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RESEARCH ARTICLE

DIGITAL IMPRESSIONS- PAVING PATH TOWARDS GREEN DENTISTRY: A REVIEW

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Abstract

The concept of making an impression has undergone a paradigm shift as a result of the development of highly accurate and novel impression systems based on new technologies.[1] Digital intraoral imaging represents a cutting-edge technique that allows the dentist to create a virtual computer-generated replica of the hard and soft tissues. Digital impression-making techniques are highly accurate, and they will undoubtedly lessen the need for traditional techniques in the near future. The information is stored in specialized software to be utilized in the manufacture of appliances, positive replicas, or other restorations. Additionally, this makes it possible to access data at any moment for further research and follow-ups. The future of digital dentistry is bright, but there is still work to be done to make sure that the technology delivers significant benefits to practitioners and patients in terms of therapeutic outcomes, regardless of how "beautiful" the process itself maybe. At the same time, it must be kept affordable and investments should yield a solid return.[1]

Introduction:-

The concept of making an impression has undergone a paradigm shift as a result of the development of highly accurate and novel impression systems based on new technologies.[1] Computerized digital technologies have advanced greatly, bringing new developments including digital extra-oral and intra-oral scanners, cone beam computed tomography, three-dimensional printers, laser sintering units, and milling machines. Restorations, including inlays, onlays, bridges, veneers, ceramic crowns, and implant abutments, are fabricated using CAD/CAM technology.[2] With the aid of lasers and other optical scanning devices, digital intraoral imaging represents a cutting-edge technique that allows the dentist to create a virtual computer-generated replica of the hard and soft tissues. Digital impression-making techniques are highly accurate, and they will undoubtedly lessen the need for traditional techniques in the near future. The information is stored in specialised software to be utilized in the manufacture of appliances, positive replicas, or other restorations. Additionally, this makes it possible to access data at any moment for further research and follow-ups.[1]

The three fundamental components of any CAD/CAM system are:
1. A unit that collects data on the teeth as well as the tissues adjacent to the teeth as they are prepared and afterwards converts it, either directly or indirectly, into optical or visual impressions.

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2. Different software is employed to design the final restorations, which are secured in optical impressions and sent for milling.
3. A computerised milling device for constructing the final restoration of any appropriate restorative material. The CAD phase involves the first two components, whereas the CAM phase involves the third.[3]

History
1. The CAD/CAM technology was initially introduced to dentistry in 1973 by Dr. Duret. Dr. Mormann expanded on the CAD/CAM system concept.
2. The very first digital impression technology intended for use in dentistry was CEREC, developed by Mormann, in 1980. Procera System was designed by Dr. Anderson.
3. The Duret system and the CEREC 1 system (Sirona, Bensheim, Germany), served as the first intraoral digital impression systems in 1987.
4. HINT - ELS GMBH (DE) introduced DirectScan in 1998.
5. Itero was officially launched in the market in 2007 by Cadent Inc. (Carstadt, NJ).
6. Lava TM C.O.S. (Lava Chairside Oral Scanner; 3M ESPE, Seefeld, Germany) was introduced in 2008.
7. 2011 witnessed the launch of TRIOS by 3Shape (Copenhagen, Denmark)
8. 2012 witnessed the launch of the latest CEREC AC Omnicam.[4]

Conventional Impressions[1]

ADVANTAGES	DISADVANTAGES
➢ The method is well-known and approved. ➢ Simple tools are required. ➢ Costs range from modest to moderate. ➢ Reliable accuracy ➢ Clinical procedure that is comparatively simple and predictable.	➢ Creates mess ➢ Causes discomfort to the patient ➢ The presence of debris or air bubbles lead to inaccuracies. ➢ Stocking the materials and trays

Digital Impressions[1]

ADVANTAGES	DISADVANTAGES
➢ Comparable accuracy to traditional impressions ➢ After some practise and learning, it becomes easier to use. ➢ Patients experience less discomfort ➢ No stocking materials or trays are required ➢ Disinfection is not required ➢ No risk of cross infection ➢ Transfer to laboratory is simple ➢ does not require the casts to be articulated ➢ The need for pouring the impression, making the base, and trimming are eliminated ➢ Data obtained is stored for a longer period of time.	➢ Lack of dentist's familiarity with the concept ➢ Complex digital equipment ➢ High initial cost of purchase

Chairside digital impression vs. In-office cad/cam systems
Two types of digital systems are employed in dental office:
1. digital impression systems
2. in-office CAD/CAM systems

The initial step in all of these systems is to obtain a digital impression.

