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Digital Impressions: Evolution or Revolution– A Review

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Review Article

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ABSTRACT

Digital and manufacturing technology is evolving on a large scale and the use of these technologies in the field of dentistry has become a major trend for diagnosis. Computer-aided design/computer-aided manufacturing technology has drastically modified dentist's method of treatment planning and restorative workflow. As the CAD/CAM market evolved, new scanners, designing software, mills, and printers are added. New materials are under development, and current software is still being modified. To overcome the shortcomings of the traditional impression system, digital impressions were familiarised. These systems are more efficient and effective. Sophisticated digital scanners and software programs are included in CAD / CAM to capture the amount of information and manipulate the collected data needed to fabricate custom milled restorations in dental practices.

Keywords: Accuracy, CAD/CAM, Digital Impression, Intraoral Scanners, Milling Units, Optical Impressions.

Introduction

Fabrication of well-fitting indirect prosthetic restoration is an art in which impression making plays a critical role. Digital impressions were technologically advanced to construct the restoration easier, faster, and more accurate. Since 1971 CAD/CAM has become a growingly common part of dentistry. The development of CAD/CAM is the result of work carried out by three pioneers. Dr. Duret was the first one who introduced the Sopha system, afterward, Dr. Morermann developed the CEREC (Chairside Economical Restoration of Esthetic Ceramics) system and Dr. Andersson developed Procera (Nobel Biocare) System. This technique is used both in the laboratory and also in the dental clinic; it can then be extended to inlays, onlays, veneers, crowns, cast partial dentures, implant abutments, and even full- mouth reconstruction. The development of CAD/CAM technology helped in solving 3 major challenges. The primary challenge was maintaining sufficient strength in the restoration of posterior teeth. To fabricate prosthesis with a natural aspect was the second challenge and doing restorative procedures faster, easier and accurate was the third challenge. Using the CAD/CAM technology, single-visit restorations can be provided to patients. Historically, with the aid of physical tooth impressions, clinicians have produced indirect restorations created from the material used to make an impression. This process has several weaknesses including flaws in impression and errors in laboratory production.[1] CAD/CAM is utilised to obtain a digital scan of oral tissue followed by chairside or laboratory production of a prosthesis.

CAD / CAM production steps in dentistry: Production concepts in CAD/CAM are based on the location of the system such as chairside production, laboratory production, and centralised fabrication in the production centre.[2] When all the parts of CAD / CAM systems are situated in the working area of the dental unit, dental restoration, and fabrication can be done by the chairside without a laboratory procedure. The best benefit of chairside development is that it saves time and, at a single visit, provides patient indirectly produced restoration. An intraoral scanner is used in this procedure, which replaces the conventional impression fabrication, in the majority of clinical circumstances. CEREC device currently works with water cooling, from glass, ceramic to high-performance oxide ceramics; a range of materials can be processed. For CAD/CAM produced inlays, scientific literature has reported a success rate of 90 percent after a follow-up of 10 yrs and 85 percent after a follow-up of 12-15 years.[3-5] Traditionally, this was the first system in dentistry and currently available in the 5th generation.[6] The laboratory procedure, that follows, after recording the impression, is similar to the conventional impression system. Impressions are taken to the laboratory where the master cast is fabricated. CAD/CAM measures later are performed in the laboratory. Scanners are used to scan the model and obtain three-dimensional data that is processed using software for the dental design. Once the scanning is complete, data will be transmitted to special milling devices in the dental laboratory which produces real geometry. Finally, the precision of the construction can be determined and corrected, if necessary, on the basis of the master cast. The method of veneering the frame in a powder layering or over-pressing technique is carried out later on by ceramist.[7-10] The third method of computer-assisted dental prosthesis development is centralized milling center development. In this process; satellite scanners within the dental unit are often connected via the web to the assembly center. Data produced in the laboratory is forwarded to the CAD/CAM manufacturing center. The first two steps in development are carried out in the dental working area, while the third step takes place at the centre.[8,11] The key advantage of outsourcing CAM production is that small investment requirement because only the digitalisation tool and software is to be purchased.

