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Digital Impressions

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Abstract
The techniques put forward by the computer aided design and computer aided manufacturing (CAD/CAM) has made an entry to the arena of intraoral digital impressions in the field of prosthodontics.This concept has attracted many dentists in the fabrication of dental prosthesis in many cases.Studies haveshown that dental prostheses fabricated fromintraoral digital impressions have exhibited remarkable advantagesover those from conventional impressions in severalrespects. The aim of this review is to give insight into various digital impressions systems and their comparison with conventional impressions.
***Key words**: intraoral digital impression systems, conventional impressions*

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I. INTRODUCTION

The invention of digital dentistry has been one of the most lauded advancement in dentistry in recent years.[1,2] Impressions have always been critical in Prosthodontics especially where indirect restoration like inlays, onlays, crown, veneers, etc. are indicated.[3]

The concept of CAD CAM was first introduced to dentistry by Dr Duret in 1973 in Lyon, France in his thesis entitled Empreinte Optique, which then translates into Optical Impression.

It was further developed by Dr. Mormann, a Swiss Dentist, and Mr. Brandestini, who was an electrical engineer.[4] CEREC, was the first commercially available CAD-CAM system which employed a digital impression system in the field of dentistry. They construct a virtual computer-generated copy of the hard and soft tissues with the help of lasers and other optical scanning machines. Theiradvantages include greater accuracy and precision, reduce chairside operator time, simplify treatment planning, and also effectively reduce the overall treatment time.[5]

For many decades, conventional impression techniques have been used to make impressions of the teeth and surrounding soft tissues. With the advent of digital impressions techniques, Intra-Oral Scanning (IOS) has become the preferred choice of impressions making.[6,7] Here, using digital intraoral impressions, we easily circumvent the limitations of conventional impressions like polymerization shrinkage and distortions following improper handling or disinfection. Also, the fabrication of stone models, their handling and disinfection as well as need to transport them to the lab are all overcome with digital intraoral impressions.[8,9] Digital impressions by Intra-Oral Scanning have been documented to be significantly more accurate, easier to perform and is definitely more comfortable to the patient than conventional impressions.

These intra-oral scanning devices primarily capture the shape and size of the dental arches through the emission of a light beam.[5]They project a light source (structured light or laser) onto the dental arches, tooth surface or implant scan bodies through high resolution cameras. The information collected by these imaging sensors is then processed by powerful scanning software that reconstructs the three-dimensional (3D) model of the desired structures virtually by generating point clouds which are triangulated by the same software.[10] These 3D surface models of the dento-gingival tissues, which are the result of the optical impression, are the ‘virtual’ alternative to traditional stone models.[11]

II. MAIN INTRAORAL DIGITAL IMPRESSION SYSTEMS

1. WOW SCANNER
2. CEREC SYSTEM
3. LAVA C.O.S SYSTEM
4.iTero SYSTEM
5. E4D SYSTEM
6. TRIOS SYSTEM

III. WOW SCANNER

The WOW intraoral scanner was introduced by Biotech Dental in 2019. The scanner has aintraoral video camera where recording of the anatomic structures was done creating a 3D model. WOW starter kit consists of black gloves, black suction tips and black clip-on scanning guides, which means that WOW scanner does not see the colour black while in operation which enables to retract the soft tissues making it easyfor the scanner to identify the artefacts. Scanner also includes a laptop which is not seen with other intraoral scanners. Both quadrant scanning and full arch scanning was done by the scanner. The main feature was that it does not require any powders or scan sprays and produces a hyper-realistic colour image. It is the smallest scanner and also smaller than TRIOS scanners, Medit i500. It is very lightweight weighing onlyabout 110 grams.

IV. CEREC SYSTEM

The CEREC 1 system (Sirona, Bensheim, Germany) was introduced in 1987 together with the Duret system as the first intraoral digital impression and CAD/CAM device.This system was designed with the concept of “triangulation of light,” in which the intersection of three linear light beams is focused on a certain point in 3D space. Surfaces with uneven light dispersion adversely reduced the accuracy of scans. Therefore, the adoption of an opaque powder coating of titanium dioxide was required for producing uniform light dispersion and increasing scan accuracy.

Another widely used system is the CEREC system. Currently it is in its fourth-generation product known as CEREC AC Bluecam. It captures images using visible blue light emitted from an LED blue diode as its light source. The CEREC AC Bluecam can capture one quadrant of the digital impression within 1 minute and the antagonist in a few seconds. The newest CEREC system is the CEREC Primescan (2019). Primescan promises to be faster, easier to use, and more accurate than the CEREC Omnicam. The scanning area of the Primescan measures 15 mm by 15 mm, while that of the Omnicam is 10 mm x 11 mm. It has same kart design as the Omnicam with mouse cursor controlled with a touch pad with two smaller regions underneath corresponding to the left and right mouse buttons. It also has a larger scanning field than other intraoral scanners which uses specific wavelength of blue light that can accurately capture the surface data. The CEREC Omnicam introduced in 2012 is one of the most widely used systems. The Omnicam imaging technique has a continuous imagingtechnique, where consecutive data acquisition generates a 3D model, whereas in Bluecam imaging isusually single image acquisition. Omnicam can be used for a single tooth, quadrant, or full arch, but Bluecam can only be applied for a single tooth or quadrant. Powder-free scanning and precise 3D images with natural colour are the most prominent features of Omnicam.

