OPINION

IMPRESSION MAKING IN FIXED PARTIAL DENTURE: TRADITIONAL OR GO DIGITAL?

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ABSTRACT

Digital technology, today controls every aspect of our life and dentistry is no exception to it. Impressions made using elastomeric impression material is an everyday procedure in almost every general dental practice, for the production of bridges, crowns and dentures. The great success of the indirect fabrication of intracoronal/extracoronal restorations such as inlays and onlays, advancing to full coverage gold, metal-ceramic,on all ceramic crowns, have been facilitated by the development of accurate elastomeric impression materials and die stones.[1] The concept of digital impression is emerging rapidly on the horizon and it is believed that digital impression will solve the challenges and difficulties of the conventional impressions

KEY WORDS
digital impressions, CEREC, CAD/CAM

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History

The history of today's traditional impression materials began in the mid-1930's with the introduction of reversible hydrocolloids. By the year 1955, the polysulfides were introduced and for the first time an elastomeric impression material was used. There was a great improvement in reproducing the characteristics of prepared teeth, but still there were inherent problems like shrinkage and dimensional instability of material.

In 1966, further improvements in impression materials occurred with the introduction of polyether. This material proved to be far superior to the hydrocolloids followed by silicones in 1976. Although they are hydrophobic by nature, they are highly dimensional stable even in the presence of a moist environment, resulting a superior elastic recovery. With the advancement of time and technology improvements are made to these materials to reduce tearing, chairtime and enhance the patient comfort.

Evolution of digital impression

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. The first commercially available digital impression system for use in the field of dentistry was introduced in 1980 pioneered by PROCERA and CEREC. Over the last 10 years, systems like 3M LAVA COS, Cadent iTero,E4D dentist and 3Shape Trios have been introduced. Each employs a specific, distinct technique for making impression.

Disadvantages of conventional impression materials

In comparison to digital impressions, conventional elastomeric impressions have various limitations which could be a direct or indirect result of factors such as choice of tray, choice of material, manipulation of the materials or certain inherent properties of the material used. The errors or misjudgment on the dentist part to select a tray is the foremost error that can take place. While placing the tray or during its removal, movement by patient can cause errors in the impression. Dimensional stability of the set materials is also another major limitation. Flow of the material, hydrophilicity, voids, inadequate wetting, tearing, and deformation are some of the disadvantages of elastomeric impression. The errors that could occur during the fabrication and steps in making the prosthesis can be eliminated by the digital impression.

Types of CAD/CAM production concepts

The three different production concepts are available, depending upon the location of the components are

- Chairside production
- Laboratory production
- Centralized fabrication in a production center

(a) Chairside Production

All of the CAD/CAM systems are located in the dental clinic. The chairside production, fabricates final dental restoration at chairside without laboratory procedures. The intra-oral camera (the digitization component) replaces a conventional impression in most clinical situations. This saves the patient multiple appointments and also the cost for indirect fabricated restorations. Although this production concept is very convenient, it's not very economical.

(b) Laboratory production

In this production system, the traditional working sequence between the dentist and the laboratory is carried out. The dentist makes an elastomeric impression and sends the cast/model to the laboratory. The CAD/CAM steps are carried out completely in the laboratory. By the assistance of the scanner, 3D data is produced on the basis of the master die. This data is produced by the means of a dental design software, and then sent out to the milling device that produces real geometry in the dental laboratory. After this, the exact fit of the framework is evaluated and corrected on the basis of the master cast, if necessary. The ceramist then carries out the veneering of the framework in the powder layering or overpressing technique.

(c) Centralized Production

In this computer-assisted production of dental prosthesis, centralized production is done in a milling center. The 'satellite scanners' in the dental laboratory are connected with a production center via the internet. The data is sent to the production center for the production of the final restoration with a CAD/CAM device. Finally, the production center sends the prosthesis to the responsible laboratory [2].

Components of CAD/CAM

CAD/CAM machinery, irrespective of the system, consists of three basic components:

Scanner

The data collection tools are called as scanners. It scans and collects three dimensional data of jaw and tooth structures and transforms them into digital data sets.