Systems that use digital scans instead of impressions are known as digital impression systems. A scanner wand is used intraorally to capture the digital image of the prepared tooth, doing away with the necessity for any impression material, disinfecting, and pouring the casts. The dentist can then analyse the digital image to make sure the necessary areas were recorded and that there was enough occlusal clearance.[3]

Advantages

At even higher magnification, a rapid reassessment of the preparation is possible. The dentist can rescan after making the appropriate adjustments if the issue still exists in the scanned images. Once the dentist is pleased with the prepared tooth and scanned digital images, the data and instructions can be electronically sent to a dental lab. Any kind of restoration, from inlays to all-ceramic crowns, can be fabricated utilizing digital impressions. After obtaining the scanned images, the dental laboratory or its manufacturing partner employs sophisticated software to determine the prepared tooth's margins before digitally marking and trimming the die. The laboratory creates a three-dimensional (3D) printed or milled model that can be utilized to design the desired restorations. On these models, restorations can be created both digitally and conventionally. Additionally, the laboratories can fabricate modelless restorations making use of digital impressions, monolithic pressed or milled restorations, and other techniques, which speeds up the production process.[3]

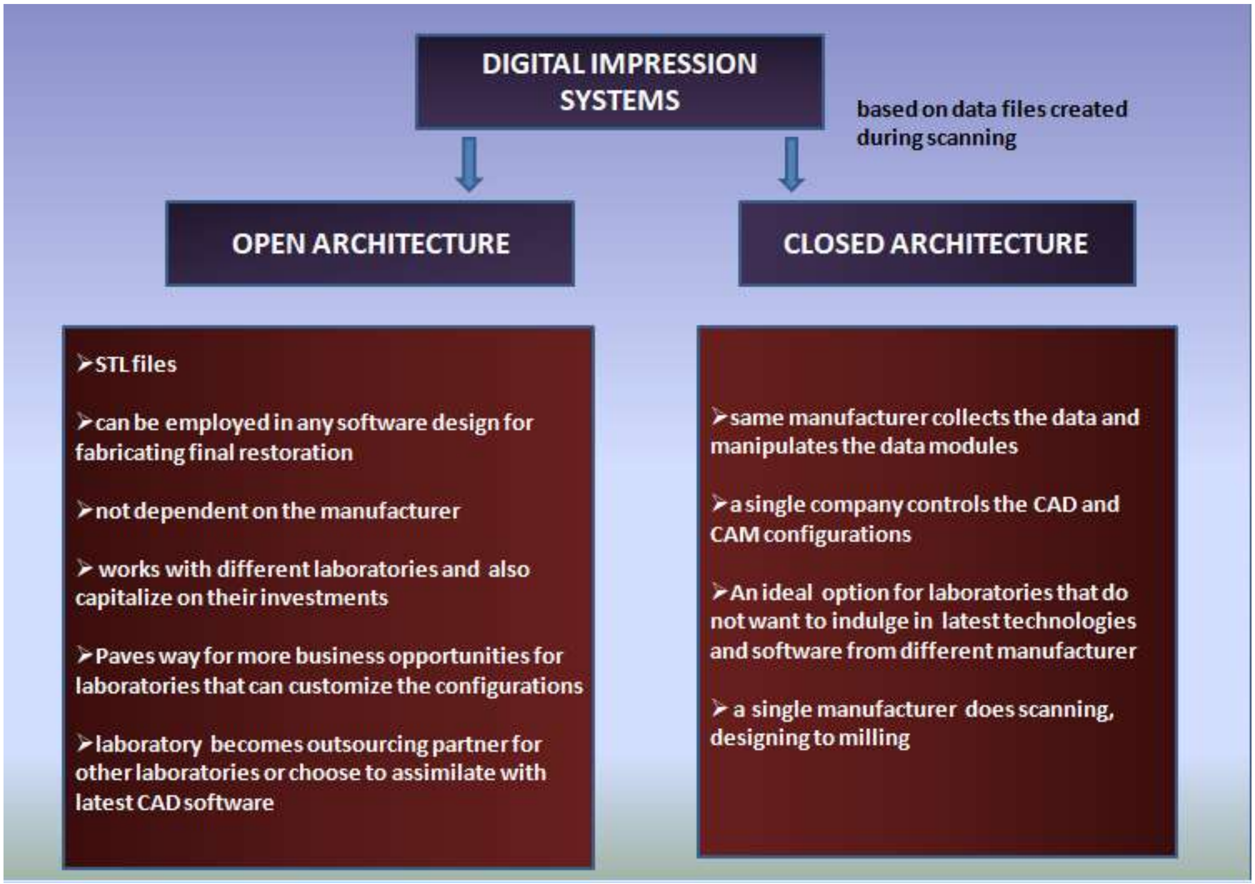
Chairside CAD/CAM

A scanner and a mill are both components of CAD/CAM for chairside use when constructing a restoration. These systems enable the dentist to scan, design, and mill a full-contour restoration entirely within the dental office. Using the CAD/CAM system software, the dentist can create the chairside restoration instead of electronically transmitting the data to a dental laboratory. The type of restoration can be decided by the dentist when it is being created chairside.

Depending on the anatomical characteristics of the nearby teeth, this software offers a variety of designing options, such as duplicating an existing tooth or choosing from a pre-existing collection. The software also comes with a variety of tools for modifying the planned restoration. The interproximal contacts, occlusion, height of the contour, and other aspects can all be adjusted using these tools.[3]

The clinician has more control and flexibility when customising the restorations based on the material by employing stains, glazing, and firing in a porcelain oven. It is possible to reduce the number of appointments by cementing the final restoration on the same day. As temporary restorations are not necessary and there are fewer appointments, patients respond well to these types of systems.

There are several digital impression systems available in the market,, including CEREC, Lava C.O.S. system, E4D, and TRIOS. Each system differs in terms of its light source, working principle, operational procedure, and output file format.[3]