Tooth surfaces with uneven light dispersion adversely reduce the accuracy of scans. Coating of titanium dioxide before scanning is done to induce uniform light dispersion and improve scan efficacy. When digitally scanning, the dentist holds the scanner and aims the camera towards the area to be scanned. The camera tip should be few millimetres away from the tooth surface orit should just slightly touch the surface. The camera is held over the teeth in a single direction gently to generate the successive data into a 3D model. This seamless scanning process can express a notable depth of field. Besides, the scan can be interrupted and resumed at any time by the operator. Shake detection system has ensured the 3D images are only captured when the camera is stable and still, so itpossibly avoids inaccurate data due to shaking or trembling of the operator’s hand.

When scanning is complete, the preparation can be seen on the monitor and can be viewed from different angles. A virtual die is cut on the effective model, and the finish line is outlined directly on the die image. Then, CAD system bio generic software proposes an idealized restoration design and the operator make final adjustments using several on-screen tools. Once restoration is satisfied and properly done, the operator can mount a block of ceramic or composite material with the desired shade in the milling unit and start to produce the final restoration. During the design stage, color-coded tools determine the degree of interproximal contact and ensured that the finished restorations require minimal adjustments, if any, before cementation.

The operator captures the image digitally and fabricates a restoration in a single visit or can transfer the data to the dental laboratory by CEREC Connect, where the restoration can be virtually designed and then it is milled by skilled laboratory personnel. This type of intraoral scanner can be used for single crowns, veneers, inlays, onlays, and implant-supported FDPs. For crowns over implants, the prepared abutment can be directly scanned, or a scan body seated on the implant can be scanned by the dentist.[12]

V. 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. It works below the principle of active wavefront sampling. This percept refers to acquiring 3D data from a single-lens imaging system. Three sensors can capture clinical images from various angles simultaneously and generate surface patches with in-focus and out-of-focus data by proprietary image-processing algorithms. Twenty 3D datasets may be captured per second, embodying over 10,000 data points in each scan. This lets the system to produce a precise scan out of 2400 more datasets (or 24 million data points). The manufacturer states that the high data redundancy ascribed to many overlapping pictures guarantees the highly accurate image quality. The Lava C.O.S. has a small scanner tip measuring only 13.2mm in width. The scanner sends out pulsating visible blue light as a light source and works with a mobile host computer and a touch-screen display. Similar to CEREC AC Bluecam, the Lava C.O.S. also requires a powder coating spray on the tooth surface before scanning. After the mouth is rinsed and air-dried, the particular powder (LavaTM powder for chairside oral scanner; 3M ESPE) is sprayed on the tooth surface to form a homogeneous layer. The dentist begins with the posterior tooth area and move the camera ahead, ensuring both buccal and lingual sides are captured. The Lava C.O.S. can display the images seized from the mouth on the touch screen at the same time. With real-time visibility, dentists can right away see if they are receiving enough facts from the preparation. Once it is confirmed that all necessary details were captured at the preparation scan, a quick scan of the rest of the arch is needed. If the scanning shows a critical missing or blurry area, the dentist without a doubt rescans this specific area, and the software can be amended automatically. The dentist now scans the opposite arch in the same manner. Finally, a scan from the buccal side with the patient in occlusion is taken, and the system will articulate the maxillary and mandibular teeth automatically to create a bite record. After reviewing all the scans, the dentist can fill out an on-screen laboratory prescription. The data are wirelessly transferred to the laboratory, where a technician cuts the die accordingly and digitally marks the margin with customized software. The digital data are virtually ditched after being transferred to 3M ESPE. Afterward, the data is normally articulated with the opposing and bite scans. A stereolithography (SLA) model is created by the manufacturer and delivered to the laboratory. All types of finish lines may be reproduced on the SLA dies, allowing for any type of crown to be manufactured by the dental laboratory.[12]

VI. iTero system

Cadent Inc. (Carstadt, NJ) introduced iTero in 2007. The iTero system captures intraoral surfaces and contours by laser and optical scanning primarily based on the principle of parallel confocal imaging. A total of 100,000 points of laser light at 300 focal depths of the tooth structure can be obtained during one scan. These focal depth images are separated at the level of approximately 50 µm, allowing the camera to acquire precise data of tooth surfaces. Parallel confocal scanning with the iTero system can capture all structures and materials in the mouth without coating teeth with scanning powders. This system uses a red laser as a light source and consists of a host computer, a mouse, a keyboard, a screen, and a scanner. When the prepared tooth is finished by rinsing, retraction, haemostasis, and air drying, the dentist puts the scanner over the tooth and starts the scan process. Scans over prepared teeth should involve the occlusal, lingual, buccal, and interproximal contacts of the adjacent teeth. The system requires a rescanif any shake is detected. After completion, a 45° angle view from buccal and lingual directions of the remaining teeth in the arch and opposite arch are accomplished. Lastly, a buccal scan of the patient’s centric occlusion is obtained. The device will carry out a virtual bite registration instantly.[12]

