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Digital Impressions: A New Era in Prosthodontics

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Abstract: *In the field of Prosthodontics, the concept of digital impressions using CAD/CAM is growing quickly for impression making procedures over conventional methods. The new technology is easierand precisefor the clinician and more comfortable to the patient.From various studies it has been found thatdental prostheses fabricated from intraoral digital impressions displayed various merits over conventional impressions in many respects. This article discusses the various digital impression systems available in the market, to provide the clinician complete information and knowledge ofapplication of the technology.*
Key Words: *virtual impressions, CAD/CAM, precision impressions*

I. Introduction

Fabrication of final dental restorations through conventional practices involves a complicated process the fabrication of final dental restorations. A comparatively new approach employs Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) technology such as to take a digital impression intra orally, fabricate the master model, and design as well as produce the final restoration.[1]There are certain advantages of digital impressions in implant and fixed prosthodontics as we compare with the conventional impression techniques which include lessened time interval between clinic and dental laboratory, less discomfort to the patient and elimination of laboratory steps that may lead to more fit issues.The digital impression concept has become a trend and spreading quickly on the horizon and it is accepted that digital impressions will solve the limitations and difficulties of the conventional impressions.Dr. Duret first introduced the CAD/CAM concept to dentistry in 1973 in Lyon, France in his thesis entitled Empreinte Optique, which translates to Optical Impression. The concept of CAD/CAM systems was further developed by Dr. Mormann, a Swiss Dentist, and Mr. Brandestini, who was an electrical engineer.[2]8 CEREC was the first commercially available digital impression system for use in the field of dentistry. Over the last 10 years, systems like 3M Lava C.O.S., CadentiTero, E4D Dentist, and 3Shape Trios have been introduced. Till date, various CAD/CAM systems are now available for dental applications. Each employs a specific, distinct technique for making impressions.

How Do They Work?

CAD/CAM systems are having three main parts:

(1) A data acquisition unit, which gathers the information or data from the prepared teeth and the adjacent structures and then converted into visual or optical impressions which are created directly or indirectly at the same time;

(2)Differentsoftware's are used for the designing of the final restorations which are secured in optical impressions and prepared for the milling parameters;

(3) A computerized milling system for the final manufacturing of the restoration with solid blocks of the appropriate restorative material. The first two partsof the system are associated in the CAD phase, while the third one is the CAM phase.[3]

Digital scanners are used to take the image of the prepared teeth which ultimately lead to the removal of conventional impressions. As previously discussed data acquisition is done with the help of scanners having camera that will collect the images, designing of the restoration is done with the help of software and finally computerized milling device is used for the manufacturing of the restoration.[4]

Types, Propositions and Features of Different Digital Systems

The main digital impression systems those are available on the market include CEREC, Lava C.O.S. system, iTero, E4D, and TRIOS. They vary from each other in terms of various features such as working principle, light source, the necessity ofpowder coat spraying, operative process, and output file format.

CEREC System

The CEREC 1 system (Sirona, Bensheim, Germany) was brought to market in 1987 together with the Duret system as the first intraoral digital impression and CAD/CAM device.[5] The principle of this system is designed with the concept of "triangulation of light," where the intersection of three linear light beams is focused on a certain point in 3D space.[6] CEREC AC Bluecam is the fourth generation product and currently is the most

prevalent CEREC system. LED blue diode is the light source which will emit visible blue light for the image capturing. The CEREC AC Bluecam can capture one quadrant of the digital impression within 1 minute and the antagonist in a few seconds. In 2012, the latest and newest CEREC system, CEREC AC Omnicam, was brought to market. The Bluecam imaging technique involves the single image acquisition while the latest Omnicam takes continuous various images, where a 3D model is generated after data acquisition. Bluecam can only be applied for a single tooth while Omnicam can be used for a single tooth, quadrant, or full arch. Powder-free scanning and precise 3D images with natural color are the most prominent features of Omnicam.[7]The CEREC system is a closed system, Sirona's supporting CAM devices such as CEREC MC and CEREC In-Lab works on the proprietary format file those contain the digital impression date.[8]

Lava C.O.S. system

LavaTM C.O.S. (Lava Chairside Oral Scanner; 3M ESPE, Seefeld, Germany) is an intraoral digital impression device invented in 2006 and brought to market in 2008. [i]The principle on which it works is active wavefront sampling. Single-lens imaging system is used to obtain the 3D data under active wavefront sampling. Three sensors are used to capture clinical images from different angles simultaneously such as to develop surface patches with in focus and out-of-focus data by proprietary image-processing algorithms.[9]The Lava C.O.S. has the smallest scanner tip—only 13.2- mm wide. The scanner sends out pulsating visible blue light as light source and they work with a mobile host computer and a touch-screen display.[10] In most cases, supporting CAD software and CAM device are used for desiging and manufacturing of data proprietary files exported by Lava C.O.S.

