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Digital Impressions In Fpd - A Systemic Review

Dr Anu.A.B,
Dr.L.Shashanka,
Dr.M.Krishnaveni,
Dr.R.Kamalakannan,
Dr.S.Gokul,
Dr.Sameera.Y

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I. INTRODUCTION:

A dental impression is an essential part of dentistry.· In order to reduce the inaccuracy with traditional impression technique and material.Computer-aided design/computer aided manufacturing (CAD/CAM) technology has been introduced in dentistry which resulted in more accurate manufacturing of prosthetic frameworks, and greater accuracy of dental restoration· (2).

From the 1980s, CAD/CAM technology has been utilized in dentistry to create implants, crowns, laminates, inlay and onlay fillings, fixed dental prostheses (FDPs), and laminates(3).The combination of IOS and CAD/CAM have provided ease for laboratory communication, reduced chair-side operator time, easier treatment planning· (1) The CAD/CAM system includes a data collection unit for converting teeth and structures into virtual impressions, software for designing virtual restorations, and a computerized device for manufacturing solid bocks of restorative material in the CAD and CAM phases(4).

Based on their ability to share digital data, CAD/CAM systems can be categorized as either open or closed (10). All CAD/CAM processes, including data collecting, virtual design, and repair manufacturing, are available in closed systems. The one-of-a-kind system incorporates each phase. Different systems cannot be used interchangeably. Open systems enable other CAD software and CAM equipment to use the original digital data.

There are still a number of challenges and issues with intraoral digital impressions that need to be fixed. The movement of the scanner throughout the scanning process is a significant issue that might compromise the accuracy of the scan.

This article focuses on classifications, concepts, and operation while reviewing some of the key intraoral digital impression devices that are currently available on the market. Additionally, we go through the variations between intraoral digital and traditional impressions.

II. HISTORY AND EVALUATION OF DIGITAL IMPRESSIONS:

Models have been created using impressions since the 18th century[5,6]. Dr. Charles Stent[5] created a device in 1856 using an impression material under his name to repair oral malformations. Agar impression material for crowns was put forward by Sears[7]. Impregum – 1st polyether elastomeric material was introduced by ESPE in 1965[8].

Condensation Silicone was created, however it had dimensional errors. Numerous issues, such as modulus of elasticity, flexibility, precision in measurements, tear strength, and a bad odor excellent flavour and flow were resolved with the introduction of Polyvinyl Siloxane[8]

Since the 1960s, CAD/CAM (Computer Aided Design/Computer Assisted Manufacturing) has been utilized in the production of cars and airplanes. Dr. Francois Duret used CAD/CAM for the first time in dentistry in his thesis on "Optical Impression" back in the 1970s. A CAD/CAM equipment was created and patented by Duret in 1984. He also demonstrated how to make a crown in under four hours. In 1985, Drs. Mormann and Brandestini created the first commercially successful digital impression technology, the CEREC1[9].

EREC 1 utilized a milling device and a 3-dimensional (3D) digital scanner to produce dental restorations from readily accessible ceramic material blocks in a single session. For the production of ceramic inlays and onlays, CEREC 1 was created. Sirona Systems was also licensed today by Dr. Mormann. In 1994, 2000, and 2003, Cerec 2, Cerec 3, and Cerec 3D were released[8].

MECHANICS BEHIND CAD/CAM:

The CAD/CAM systems include three main procedures:

1. A data collection unit, which collects the data from the region of the prepared teeth and neighbouring structures and then converted into virtual impressions,
2. Software for designing virtual restorations designed in virtual impressions and setting up the parameters,
3. A computerized designing device for manufacturing the restoration with solid bocks of the chosen restorative material. The first two parts of the system referred as the CAD phase, while the third is referred as the CAM phase. [(4)]

In order to remove traditional imprints, digital scanners are utilized to capture a picture of the teeth after they have been prepared. As previously said, data collection is accomplished using scanners with cameras that will gather pictures, restoration design is accomplished using software, and lastly the fabrication of the repair is done using a computerized milling machine[11]

The output and accuracy of computerized impressions can be affected by a number of variables; further research into imaging technologies, scanning methods, and screening approaches is needed to increase the accuracy and specificity of implant scan body visual acquisition. Many commercial brands created ISBs with various geometries and designs as digital technology enabled implant dentistry[12].[FIG:1]

There are three distinct regions that comprise the ISBS:

• Scan (correlating to upper part)
• Body (correlating to mid part)
• Base (correlating to the most proximal section of the body that links to the implants)

TYPES, SPECIFICATIONS, AND ATTRIBUTES OF SEVERAL DIGITAL SYSTEMS:

The two most popular digital impression systems on the market are the following:
CEREC System and Lava C.O.S System
The other systems include:
i Tero System
E4D SYSTEM
The Trios System

The elements that distinguish them from one another include the operation procedure, output file format, light source, operating principle, and need for powder coat spraying.

