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Review Article

Revolutionizing Dentistry: The Rise of Digital Dental Impressions in Prosthetic Dentistry: A Review

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ABSTRACT

In the ever-evolving field of dentistry, technology continues to push boundaries, enhancing both patient experience and clinical outcomes and digital intraoral scanners are one of the tools contributing to it and have been developed significantly in the recent years. Traditionally, dental impressions involved messy trays and putty-like materials, often causing discomfort to the patients, time consuming and sometimes resulting in inaccuracies. However, with the advent of Intraoral scanners, it has offered numerous benefits to both dentists and patients. The scanner comprises of two types- direct scanners and indirect scanners. The various intraoral scanning systems are reviewed in this article.On reviewing a total of fifteen articles data was obtained based on dimensional accuracy, several trials of scans, internal and marginal gaps to compare both the types of scanners. These articles are obtained from PubMed and EBSCO Host which are published between 2015 and 2022. Direct scanner excels in the property of having a lower deviation in teeth that have undergone more extensive preparation in the full and half arch but has a low amount of internal and marginal gap as compared to indirect scanners. The results of studies conducted were inconsistent based on dimensional accuracy, but indirect scanners were considered superior to direct scanners. The type of scanning systems was determined on various factors like time, convenience, area to be scanned and patient's comfort. The clinical results were accepted for both the scanning systems.

Key words: Digital Impressions, Intraoral Scanners, Lab Scanners, Dental Marginal Adaptation, Impression accuracy.

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INTRODUCTION

Advancements in digital dentistry have made computer-aided design (CAD) and computer-aided manufacturing (CAM) widely popular. These technologies have led to more effective and predictable treatments. Three-dimensional imaging has improved the accuracy of traditional prosthetics and allows for virtual planning and design of various restorations.

Different techniques and technologies are used based on the type of tissue being scanned.[1] Various authors have found challenges in the conventional impression procedures that eventually have increased the use of intraoral scanners (IOSs). Intraoral digital scanning is seen as a faster and more convenient method for both dentists and patients.

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It offers many benefits, including real-time visualization, easy repeatability, targeted capture of necessary areas, and eliminating the need to disinfect and clean dental impressions and trays. It also avoids wear and tear on models, allows for quick communication, and provides faster treatment outcomes. Many CAD-CAM systems are now available for chairside digital impressions and prosthesis fabrication.[15]

FEATURES OF INTRAORAL SCANNERS

Precision and Accuracy: Digital Dental Impressions utilize cutting-edge technology, such as intraoral scanners, capturing highly precise 3D images of the patient's teeth and oral tissues.

This level of accuracy surpasses traditional impression techniques, reducing the likelihood of errors and ensuring a more precise fit for dental restorations, such as crowns, bridges, and implants.

Enhanced Patient Experience: One of the most significant advantages of digital impressions is the improved patient experience. Gone are the days of uncomfortable trays and gag reflexes associated with traditional impressions. Instead, patients can now enjoy a more comfortable and efficient process, as digital scanning is quick, non-invasive, and minimally discomforting.

This leads to increased patient satisfaction and compliance with dental treatment plans.

Time Efficiency: Digital dental impressions streamline the workflow in dental practices, saving valuable time for both dentists and patients. Unlike traditional impressions that require multiple steps and materials, digital scanning can be completed swiftly, reducing chair time and allowing for more efficient treatment planning and delivery. Additionally, digital impressions eliminate the need for physical shipping of impressions to dental laboratories, further expediting the process.[1]

Improved Communication and Collaboration: With digital impressions, dentists can easily share 3D models and digital files with dental laboratories and specialists, facilitating better communication and collaboration. This seamless exchange of information ensures that all stakeholders are on the same page regarding treatment plans and expectations, leading to superior outcomes for patients.

Environmental Sustainability: Digital dental impressions contribute to environmental sustainability by reducing the reliance on disposable materials, such as impression trays and impression materials. By embracing digital technology, dental practices can minimize waste generation and contribute to a greener, more eco-friendly healthcare environment.

Future Potential: As technology continues to advance, the capabilities of digital dental impressions are expected to expand even further. Innovations such as Al-assisted scanning and cloud-based software platforms hold the potential to further optimize the accuracy, efficiency, and accessibility of digital impression systems, paving the way for the future of dentistry.[2]

CAD/CAM systems comprise of 3 major parts:[3]

1) **Data acquisition unit with digital camera**, which converts the data into visual or optical impressions after obtaining information from the concerned prepared tooth and other structures adjacent to it.
2) **Software to design virtual restoration,** which are captured in optical scans and configured for milling procedure**.**
3) **An automatic milling system,** for final production of restorations using blocks of appropriate restorative materials. CAD phase comprises the first two system and the third one is under CAM phase.