Design Software

The software is provided by the manufacturers for the design of various kinds of dental restorations. With such software, various restorations like, crowns and fixed partial dentures (FPD's) frameworks, full anatomical crown, partial coverage crowns, inlays, inlay retained FPD's as well as adhesive FPD's etc are fabricated. The software of CAD/CAM systems available are continuously upgraded in the market. Various data formats are available for storing the data of the three dimensional construction. The basis for data storage is often standard transformation language (STL) data.
Many manufacturers use their own data formats, specific to that particular manufacturer.

Processing Devices

The data, which is produced by the CAD software is converted into milling strips for the processing of CAM and then finally loaded into the milling device.
Processing devices are distinguished by means of the number of milling axes:-

- 3-milling axes devices
- 4-milling axes devices
- 5-milling axes devices[2]

Milling variants

Dry processing

Dry processing is applied with respect to zirconium dioxide blanks with a low degree of pre-sintering.
This offers several benefits:-

- Minimal investment costs for the milling device.
- No moisture absorption by the die (zirconium dioxide mould), as a result of which there are no initial drying times for the zirconium dioxide frame prior to sintering.

Disadvantages: The low degree of pre-sintering results in higher shrinkage values for the frameworks.

Wet milling

In this process the milling diamond or carbide cutter is protected by a spray of cool liquid to protect against overheating of the milled material. This kind of processing is necessary for all metals and glass ceramic, materials in order to avoid damage through heat development. Wet processing is recommended, if zirconium oxide ceramic with a higher degree of pre-sintering is employed for the milling process. A higher degree of pre-sintering results in a reduction of shrinkage factor and enables less sinter distortion.

Open and closed architecture

There are two important categories of digital impressions systems in terms of data files created during scanning:- open and closed architecture. Open architecture files, typically termed as STL files, are not dependent on the manufacturer and can be used in virtually any design software to fabricate a final restoration. Open architecture systems allow the individual dentists to work with several different laboratories and maximize the potential of their investment with options such as implant restorations etc. Closed system software architecture collects and manipulates data modules by the same manufacturer, offering laboratory owners security and a one stop shop for resolving problems. For laboratories which do not want to immerse themselves in all the new technologies and software from each different manufacturer, closed architecture systems generally do a great job of taking the user by the hand from the start to finish [3].

Procedure

The dentist captures the image of the tooth/teeth involved using the digital impression system. Some digital impression systems use a reflective powder which is a specially formulated titanium dioxide powder in order to scan both arches and bite and this is done once the area to be treated is anaesthetized and free of saliva and blood. Some other systems for example, Cadent iTero allow dentist to create a three dimensional image of the patient's teeth without the use of reflective powder. The intraoral wand/scanner is inserted into the patient's mouth and moved over the surface area of the tooth or teeth. Chairside monitors are usually used to display the captured picture of the impression image. Approximately 90 seconds are required to capture the digital impression of prepared teeth and 45 seconds for the opposing arch.

Enlargement and adjustments can be done for enhanced detail to ensure any possible mistakes to be identified and corrected onscreen before sending it to be milled. The delivery workflow depends upon the digital impression system used by the dentist [4].

Tissue management

Management of soft tissue during the preparation and impression taking stages is critical for the success of the final impression, for both traditional and digital methods. Although supragingival margins are the most effective way to achieve visualization of the margin, in many situations, an equi-gingival or a sub-gingival margin may be required. A dual-cord retraction technique is recommended in such situations.

After the preparation, a thin cord is placed and an initial scan is made. The areas on the preparation that need modification are identified and the preparation is refined. A hemostatic agent maybe used, and a thicker cord is placed for 5minutes. The final scan is then accomplished. A great deal of attention needs to be placed on the soft tissue management to ensure the camera has an unobstructed view of the margin, as the scanner cannot distinguish debris and soft tissue from the sound tooth structure[5].

Scanning systems

CEREC (chairside economical restoration of esthetic ceramic [SIRONA]) uses optical scanning and requires the entire area to be captured in the impression to be coated with a reflective powder. It is based on the principle of laser triangulation.