iTero system

Cadent Inc (Carstadt, NJ) introduced iTero to the market in 2007. They work on the principle of parallel confocal imaging, the iTero system captures intraoral images and contours them by laser and visual scanning.[11]One scan results a total of 100,000 points of laser light at 300 focal depths of the tooth structure. These focal depth images are separated at the level of approximately 50 μm, allowing the camera to acquire precise data of tooth surfaces.[11] Coating of teeth with scanning powder is not recommended in this system, it can capture all the structures in mouth without any use of coating powder. Red laser is used as a light source in this system and further it consists of a host computer, a mouse, a keyboard, a screen, and a scanner. iTero is an open system in the treatment of crowns, FPDs, veneers, implants, aligners, and retainers. Digital image files are send as an STL format, which can be shared by any other lab equipped with a CAD/CAM system.

E4D system

The E4D system was developed by D4D Technologies, LLC (Richardson, TX). It works under the principle of optical coherence tomography and confocal microscopy.[12] Micro mirrors and red laser is used as a light source to vibrate 20,000 cycles per second. E4D's are having high-speed laser those formulates a digital impression of the prepared and proximal teeth such as to create an interactive 3Dimage. The images are obtained in every angle with the laser technology. The software will compile all the images. The image library can wrap around a precise virtual model in seconds. This system also functions as a powder-free intraoral scanning device. It includes a cart with the design center (computer and monitor), laser scanner head, and a separate milling unit.[7]The E4D system can work with a chairside-milling device just like CEREC AC Bluecam and Omnicam systems. That means this system can also function as a "single-visit treatment" and provide high-strength ceramic prostheses or composite even for minimally prepared teeth.[13]

TRIOS system

A new type of intraoral digital impression system, TRIOS, was introduced in 2010, by 3Shape (Copenhagen, Denmark) and was presented to market in 2011. This system works under the principle of ultrafast optical sectioning and confocal microscopy.[14] They maintain a fixed spatial relation of the scanner and the object being scanned and recognizes variations in focal plane of the pattern over a range of focus plane. Moreover, they have a quick scanning speed of up to 3000 images per second thereby reducing the influence of relative movement between scanner probe and teeth. Analyzing a large number of pictures obtained, this system can create a final digital 3D model spontaneously to reflect the exact configuration of teeth and gingival color. Similar to the iTero and E4D systems, the TRIOS intraoral scanner is a powder-free device in the scanning process.TRIOS include two parts: TRIOSR Cart and TRIOSR Pod. The TRIOSR Pod is having a handheld scanner which offers better flexibility and mobility, so due to its simple construction it is compatible with other computers and iPad also.[15]

Precision Between Digital And Conventional Impression

Marginal and internal fitness are important criteria for the success of FDPs like ceramic restorations. To obtain a precise restoration, a high level of impression accuracy is important.[16] Syrek et al conducted an in vivo experiment to compare the fitness of zirconia single crowns made from an intraoral digital impression with that from a conventional silicone impression. The study concluded that ceramic crowns fabricated from a digital impression had a better fit than conventional impressions. The interproximal contact was better for digital impressions than for the conventional impressions.[17]

Ender and Mehl conducted an in vitro experiment on full arch scanning to evaluate the precision of conventional and digital impressions, and determined the values to be 30.9 μm for CEREC Bluecam, 60.1 μm for Lava C.O.S., and 61.3 μm for a conventional impression. Few authors concluded that the accuracy of digital impressions was similar to that of conventional impressions, potentially due to a powder coat spraying, which was applied before both Lava C.O.S. and CEREC scanning.[18]

II. Conclusion

In prosthodontics, the intraoral digital impression technique aids the CAD/CAM process. As a relatively new technique, dental products fabricated with intraoral digital impressions have presented accuracy as compared with conventional impressions but there is a repeatability of the intraoral digital impression which needs to be solved. Although conventional impression materials like poly (vinyl siloxane) and polyether are well developed and present great accuracy in many prostheses, the intraoral digital impression technique has a distinct superiority in work efficiency and saving of materials.The further improvement of the intraoral digital impression technique will lead to its wide use in dentistry.

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