Advantages of digital impressions:

Impressions can be viewed, adjusted and rescanned.[4]

Time-saving and single visit for systems installed in dental clinics.[4]

Ease to view occlusion.[4] (Figure 1)

Precise restorations are created[4]

Accurate, wear and chip-resistant models.[4]

Accuracy of impressions.[4] (Figure 2 and 3)

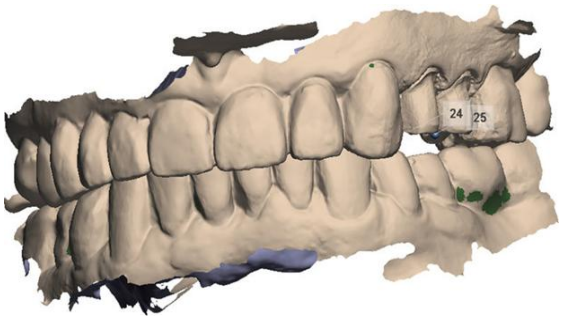

Figure 1: Buccal scan of teeth in occlusion for an interocclusal registration

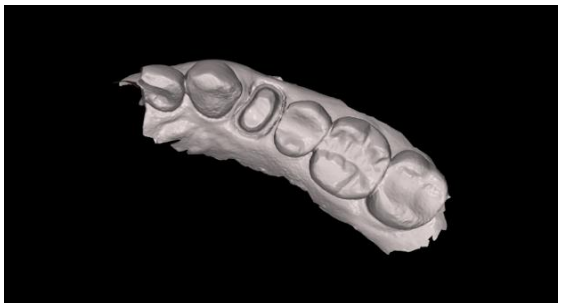

Figure 2: Digital Impression For Posterior Single Crown Fabrication

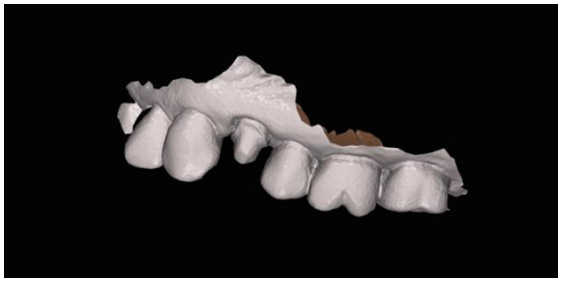

Figure 3: Digital Impression For Anterior Single Crownfabrication

Cross-contamination control.[5]

Capture excessively movable tissue in a relaxed condition achieving a mucostatic impression.[4]

Minimizes gag reflex and sensitivity to impression material.[4]

Disadvantages of digital impressions: Lack of proficiency among dentists.[4]

Equipment cost is high.[4]

The scanning procedure should concentrate on finish lines and accurately reproduce surrounding and occlusing teeth.[4]

Intraoral scanner also requires moisture control, soft-tissue management and retraction as conventional impressions.[7]

MECHANISM OF INTRAORAL SCANNERS (IOS)

Intraoral scanners work by using a small handheld device to capture detailed images of the inside of the mouth through simple and efficient process. The working mechanism of IOS is:

1. Image Capture: The process begins with the dentist using a small, handheld scanning device. This device is gently moved around inside your mouth, capturing thousands of high-speed images. The scanner uses advanced light technology, such as lasers or structured light, to accurately record the surfaces of your teeth and gums.

2. Image Processing: These captured images are then instantly processed by sophisticated software. The software stitches these individual images together to create a comprehensive and precise three-dimensional (3D) digital model of your entire mouth.

3. Real-time Visualization: As the dentist scans your mouth, the 3D model is displayed in real-time on a computer screen. This immediate visualization allows the dentist to examine a highly accurate representation of your teeth and gums. They can rotate, zoom in, and inspect the digital model from various angles, ensuring every detail is captured.

4. Design and Fabrication: With the 3D model ready, the dentist can then proceed to design dental restorations, such as crowns, bridges, or aligners, directly on the digital model. This design can be sent to a CAD-CAM (Computer-Aided Design and Computer-Aided Manufacturing) system, which fabricates the restoration with high precision.

This technology offers numerous advantages. It's much faster and more comfortable than traditional impression methods, which involved biting into a tray filled with a gooey material. Intraoral scanning eliminates the mess and discomfort, providing a more pleasant experience for patients. Additionally, the digital model is more accurate, leading to better-fitting restorations and more predictable treatment outcomes. It also allows for quick communication and immediate availability of results, making the entire dental process more efficient.

VARIOUS TYPES OF DIGITAL IMPRESSION SYSTEMS

Lava C.O.S. system

Lava TM C.O.S., also called Lava Chairside Oral Scan is an intraoral scanner developed in 2006. It operates based on active wavefront sampling, which entails acquiring 3D data using imaging system with a single lens. The sensors simultaneously capture clinical images from various angles, generating surface patches with both sharp and blurred data through algorithms of image processing. Twenty 3D datasets can be captured per second, incorporating over 10,000 data points in each scan. The scanner sends out visible blue light as a source and works with a mobile host computer and touch-screen.

E4D system

The E4D system operates based on confocal microscopy and optical coherence tomography. A red laser light source and micro-mirrors are used for vibrating 20,000 cycles per second. E4D utilizes a high-speed laser to capture a digital impression of the prepared and adjacent teeth, producing a 3D image.[8]. The laser source gathers images from different perspectives. The software compiles a collection of images. The image library is used to construct an accurate virtual model in seconds.[9] Similar to CEREC Bluecam and Omnicam systems, E4D system is also compatible with a milling device.