Table 1: Various CEREC Systems

YEAR	HARDWARE	SOFTWARE CAPABILITY	RESTORATION TYPE	DEVELOPER
1980	Basic concept	Two dimensional	Inlays	Mormann(university of Zurich) and Brandestini(brandestini instruments, Zurich)
1985	CEREC 1	Two dimensional	First chairside inlay	Mormann and Brandestini
1988	CEREC 1	Two dimensional	Inlays(1), Onlays(2), and veneers(3)	Mormann and Brandestini

1994	CEREC 2	Two dimensional	1-3, partial(4) and full crowns(5) and copings(6)	Sirona (Munich, germany)
2000	CEREC 3 & inLab	Two dimensional	1-6 and three unit bridge frames	Sirona (Bensheim, germany)
2003	CEREC 3 & inLab	Three dimensional	1-6, and three and four unit bridge frames	Sirona
2005	CEREC 3 & inLab	Three dimensional	1-5, and automatic virtual occlusal adjustment	Sirona

Courtesy- The evolution of the CEREC system. JADA 2006:137:7S-13S.[6]

The E4D dentist system (D4D Technologies) uses laser scanning (high speed swept laser scan) and requires no reflective powder. Like the CEREC system, the E4D system can be connected directly to a milling machine to create the restoration.

There are two digital impression systems, introduced in 2008 that are not connected directly to a milling machine. It uses a red light laser to reflect off the tooth structure. The iTero system (cadent) uses a camera that takes several views (stills) and uses a strobe effect and the use of reflective powder is not required with this system. This system does not require the aid of the reflective powder to facilitate the impression .The LAVA COS (Chairisde oral scanner) (3M ESPE) uses light powder to facilitate scanning by an optical video system. It takes a completely different approach by using the continuous video stream of the teeth. Adequate tissue retraction and fluid control is very important for all of these systems.[7]

Other Dental CAD/CAM systems:-[8]

- ZENOTec (Weiland Dental & Technik GmbH & Co KG)
- Hint-ELs DentaCAD system (Hint-ELs, Griesheim, Germany)
- Cerasys (Cerasystems, Buena Park, CA)
- Wol-Ceram (XPdent corporation, Miami FL)
- BEkGO Medifacturing (BEGO Medical GmbH, Bremem, Germany)
- Tturbodent System (u-Best technology Inc. Anahiem, Germany)
- Etkon system (etkon USA, Arlington, TX)
- iTero (Cadent, Carlstadt NJ, US

Table 2: Comparison of Common Dental CAD/CAM Systems

SYSTEM	MARKET LAUNCH	PROCESS CENTRE	SCANNING MECHANISM	CAD PROGRAM	CAM PROCESS
Cerec 3	2000	Chairside	Optical	Yes, custom design and database	Fully Automatic
Cerec InLab	2001	Dental Lab	Laser	Yes, custom design and database	Fully Automatic
DCS Precident	1989	Dental Lab	Optical	Yes, custom design and database	Fully Automatic
Procera	1993	New Jersey or Sweden	Manual	Yes, custom design and database	Fully Automatic
Lava	2002	Dental Lab	Optical	Yes, custom design and database	Fully Automatic
Everest	2002	Dental Lab	Optical	Yes, custom design and database	Fully Automatic
Cercon	2001	Dental Lab	Laser	No	Fully Automatic

Courtesy: Panorama of Dental CAD/CAM restorative systems. Compedium, July 2005:26(7):507-512.[9]

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Images retention and transmission

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. The form that digital transmission takes for the indirect CAD/CAM methods depends on the system used. The lab can create a physical model and fabricate restorations traditionally from any material, or design and fabricate restorations using CAD/CAM, depending upon the system.

Materials used

As materials evolve, there is a continual push towards strong-yet esthetic restoration. Depending on the milling unit, there are many material choices now available in the form of CAD/CAM blocks. Restorations can be milled from a variety of materials such as composites, feldspathic porcelain, leucite-reinforced ceramic, lithium disilicate ceramic and zirconia.

Wax patterns and acrylic provisional restorations can also be milled. Metals, resins, composites and ceramics can also be milled by the processing devices. Commercially pure titanium, titanium alloys and cobalt chrome alloys are metals commonly used in the devices. Resins can be milled to create lost wax frames for casting and also for long-term provisional prosthesis. Composite blanks that are prefabricated to mimic enamel and dentin in their translucency and color can be milled to create final anterior restorations. Zirconia is a high performance ceramic with excellent mechanical characteristics. It is used in milling devices for crowns, fixed partial prosthesis and implant abutments [10].