Different Digital Systems For Intraoral Imaging
Cerec System
Along with the Duret system, Sirona, Bensheim, Germany, launched the CEREC 1 system in 1987. It was the first digital system to include both intraoral imaging and a CAD/CAM device. The CEREC AC Bluecam, introduced in 2009, is the most widely used system. It is a fourth generational product. This system operates according to the light triangulation principle, which involves the interaction of three light sources that are directed at a particular region in three-dimensional space. The images are captured with the help of blue LED diode, that emits blue visible light. Within the first minute, a single quadrant is captured, which is then followed by the antagonist within few seconds. The most recent version, known as Omnicam, was then released in 2012, which obtains all the data and captures multiple images, thus constructing a three dimensional model. Bluecam can only be employed for a single tooth, whereas Omnicam can be utilised on a single tooth, a quadrant, or an entire arch.[5]

Lava Chairside Oral Scanner system
An intraoral device called Lava C.O.S., developed by 3M ESPE in Seefeld, Germany, records impressions digitally. This system was first marketed in 2006. This technology employs a single lens imaging system to acquire data in 3D format and operates on the basis of active wave front sampling. In order to capture the object images from various angles and create patches on the surface utilising the in focus and out of focus processes of the imaging algorithms, a total of three sensors with smaller scanning tips of 13.2 mm width are required. A coating is essential for this technology as well, though less so than for CEREC Bluecam. In reality, this coating serves more as connectors that are the finest particles utilized during the intraoral scanning procedure. The pulsating blue light that is emitted to capture the images is the light source employed in this technique. Most often, it is employed to design and generate the Lava C.O.S. data export proprietary files.[5]

iTero system
Cadent Inc. released iTero onto the market in 2007. (Carlstadt, NJ, USA). It operates on the parallel confocal imaging technology theory, where images are first taken intraorally and then contoured using a laser and visual

scanning. Antireflective coating powder is not necessary for the iTero scanner to function. The red laser light is the source of light for this system. Dental services such crowns, fixed partial dentures or prostheses, veneers, aligners, and implants are easily accomplished with iTero. When this scanner is employed, the sequential technique ensures accuracy, precision, and trueness when recording intraoral images of long span areas. The STL file format makes it simple to transfer digitally generated image files with any CAD/CAM-equipped laboratory.[5]