VII. TRIOS system

In 2010, 3Shape (Copenhagen, Denmark) launched a new type of intraoral digital impression system, TRIOS, which was presented to the market in 2011. This system works below the principle of ultrafast optical sectioning and confocal microscopy. The system identifies variations within the focus plane of the pattern over a range of focus plane positions while maintaining a fixed spatial relationship between the scanner and the object being scanned. Furthermore, a quick scanning speed of up to 3000 images per second reduces the influence of relative movement between scanner probe and teeth. By analyzing a large number of pictures obtained, the system can create a final digital 3D model instantly to reflect the real configuration of teeth and gingival colour.

Similar to the iTero and E4D systems, the TRIOS intraoral scanner is a powder-free device in the scanning process. The TRIOS system boasts an essential trait, “the variation of the focal plane without moving the scanner in relation to the object being scanned.” The operation of TRIOS is relatively simple. The dentist holdsthe scanner at a range of distances to the tooth. Either closely over the tooth or 2 to 3 cm away will not affect the focus and the capturing of images. The 3D profiles of teeth and gingiva are generated simultaneously, while the dentist moves the scanner gradually above them. After scanning the upper and lower teeth, a buccal scan can be taken when the patient closes into an intercuspal position. The system of the host computer will implement a digital registration to create a 3D occlusion relationship. TRIOS consistof two parts: TRIOS® Cart and TRIOS® Pod. The TRIOS® Pod offers better mobility and flexibility due to its easy construction with a handheld scanner only and its compatibility with other computer systems. For both the TRIOS® Cart and the TRIOS® Pod scanner, clinicians can pick out either a TRIOS® Standard or a TRIOS® Color solution program. The latter is capable of capturing and demonstrating the teeth and soft-tissue images in real colour. The TRIOS system provides scanning of crowns, FPDs, veneers, inlays, onlays, implants, and orthodontic cases. With the introduction of TRIOS® Color, it is expected that the patients with a removable partial denture or complete denture could be intraoral scanned directly in the future. The TRIOS system is an open system that can export 3D data as an STL file or a proprietary file. The STL file can work together with other CAD/CAM systems. The proprietary encrypted file can only be designed by 3Shape’s specific CAD software and 3Shape Dental SystemTM. Moreover, TRIOS is a professional digital impression acquisition with CAD system and does no longer consist of a CAM milling device.[12]
The most recent version of Trios is 3Shape Trios 4 Wireless which was presented in Cologne in March 2019.

VIII. MANIPULATIVE CHARACTERISTICS

The operator will make a standard preparation of the abutment tooth for FPD preparation. Two retraction cords are used to expose the margins which are placed in the gingival sulcus. After waiting for 5min when the sulcus has expanded properly the area to be scanned is rinsed and dried. According to system powder application is done according to the manufacturer’sinstructions. The coronal cord is then removed and spraying is done over the area of the removed cord. After that the process of scanning is initiated. The scanner tip is allowed to capture various images of the prepared tooth from different angle. The system can figure out if the scan is accurate or if rescan is necessary. After the scan of the prepared tooth is completed, the scanning of the opposite arch can be initiated. The final digital scan from the system is then transferred to the technician for CAD/CAM process, designing and manufacturing.[12]

IX. DISCUSSION

Digital impression scanners eliminate tray selection, dispensing and setting of impression materials, no hypersensitivity reactions, disinfection, and impression shipping to the laboratory. Patient comfort and education are additional advantages. Furthermore, the laboratory saves time by no longer having to pour base and pin models, cut and trim dies, or articulate casts. Digital scanning datasets are saved on computer hard drives, whereas conventional stone casts must be stored physically, which regularly requires extra space in the dental office, and are subject to damage.

X. CONCLUSION

Digital dentistry is changing the manner in which clinicians can provide indirect restorations which can be highly precise restorations made on accurate models. This increases the chair side productivity with advanced lab communication. The conventional impression materials like poly (vinyl siloxane) and polyether are well developed and present great accuracy in many prostheses. However, the intraoral digital impression technique has a distinct superiority in work efficiency and reduced material utilization. All materials and techniques developed in dentistry aim continually reduce the technique sensitivity and improve patient comfort with predictable accuracy.[3] Intraoral digital scanners have come an extended manner and the clinician’s acceptance and usage now becomes vital to make this digital workflow a success. It is also apparent that traditional impressions will stay for certain indications. For digital impressions to become a routine procedure, the purchase of the equipment and the initial learning curve are the primary requisites. But the future is definitely digital dentistry. Further improvement in the intraoral digital impression techniques and reduced initial costs will result in its widespread use in dentistry.[4,5]

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