D system is a complete system that allows the restoration to be made chairside.[3]

CEREC Connect is used to export the final digital image directly to a Laboratory. A CEREC inLab milling unit is used to fabricate the prosthesis[3].

The iTero system offers two options – transmission of the digital image to an iTero laboratory where a model is milled using the image and can then be used in a traditional manner to create the restoration in CAD/CAM and non- CAD/CAM laboratories alike, thereby transforming the software image into a physical model; alternatively, the digital image can be used to create the restoration using CAD/CAM (Figure 5).[3]

Figure 5: iTero image.

The LAVA system enables transmission of the data directly to the LAVA lab machine (Figure 6) for a coping that can then be placed on the acrylic model for the porcelain or other material to be added; LAVA can be used to print via stereolithography (SLT) physical models.

Figure 6: Lava COS.

Alternatively, the digital impression can be sent to a laboratory for any CAD/CAM or traditional restoration fabrication. A chairside system is being developed that will scan a traditional impression in the office and create a digital impression file (3Shape). During the scan, a pulsating blue light emanates from the wand head as an on-screen image of the teeth appears instantaneously. The dentist guides the wand over the occlusal surfaces, rotates the wand so that the buccal surfaces are scanned, then rotates again to capture the lingual surfaces. The “stripe scanning” is completed once the dentist returns to scanning the occlusal of the starting tooth.[1,3,5]

The E4D dentist system consists of a cart containing the design center (computer and monitor) and laser scanner (Figure 7), a separate milling unit, and a job server and router for communication.

Figure 7: E4D imaging unit.

The scanner, termed the IntraOral Digitizer, has a shorter vertical profile than that of the cerec, so the patient is not required to open as wide for posterior scans. Therefore, once proper retraction and hemostasis have been obtained, scanning begins by simply placing the IntraOral Digitizer directly above the prepared tooth. The scanner must be held a specific distance from the surface being scanned—this is achieved with the help of rubber-tipped "boots" that extend from the head of the scanner. Placing these rests on adjacent teeth steadies the scanner at this optimal distance. The user holds down the foot pedal while centering the image. Once the desired area is centered on the on-screen bulls eye, the pedal is released and the image is captured (Figure 8).

Figure 8: Intraoral digitizer, which in most cases, does not require the use of a reflective powder to capture images, can be used to scan teeth, models, or elastomeric impressions.

The ICEverything feature of the E4D takes actual pictures of the teeth and gingiva. A diagram on the monitor shows the user how to orient the scanner to obtain the next image. As successive pictures are taken, they are wrapped around the 3D model to create the IC Everything model. This 3D ICE view makes margin detection simpler to achieve. The touch screen monitor enables the dentist to view the preparation from various angles to ensure its accuracy[1].

Occlusal consideration

Each unit has its own method of determining centric. The LAVA COS and iTero have the ability to capture a bite from the buccal with the patient closed in total contact and occlusion. There is no wax or impression material between the teeth and the practitioner can guide 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 upper to the lower occlusal planes to examine points of contact (Figure 9).

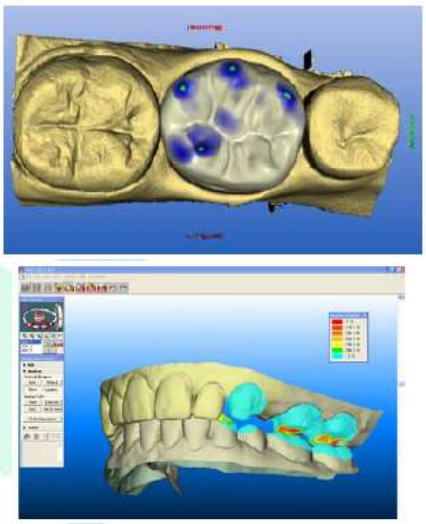

Figure 9: Imaging of occlusion.

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 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[3]. In E4D system, it is not necessary to scan the opposing arch. Instead, an occlusal registration is created with impression material, trimmed, and then placed on top of the prepared tooth. The

scanner captures a combination of the registration material and the neighboring teeth that are not covered by the material. This data is used to design restorations with proper occlusal heights. The design system of the E4D is then capable of autodetecting and marking the finish line on the preparation. Once this landmark is approved by the dentist, the computer uses its Autogenesis feature to propose a restoration (Figure 10), chosen from its anatomical libraries, for the tooth being worked on.[1,5]

Figure 10: Autogenesis feature of the E4D system proposes a restoration, which can be enhanced by the operator with simple on screen tools before milling.

From the impression to the model – comparison of process steps[7] (Table 1)

In house milling machine

The most current version of the Cerec system is the new Cerec AC (Figure11), a modular unit that contains an acquisition unit and was introduced in January 2009. A separate milling unit (Figure12) has evolved to allow it to fabricate virtually any type of individual restoration with ease and precision unmatched by its predecessors.

Figure11: CEREC AC unit and bluecam scanner.

Table 1: From the impression to the model – comparison of process steps[7]

Conventional impressions **Processing steps in the dental practice**	**Digital impressions**
Prepare the impression tray	Apply Optispray
Make silicone impression	Acquire digital impression
Transfer impression	Complete order form
Disinfect	
Complete order form	
	Data transfer Connect portal
Dental laboratory steps	Dental laboratory steps
Clean	Confirm receipt of data
Trim impression	Cheek accuracy of data in 3D
Pour stone material	
Trim arch	
Pin	
Trim base	
Perform saw-cut	
Ditching	
Fabrication of prosthesis	
Finished model	Finished model

Figure12: Milling unit.

The main feature of the new system is the camera, which is referred to as the "Bluecam" or "Omnicam" uses blue-light light emitting diodes (LEDs) to create highly detailed impressions. . Unlike previous generations of scanners, which took one image at a time, the Bluecam is a "continuously on" camera that once you turn it on with a click of the mouse, it stays on, snapping images automatically as soon as the camera is held still over a patient's tooth. This allows the clinician to take a quadrant of images in as little as a few seconds.

Table 2: Differentiation chart of various camera available[7,2]

	CEREC	E4D	iTero	LAVA COS
Full-arch digital impressions Indicated	Yes	No	Yes	Yes
Powdering Required	Yes	no	No	Some
Acquisition Technology	Blue light LED	Red light laser	Confocal	Blue light LED video
In-Office Milling	Yes	Yes	No	No
Connectivity to Labs	Yes	No	Yes	Yes
Restoration Design (CAD) Software	Yes	Yes	No	No
Indication for bridges	yes	No	Yes	Yes

Differentiation chart of various camera available[7,2] (Table 2)

Benefits of digital impression[3,8,9]

A. Accuracy of impressions
B. Opportunity to view, adjust and rescan impressions
C. No physical impression for patient
D. Saves time and one visit for in-office systems
E. Opportunity to view occlusion
F. Accurate restorations created on digital models
G. Potential for cost-sharing of machines
H. Accurate, wear- and chip-resistant physical CAD/CAM derived models
I. No layering/baking errors
J. No casting/soldering errors
K. Cost-effective
L. Cross-infection control
M. Patient is comfortable

Conclusion

With the numerous advantages of digital impressions over traditional impressions and the ability to benefit from digital impression-taking and/or CAD/CAM, more and more dentists are purchasing digital impression systems. It will likely be a routine procedure in most dental offices in the near future, as dentists, laboratory technicians, and patients all reap the benefits.[10]

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