CEREC SYSTEM:

The first intraoral digital impression and CAD/CAM tool was the CEREC 1 system, which launched in 1987[11]. Three linear light beams are concentrated on a single location in three-dimensional space using the "triangulation of light" principle[13]. An opaque titanium dioxide powder coating is necessary for consistent light dispersion because surfaces with uneven light dispersion diminish scan accuracy[14]. The most widely used CEREC system is the CEREC AC Bluecam, which uses a visible blue LED blue diode to take pictures. The most recent CEREC system, CEREC AC Omnicam, which was released in 2012, allows continuous imaging and produces continuous data for a 3D model.

While Bluecam is only appropriate for a single tooth or quadrant, Omnicam may be utilized for single teeth, quadrants, or the entire arch. With its powder-free scanning and accurate, natural-colored 3D pictures, Omnicam is especially useful for wider scanning regions[15]. A shaking detection mechanism provides reliable data acquisition, and the operator may pause and resume the scanner.

Single crowns, veneers, inlays, onlays, and implant-supported FDPs can all be created with the CEREC technology. The prepared abutment can be immediately scanned for crowns over implants, or the dentist can scan a scan body that is situated on the implant. Dental impression data is exported from the CEREC system in a format that can only be read by Sirona's compatible CAM systems, including CEREC MC and CEREC In-Lab. The CEREC MC X and CEREC MC XL may now be utilized with CEREC AC Omnicom for the majority of indications and materials, including zirconium oxide[14] and FPDs, thanks to recent improvements. There are various stePs involved in CEREC system which is been shown of in FIG:2

Figure 2: Steps Involved In Cerec System

LAVA C.O.S SYSTEM:

An intraoral digital imprint tool called LavaTM C.O.S. was created in 2006 and released in 2008. It uses the active wavefront sampling concept to extract 3D information from a single-lens image system[16]. Twenty 3D datasets may be recorded by the device per second, each containing over 10,000 data points[17]. The Lava C.O.S. utilizes a touch-screen display and boasts the tiniest scanner tip—only 13.2 mm wide—among all smartphones[18]. Before scanning, a powder coating spray must be applied to the tooth surface in order to create a uniform layer. The technology may show photos on a touch screen, enabling dentists to check whether the preparation is providing them with adequate information. The information is wirelessly transmitted to the lab, where a technician uses specialized software to digitally mark the margin and cut the die in accordance with the data. As soon as the digital data are sent to 3M ESPE, they are essentially discarded. Any kind of crown may be produced by the dental laboratory thanks to a stereolithography (SLA) model that the manufacturer creates and sends there[19]. The Lava C.O.S. also exports data files in a format that is proprietary and can only be developed and manufactured by the software and hardware it supports for CAD and CAM.

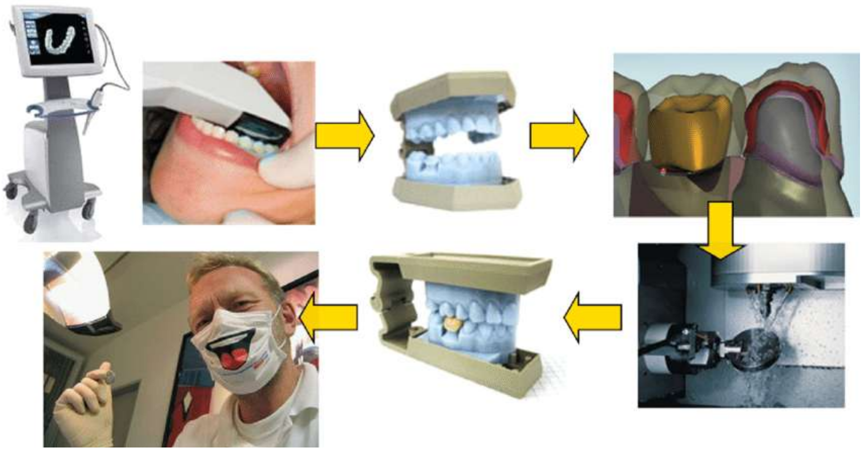

Figure 3: Steps Involved In Lava C.O.S System

TERO SYSTEM:

In order to record intraoral surfaces and contours utilizing laser and optical scanning, Cadent Inc. launched the iTero system in 2007. The system's parallel confocal imaging technique enables the exact data collection of tooth surfaces[20]. A host computer, a mouse, a keyboard, a screen, and a scanner make up the device[21]. The dentist covers the tooth with the scanner and begins the scanning procedure after cleaning, retraction, hemostasis, and air drying. Occlusal, lingual, buccal, and interproximal contacts of neighboring teeth should be included in scans. The system has to be scanned again if shaking is found.