E4D system

The E4D system was created by D4D technologies LLC (Richardson, TX, United States). It uses the same principles as optical coherence tomography and confocal microscope imaging technology. Red lasers and micromirrors, which create 20,000 cycles per second as a light source, are used in this system's powder-free scanner. High-speed lasers create an impression of the hard tissues that have been prepared in order to provide a 3D image from every angle. After compiling all the acquired data, it quickly wraps a virtual model. Also, this technology is a powder-free scanning system that may provide high-strength ceramic or composite prostheses for teeth that require the least amount of preparation in a single visit.[5]

TRIOS system

In 2010, 3Shape (Copenhagen, Denmark) unveiled TRIOS, a revolutionary technology for digital impressions, which was introduced to the market in 2011. It operates via ultrafast optical sectioning and parallel confocal imaging techniques. Here, the object is scanned while the system scanner keeps its spatial relation in a fixed place. A 3D digital model of the teeth and gingival colour that is an accurate replica is generated when this system interprets the images it has acquired. The TRIOSR Cart and TRIOSR Pod are two parts of this system, which is also a powder-free scanning technology [5]

PlanScan (Planmeca,driven by E4D Technologies 2015)

Dental data is obtained using a powder-free system that combines blue laser light with real-time video streaming. It also facilitates chair-side designing and milling. Moreover, it is an open system, as it also facilitates export and import of STL files. Both hard and soft tissues with different translucencies, dental restorations, models, and conventional impressions can be easily obtained with this system. High-level disinfection is made possible by detachable scanner tips with built-in heated mirrors, which eliminate downtime between patients. The restorations can also be processed, designed, and manufactured in a laboratory, or they can be chair-side milled using a PlanMill 40 milling machine (a four-axis dual spindle machine). The inlays, onlays, crowns, bridges, and veneers can all be fabricated using the digital casts. There are several scanners available, including PlanmecaRomexis and EmeraldTM S.[2]

CS3500 intraoral digital impression scanner(2015)

CS3500 is the portable digital impression system. The "confocal laser scanner microscopy" mechanism employed by the system enables the acquisition of true-color 2D and high-angulation 3D scans. For scanning, opaque powder is not required. The CS 3500 pairs well with open source software and can also be used with the Carestream CAD/CAM dental restorations system.[2]

IOS FastScan – by IOS TECHNOLOGIES, INC.5. (US 2007

"Active triangulation" is the underlying principle of this technology. Either passive triangulation or active triangulation is used to integrate the light from two perspectives onto a single camera. The scanned data is retained in STL format, an open source data format that other laboratories can access it and use as needed. IOS FastScanTM comes with a scanner that records data as well as the dentition's three-dimensional shape. The system includes a built-in CAD module to store colour and translucency data as well as the 3D shape, generating a coloured accurate picture of the prosthesis. A single digital prescription containing the information on colour, translucency, and surface is electronically sent to a lab or CAD/CAM system for manufacturing.[2]

Densys 3D MIA3d (IL)(Migdal Ha'Emeq, Israel, February 2009)

A separate chair-side scanner is used and it operates on the principle of structured light projection and the "active stereophotogrammetry". With complete interproximal scan coverage, Densys scanning system is the most user-friendly software, quickest analysis, and most precise and durable wand on the market. This system's goal is to efficiently reproduce 3D intra-oral dental structures for applications like veneers, laminates, inlays, and onlays. Reduce the impact of patient, practitioner, and equipment movement when doing 3D intraoral imaging.[2]