Components of CAD/CAM: Scanner, designing software and processing devices are the three main components of CAD/CAM which are essential for fabrication of any restorations. Scanners are the one that helps to measure 3-dimensional jaw and tooth structures in data collection and then finally turns them into digital data set. Scanning principle is basically differentiated into two main broad categories, that is optical scanner and mechanical scanner.[2]

The basic concept of an optical scanner is to obtain[3] dimensional structures which are often called a "triangulation process." An angle is formed between the sources of light (e.g., laser) and the receptor, which is in a definite angle in their relationship with one another. Through this angle, the computer calculates a 3-dimensional image data collection on the receiver unit.[12] Lava Scan ST (White light projection), Everest scan (Kavo, White light projections) are some examples of optical scanners. In the case of a mechanical scanner, a ruby ball is used to mechanically read for the master cast, and a 3- dimensional structure is calculated. Procera scanner from Nobel Biocare is an example of a mechanical scanner in dentistry.[2] This scanner has a high precision rate. This mechanical scanner has a ruby ball in it, which is set to the smallest grinder mode. Milling of the prosthesis can also be done from the data obtained from the scanner.[8,13] Designing software is supplied by the manufactures for the designing of various kinds of dental restorations. Construction of fixed dental prosthesis can be done using such software.[14] Data obtained from the constructions can be held back in various formats and the language used is Standard Transformation Language (STL).[12] All the data which are produced by means of CAD software are transferred to the milling unit for processing and loaded into the milling device. Depending upon the milling axes, processing devices are categorized into 3-axis, 4-axis, 5-axis. 3-Axis milling devices allow the movement in three, spatial directions. Thus the mill points are determined uniquely by the values of X, Y, Z. This 3- axis device can turn the component by 180 degrees during processing time. These milling devices have the advantages of short milling times and direct control across the three axes. As a result, such as milling machines are typically less expensive than those with a larger number of axes.[2] e.g. of 3-axis devices: Lava (3 M ESPE), Cercon brain (DeguDent) in Lab (Sirona). In 4- axis milling devices; along with three spatial planes, tension bridge can be turned infinitely. Bridge constructions with a wide vertical height displacement can therefore be modified into the normal mould dimensions, which also save time and material. In 5-axis milling devices; along with three spatial planes, a rotatable tension bridge (4th axis), has a possibility of rotating milling spindle. These aids in the milling of complex geometries, such as lower jaw FDP on converging abutment teeth, or crown and FDP substructures which display converging anatomically decreased presence of areas on the outside of the frame.

Milling in CAD/CAM: Dry processing is done with blanks of zirconium oxide with a low pre-sintering degree. The advantages of dry milling are negligible expenditure of the milling process, no moisture absorption by the die moulds, resulting in no initial drying times for the zirconium oxide frame before sintering, whereas low pre-sintering results in higher shrinkage values for the frame.[15] Wet milling is the process in which cool liquid spray is used to prevent the diamond or carbide cutter from being overheated by milled material. In wet milling, the processing is necessary for all metals and ceramic glass content to avoid harm by heat development.[15] Spark erosion, an electric current is used for the metal removal process under carefully regulated conditions. Used in fixed, removable, and implant prosthesis fabrication.[16]

Materials used: Materials used for CAD / CAM equipment processing rely on the respective production method. Following materials can normally be processed on dental CAD/CAM system as shown in table 1:

Sr. No.	Materials	Uses
(1)	Metals	Titanium, titanium alloys and alloys made from cobalt chrome are manufactured using a milling machine. It is not economical to mill these precious metal alloys because the cost of these alloys is very high and these alloys are prone for the attrition.
(2)	Resin Materials	Milling of the lost wax frames can be done using resin materials or these materials can be directly used as a framework. Example is paradigm MZ100 [2]
(3)	Silica Based Materials	They are manufactured in porous, chalky condition and then infiltrated with lanthanum glass. They originate from the Vita in-Ceram system and offered in three variations.
(4)	**Infiltrated Ceramics**	
	Vita In-Ceram Alumina (Al_20_3)	Used for anterior and posterior crown copings; 3 unit FPD system in the posterior region[18,19]
	Vita In – Ceram Zirconia (70% Al_20_3, 30% ZrO_2)	Used for anterior and posterior crown copings; three unit FDP frameworks in anterior and posterior area. This ceramic can also be used for *discoloured* teeth[18,19]
	VITA In-Ceram Spinell ($MgAl_2O_4$)	Development of highly esthetic anterior crown copings is recommended as it has the utmost translucency of all oxide ceramics.[18,19]
(5)	Aluminium Oxide (Al_20_3)	Initially this high quality ceramic is ground and then sintered at 1520° C temperature. Crowns of maxillary and mandibular anterior as well as posterior region can be produced using aluminium oxide.
(6)	Yttrium stabilized zirconium oxide(ZrO_2,Y-TZP)	It is a high-performance ceramic oxide, with excellent mechanical properties. Compared to other dental ceramics it has high tensile strength and resistance to fracture.[2,15]

Conclusion: As we know, these systems are improving in versatility, accuracy, cost-effectiveness, it will be a part of routine dental practice in the coming time. But due to the cost-effective use of these systems in dental practice is limited. Dentists should get training and access to these systems, technologies, and developments in order to incorporate its use on a routine basis to obtain a better outcome. Utilizing the concept of the conventional method along with the new system will help us in meeting the patient demands.

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