Following completion, the remaining teeth in the arch and the opposing arch are seen at a 45° angle from the buccal and lingual directions. After obtaining a buccal scan of the patient's centric occlusion, the system quickly registers a virtual bite[22]. When the digital image is finished, the doctor can choose from a variety of diagnostic tools to assess the impression preparation.

A wireless technology that complies with HIPAA is used to transmit the finished digital imprint to the cadent facility and dental laboratory. After laboratory evaluation, Cadent outputs the digital data to a model that is milled from a special blend of resin and pinned, trimmed, and articulated in accordance with the digital imprint made by the clinician. Cadent models offer a special property that lets one model be utilized as both a soft-tissue model and a functioning model[15].

In the treatment of crowns, FPDs, veneers, implants, aligners, and retainers, iTero is an open system. It produces digital picture files in the STL format, allowing any lab with a CAD/CAM system to use them. The partnership between iTero and Straumann for an optical impression of the implant location has significantly improved clinical situations involving implants[20].

Figure 4: I Tero System

E4D SYSTEM:

The E4D technology was created by D4D Technologies, LLC and produces an interactive 3D picture of prepared and proximal teeth using optical coherence tomography and confocal microscopy[23]. The program can create a library of photos that can instantly wrap around an accurate virtual model thanks to the laser technology's ability to gather photographs from any aspect. The system, which includes a cart with the design center, laser scanner head, and separate milling unit, also serves as a powder-free intraoral scanning equipment.

Holding down the foot pedal while positioning the intraoral scanner over the tooth, the dentist concentrates on the pictures. Rubber-tipped "boots" must be used to hold the scanner at the right angle and distance from the surface being scanned. These photos are automatically combined by the algorithm into a comprehensive 3D depiction.The 3D digital impression data can be exported in STL or a proprietary format, with the latter being transferred to a particular DentaLogic CAD program. The completion line on the preparation may be automatically detected and labeled by the E4Ddesign system. The system can also be converted to an STL file for usage with other CAD/CAM systems. Even for teeth that have had minimum preparation, the E4D technology can function with a chairside milling gear to provide high-strength ceramic prostheses or composite[24].

Figure 5: E4d System

TRIOS SYSTEM:

Incorporated in 2010, the TRIOS intraoral digital imprint system is a quick optical sectioning and confocal microscopy technology that upholds a fixed spatial relation between the scanner and the item being scanned[23]. It can distinguish between different focal plane patterns across a variety of focus planes. Because of the system's rapid scanning speed—up to 3000 photos per second—relative movement between the scanner probe and teeth is less of an issue. The TRIOSR Cart and TRIOSR Pod make up the two components of the powder-free TRIOS intraoral scanner. A portable scanner called the TRIOSR Pod provides greater adaptability and mobility and is iPad and other computer and device compatible[25].

Figure 6 : Trios Sytem

OPEN VS CLOSED ARCHITECTURE :

Based on the data files produced during scanning, digital impression systems may be divided into two types such as:

- OPEN DESIGN
- CLOSED DESIGN
- Open-architecture files, like STL files, let dentists collaborate with many labs and earn returns on their efforts. Open architecture gives laboratories with the ability to alter configurations or integrate with more modern CAD software greater economic prospects[26].
- In a closed-system design, CAD and CAM configurations are controlled by data collection and manipulation by the same manufacturer. This is perfect for laboratories that don't want to invest in new technologies from various manufacturers because just one manufacturer is involved in the production process[27].

STEPS INVOLVED : CONVENTIONAL VS DIGITAL IMPRESSIONS

AbutmentAbutment
Proper tray selection recantation of gingiva
recantation of gingivaexamines
impression takingdigital transfer of impression to laboratory
Sterilizationclassical design
transporting lab equipmentfabrication of restoration
cast filling
fabrication of restoration

PRECISION BETWEEN CONVENTIONAL VS DIGITAL IMPRESSIONS:

Internal and marginal fitness are crucial factors in determining whether FDPs like ceramic restorations are successful. A high degree of impression accuracy is crucial to getting an accurate restoration[29]. Using an intraoral digital imprint, Syrek et al. conducted an in vivo experiment to assess the fitness of zirconia single crowns with that obtained from a typical silicone imprint. According to the study's findings, ceramic crowns made from digital Compared to standard impressions, this impression fit better. For digital, the interproximal contact was preferable compared to the traditional impressions[30].

In order to compare the accuracy of conventional and digital impressions, Ender and Mehl performed an in vitro experiment on whole arch scanning. They found that the results were 30.9 m for CEREC Bluecam, 60.1 m for Lava C.O.S., and 61.3 m for a traditional imprint. Few writers came to the conclusion that the accuracy of digital impressions was comparable to that of traditional impressions. This may be because powder coat spraying was done prior to both Lava C.O.S. and CEREC scanning[31].