DISCUSSION

The conventional impression procedure involves the necessary steps of tray preparation, impression making and disinfection of the impression. All the dental lab steps are followed and the prosthesis is fabricated and then delivered to the patient. Multiple steps and visits are required for the prosthesis to be finally delivered to the patient. In comparison to the conventional methods, the occlusion, the fit, the quality of contacts and the long-term survival rates of the CAD/CAM crowns have been found to be better[10].It provides improved precision and consistency and allows the clinician to visualize the preparation on a computer display from many perspectives. The occlusion, fit, accuracy can be checked on the computer by the software which cannot be done with the traditional methods. It allows the clinician to design the restoration on a computer while visualizing the opposing dentition. It provides a clean and streamlined impression. It also helps in reduction of the environmental impact of disposing the materials required for conventional impressions. The clinical outcomes have shown that performance of restorations produced by the CAD/CAM systems have improved drastically in the last decade.

However, due consideration should be given to the fact that the equipment required for the digital impressions and milling is expensive. It neither economical for the patient or the dentist. Digital equipments are complex and require trained personnel for its operation and to maintain the device. Up-to-date lab support is also essential. Those with limited mouth opening may have difficulty with the scanner.

Inspite of all the benefits of these new methods, the dentists working procedures will have to be adapted to the methods of CAD/CAM and milling technology. These include appropriate tooth preparations with creation of a continuous preparation margin, which is clearly recognizable to the scanner. Shoulder-less preparations and parallel walls should be avoided. On the basis of present knowledge, a tapered angle of between 4 degree and 10degree is recommended. Subsections and irregularities on the surface of the prepared tooth as well as the creation of troughs with a reverse bevel preparation margin can be inadequately recognized by many scanners. In addition, sharp incisal and occlusal line angles are to be rounded. Sharp and thinly extending edges as well as 90degree shoulder margin in a ceramic restoration can result in a concentration of tension and at the same time, sharp edges cannot be milled exactly using rounded grinders in the milling device [2]. A radial (120°) shoulder or a chamfer would probably be the most preferred finish line.

CONCLUSION

Over the past 10 years, CAD/CAM has developed at a rapid pace, and it is likely that integration of different systems will become the industry norm. Smaller intraoral scanners that require no cart are already appearing in the market, as well as those that do not require contrast medium. More and more dentists are purchasing dental impression systems with numerous advantages of digital impression over traditional impression and the ability to benefit from the digital impression taking and/or CAD/CAM. It will likely be a routine procedure in most dental clinics in the near future, as dentists, lab technicians and patients all reap benefits. CAD/CAM technology has already changed dentistry and will replace more and more of the traditional techniques in fabricating dental restorations. One thing is for sure that, from material selection to technique, CAD/CAM is changing the way clinicians look at dentistry.

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CONFLICT OF INTEREST
There is no conflict of interest.

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REFERENCES

[1] Shillingburg: Fundamentals of Tooth Preparation.

[2] Beuer F, Schweiger J, Edelhoff D.[2008] Digital Dentistry: An Overview of the recent developments for CAD/CAM generated restorations. British Dental Journal. 204:505-511p

[3] Sabiha S, Bunek DDS, Chris Brown, BSEE, Mary E. Yakas,BA, CMC [2014]. The evolving impressions of digital dentistry. Inside Dentistry.

[4] Nayda Rondon. Digital Impressions: Benefits and cost of a digital impression.

[5] Philip's Science of Dental Materials. First Asian edition.

[6] Mormann W. [2006] The evolving of the CEREC systems. JADA:137:7S-13S.

[7] Paul Feuerstein, DMD: CAD/CAM and Digital Impressions.

[8] Feuerstein P.[2007] New Changes in CAD/CAM: Part 2 lad systems. Inside Dentistry. 82-86.

[9] Perng-Ru Lui.[2005] Panorama of dental: CAD/CAM Restorative systems. Compedium, 26(7):507-512.

[10] Craig's Restorative Dental Materials. 13th edition.