DPI - 3D BY DIMENSIONAL PHOTONICS INTERNATIONAL, INC. (US 1990s)
It is the most accurate and versatile 3D scanning system. The "accordion fringe interferometry" theory underlies the operation of DPI- 3D. It incorporates three dimensions into conventional linear laser interferometry. Since the files are stored in STL format, it is an Open system. Several image formats can be used to store scanned data. There is no need to spray or powder-coat the surface of the teeth. The system's advantage is that the light source's wavelength makes it less sensitive to noise and fluctuations in ambient light, enhancing its capacity to scan shiny and translucent objects.[2]

3D Progress (2015)
This digital impression system is compact and portable. With the use of Moiré effect detection, 3D Progress functions as a confocal microscope. Data collected is displayed in real time on computer screen and the oral tissues are scanned without the use of opacifiers. Real time automatic stitching of scanned images is achievable. 3D Progress can scan an entire arch in under 3 minutes and takes less than 1/10th of a second every scan. The margin line or finish line can be automatically detected by this system.[2]

Directscan By Hint – ELS GMBH (DE, 2011)
It is founded on both the linear projection concept and the principle of human stereoscopic vision. Every 200 milliseconds, quick scans are conducted from different angles to capture the surface and contour of each tooth and gap. Recorded data is kept in STL format so that it may be handled by CAD/CAM components as well as other open systems. The modelling of fully anatomical inlays, crowns, and long span bridges is made possible by software that has a virtual articulator.[2]

Cara i500 (Kulzer's Developed in partnership with Medit 2018
This scanner features a cloud-based workflow system, enhanced accuracy and precision, convenience of use, scaled work routines, enhanced performance, and quick and simple operation. The patient will find the process comfortable because of the small tip and powder-free scanning.

Double focus: Quick readings and high-resolution images are guaranteed by two high-speed cameras. For easier processing and design, the open system can export.stl,.ply, or.obj files. It can also produce vivid, accurate coloured scans that make it simple to distinguish between soft tissue, plaque, and teeth. Various applications include the manufacture of a single customized abutment, inlays and onlays, a single crown, a veneer, a 3 unit implant bridge up to 5 units, an implant guide, and denture processing.

Features: As part of the iScan features, which include options for modifying and creating margin lines automatically and manually. In order to establish the real margin line, the dentist might add or modify control points to the prepared tooth scan data while scanning the patient's arch or teeth. HD pictures are captured with an intraoral camera.[2]

Bluescans-I
With this method, taking oral impressions is similar to recording a video with a free-moving, simple handpiece that has integrated optics and anti-shake protection; the camera does not need to be calibrated or held stationary. There is no need for spray or powder. Oral scans are carried out using a camera system comprising two cameras that record stereoscopic pictures for the purpose of measuring the object's three dimensions based on the active stereoscopic vision principle. This system includes a tiny wand, is portable, and connects to a computer using a USB 2.0 cable.[2]

ZFX intrascan (MHT technologies® zimmer)
It is a three-dimensional optical scanner using confocal parallelism laser technology that has an 18mm operating distance.

Portability and ease of use when managing software are benefits. The digital data can be downloaded for free. [6]

PiC dental
The PiC camera is a photogrammetric optical measurement tool with incredible precision. For a computerised workflow of many implant restorations, the PiC camera is the intraoral scanner's complementary tool.[6]

DWIO (Dental Wings Intraoral) StraumannCanada.
It is a system that can record digital impressions and has an open architecture (STL files). The 3D capture is made easier with the small tip of the scanner, utilizing a technology known as "Multiscan Imaging Technology". Five 3D scanners are used in the system at once to record all anatomical information in various orientations, including hard-to-reach places.[6]

WOW
Since it is a completely open system that allows for data exchange, it enables the establishment of a full digital workflow and the acquisition of images with very realistic texture and colour.[6]

Medit 500
It is a technology that runs on productivity, efficiency, and cost. It includes two high-speed cameras that enable the scanning to pick up where it left off. Video photo grammetry is the cornerstone of this technique. The image resolution facilitates the ability to distinguish between dental structure and soft tissue, making it simple to determine where dental preparations and undercuts terminate.[6]