ADVANTAGES DISADVANTAGES OF DIGITAL IMPRESSIONS :

ADVANTAGES :

- **Reduces pain:** via placing impression materials and trays in the patient's mouth, digital impressions via IOS reduce temporary discomfort[32]. The usage of imprint trays, materials, etc. is stopped. According to literature, patients should choose visual perceptions above traditional impressions[33].
- **Reduced chair-side time:** as a result of the patient's soft and hard tissues being scanned. There are no longer any lengthy processes, such as pouring the castings, etc[34].
- **Workflow simplification:** The impression technique is simplified for complex instances, such as severe undercuts and many implants, which make the standard impression procedure challenging. Repeating the impression is also made simpler without having to start over from scratch[35,36].
- **Communication with Laboratory Personnel:** IOS allows the clinician to interact instantly with the laboratory staff following the scan. If the staff is not pleased, the clinician can immediately remake the scan without scheduling a second session for the patient[34,35,36].
- **Relationship between the doctor and the patient has improved :** with the introduction of IOS, and the patient is now more involved in the workflow, which has a good effect on the course of therapy as a whole[34,35,36].

DISADVANTAGES:

- **Sub-gingival margin detection:** There was an issue with detecting deeply positioned gingival margins, and IOS scanning can be a little problematic when there is bleeding since it might hide prosthetic edges and cause erroneous scanning. 30 The soft tissue edges and dynamic tissue interactions cannot be moved by IOS[37].
- **Learning Curve:** Older clinicians who have less interest in and familiarity with technology may find it challenging to adjust the Learning Curve for IOS. Furthermore, it is significant to remember that there is disagreement on whether scanning method is superior to the other because the manufacturer gave little details[38].
- **Cost-sensitive:** Despite the introduction of several new models into the market, the initial purchase costs of IOS are still relatively high[32,37].
- Additional management expenditures, such as those associated with software upgrades, were also involved. Along with the aforementioned, laboratory staff members also need to be knowledgeable with digital workflow[32,37].

ADVANTAGES OF CONVENTIONAL IMPRESSIONS :

• Due to their habit of using the conventional methods, the majority of doctors are reluctant to learn new ones.
• The cost might be either cheap or extremely costly.
• The practitioner uses the method and is knowledgeable.
• Prolonged usage and widespread use.
• Accurate and reliable.
• There is very little equipment. The process is uncomplicated and easy to master, and silicone and polyether imprints are known for their accuracy.

DISADVANTAGES OF CONVENTIONAL IMPRESSIONS :

• Patients' discomfort (for some, intensified vomiting)
• Making a standard impression generates a lot of "dust"; material residues may be found on the ground, in the cabinet, on the gloves, on the equipment, etc.
• Pouring models is necessary.
• Multiple processes frequently needed four to six visits.
• More time-consuming method
• Errors in the model's integration of air bubbles may be the source of discrepancies.

RECENT IOS AVAILABLE IN MARKET:

Aoralscan	Cerec Primescan	Carestream Dental 3600	Condor	iTero Element	Medit i700
Aoralscan simplifies intraoral scanning, allowing dentistsand	Dentsply Sirona, a leadingdental product manufacturer, offers	Carestream's Intelligent Matching System enables dentists to fill missing data in any mouth area at	Belgiancompany Condor Technologies N.V. has developed a compact intraoral scanner since 2010,	The iTero Element 2 from Align Technology is a mobile and stationary scanner with advanced	The Medit i700 enhances the dental practice's scanning experience, providing a comfortable and comprehensive model

techniciansto effortlessy obtain digital impressions.	itsPrimescan scanners with autoclavable and disposable sleeves for hygienic handling.	any time, without requiring precise location information.	continuously improving its software algorithms for faster, more accurate operation without hardware replacement.	capabilities, but may be overkill for average dental practitioners treating orthodontic cases.	with numerous features for a variety of services.
Features: The device features a 15 frame/second scan speed, AI data optimization, real-time scanning, realistic color, motion-sensing scanning, USB 3.0 port integration, and output file formats.	**Features:**The device offers superior accuracy, processing over 50,000 images per second, delivers 3D images instantly, features a touchscreen for intuitive use	**Features:**The device uses an LED light source, has a 13x13 mm field of view, anti-fogging technology, interchangeable tips, and a USD 2.0 port	**Features:**The device uses 15 white and 2 blue LEDs, is lightweight, takes 1 minute to scan, and supports USD 3.0 port data transmission, offering free software upgrades.	**Features:**Thedevice, compatible with Align Technology's Invisalign system, can scan a full arch in 60 seconds, features adaptive anti-fogging technology, and allows patient history visualization.	**Features:**The device features an LED light source, 70 frames/second scan speed, ergonomic handpiece, adaptive anti-fogging, full arch accuracy, 3D in-motion video, impression and facial scanning, and modeless crown fitting software.

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