Merits Of Digital Impression
1. increased patient comfort and convenience
2. minimizes the likelihood of errors (air bubbles incorporated during impression making, displacement and deflection of the tray during insertion, insufficient impression material or impression adhesive, or distortion of impressions)
3. decreases the possibility of infection and does not require disinfecting the impression
4. While digital scans can be maintained on hard drives indefinitely, conventional models demand more office space and may even fracture or chip when physically stored.
5. a lot of laboratory processes, such as cast and base pouring, the requirement of investment and die materials, and contraction of typical ceramic materials, are eliminated. [3]

Demerits Of Digital Impression
1. It is a novel approach that not everyone is familiar of.
2. A lack of understanding among dental technicians and clinicians.
3. Although newer models of the complex equipment are simpler, they still require training and practise to use.
4. Equipment is expensive.[3]

Sterilisation Protocol Of Intraoral Scanners
By preventing direct contact with the impression, pouring the cast, and packaging the material, intraoral scanners offer less potential for infection when compared to conventional impressions. According to CDC classification, intraoral scanners can have non-critical and semi-critical surfaces. Non-critical surfaces include the scanning wand, touch screen, and base. Semi-critical surfaces include the disposable sleeves or tips that shield the sensor. With a disinfectant solution that the EPA has approved, all non-critical surfaces can be disinfected. Prior to using a disinfectant-soaked gauze or a disinfectant wipe to clean the non-critical surfaces, it is crucial to clean the non-critical surfaces thoroughly. By using an autoclave or disposable sleeves or tips, the semi-critical surfaces that come into direct contact with the oral cavity can be sterilised. The sleeves are first carefully cleaned with soap water, dried with a paper towel that is free of linen, and then autoclaved. The majority of scanner tips are detachable, allowing for autoclaving and subsequent reuse. It is assessed after sterilisation for damage or scratches, and if any are found, they should be discarded. For instructions on proper disinfection, it is also an important to read the instructor's manual.[7]

Conclusion:-
The use of technology is permeating more and more facets of clinical dentistry, and the ability to take a digital imprint gives dentists access to a new level of diagnostic expertise. The cost-effective manufacture of individual pieces is now possible thanks to advancement of technology. Computer-assisted dental restorations have increased in popularity in recent years. The future of digital dentistry is bright, but there is still work to be done to make sure that the technology delivers significant benefits to practitioners and patients in terms of therapeutic outcomes, regardless of how "beautiful" the process itself may be. At the same time, it must be kept affordable and investments should yield a solid return.[1]

References:-

1. Singh I, Singh K, Sethi N. Digital Impression in Dentistry-A Comprehensive Review. Asian Pac. J. Health Sci., 2022;9(2):133-138.
2. Suresh S. Kamble, Ajit S. Jankar, Vidya A. Vaybase, Suraj Sonawane, Pratiksha Somwanshi and Shital Wagh: DIGITAL DENTISTRY: AN OVERVIEW ON RECENT ADVANCEMENTS IN INTRAORAL SCANNER **Int. J. of Adv. Res.** 2020 **Sep 8**. 1244-1250
3. Swapna B, Kamath V. Digital Impressions In Prosthodontics–An Overview. J Crit Rev. 2020;7(14):733-5.
4. Dr. Anagha Sunder Kakapoyi, Dr. Seema Pattanaik, Dr. Bikash Pattanaik, Dr. Najma Shaikh. Digital scanners in prosthodontics: A literature review. Int J Appl Dent Sci 2021;7(2):554-557.
5. Mondal SS, Bulbule NS, Anasane NS, Nandi A, Jagtap AK, Bhandhari A. Digital impressions: One-step closer to precision. Medical Journal of Dr. DY Patil Vidyapeeth. 2022 Sep 1;15(5):670.
6. Abad-Coronel C, Valdiviezo OP, Naranjo OB. Intraoral scanning devices applied in fixed prosthodontics. Acta Sci Dent Sci. 2019;3(7):44-51.
7. Devikaa TC, Kumari P, Omar S, Jaiswal H. Digital impression–A Review. Journal of Orofacial Rehabilitation, 2021:1(2), 74–82.