3Shape TRIOS

TRIOS is an intraoral scanner renowned for its high-speed, accurate scanning capabilities. It utilizes confocal microscopy technology capturing detailed 3D images of a patient's teeth and soft tissues.[9] This system offers real-color scanning, which enhances visualization and communication with patients. TRIOS integrates seamlessly with various CAD/CAM systems and dental labs, facilitating efficient workflows and precise restocrations.[10]

iTero Element

The iTero Element is a cutting-edge intraoral scanner that provides clinicians with high-resolution 3D images of the patient's dentition and surrounding tissues. It features an intuitive touchscreen interface and ergonomic design for ease of use. The scanner offers fast scanning speeds, allowing for quick chairside consultations and treatment planning. Additionally, ¡Tero's open architecture enables integration with third-party software and hardware, enhancing flexibility and compatibility.[10]

Carestream Dental CS 3600

The CS 3600 is a versatile intraoral scanner known for its high-speed scanning and exceptional accuracy. It employs active triangulation technology to capture accurate digital representations of the oral anatomy of the patient. The scanner's ergonomic wand design and autoclavable tips promote hygiene and patient comfort. With its open architecture, the CS 3600 seamlessly integrates with various CAD/CAM systems, facilitating streamlined workflows and precise restorative outcomes.[9]

Planmeca Emerald S

The Planmeca Emerald S is a compact and lightweight intraoral scanner designed for ease of use and high accuracy. It utilizes active triangulation technology to capture detailed 3D images of the patient's dentition with exceptional clarity. The scanner features autoclavable tips and a user-friendly interface, making it suitable for a wide range of clinical applications. With its open STL file format, the Planmeca Emerald S ensures compatibility with leading CAD/CAM software platforms, enabling seamless digital workflows and precise restorative outcomes.[9]

Dentsply Sirona CEREC

CEREC is a chairside milling system that revolutionizes restorative dentistry by combining digital impression-taking, CAD, and CAM technologies. It enables clinicians to create high-quality dental restorations such as crowns, veneers, and bridges in a single appointment. The system offers fast scanning and precise milling capabilities, resulting in efficient treatment workflows and excellent aesthetic outcomes. CEREC's intuitive software allows for virtual restoration design and customization, empowering clinicians to deliver patient-specific restorations with ease.[8]

3M True Definition Scanner

It utilizes high-definition video technology to capture detailed 3D images of the patient's dentition with exceptional clarity and precision.

The scanner's ergonomic design and intuitive software interface promote user comfort and efficiency. With cloud-based storage and communication capabilities, the True Definition Scanner facilitates seamless collaboration between clinicians and dental laboratories, ensuring precise restorative outcomes and patient satisfaction.[11]

Medit i500

The Medit i500 is a compact and affordable intraoral scanner known for its high accuracy and user-friendly design. It utilizes advanced scanning technology to capture detailed 3D images of the patient's dentition and soft tissues with exceptional clarity and precision. The scanner offers color scanning capabilities, enhancing visualization and communication during treatment planning. With its open CAD file format, the Medit i500 seamlessly integrates with leading CAD/CAM software platforms, enabling efficient digital workflows and precise restorative outcomes.[11]

Align Technology iTero

The Align Technology iTero system offers comprehensive digital solutions for both intraoral scanning and orthodontic treatment planning. In addition to capturing detailed 3D images of the patient's dentition, the iTero system provides advanced treatment planning tools for orthodontic treatments such as Invisalign (Figure 4). It allows clinicians to simulate treatment outcomes, monitor progress and communicate effectively with patients.[12] With its intuitive software interface and cloud-based storage, the iTero system streamlines orthodontic workflows and enhances patient engagement and satisfaction.

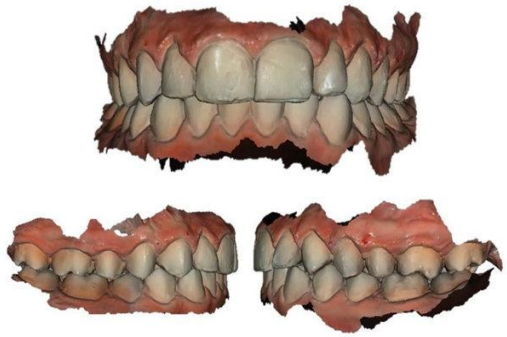

Figure 4: Digital Impression Of Dental Arches For Orthodontic Analysis

A COMPARATIVE TABLE FOR VARIOUS INTRAORAL SCANNERS

Feature	CEREC Primescan	iTero Element 5D	TRIOS 4	Medit i500	Lava COS	Planmeca Emerald S
Manufacturer	Dentsply Sirona	Align Technology	3Shape	Medit	3M	Planmeca
Accuracy	High	High	High	Moderate to High	High	High
Scanning Speed	Very Fast	Fast	Fast	Moderate to Fast	Moderate	Fast
Ease of Use	User-friendly	User-friendly	User-friendly	User-friendly	Moderate	User-friendly
Color Scanning	Yes	Yes	Yes	Yes	Yes	Yes
Real-time Visualization	Yes	Yes	Yes	Yes	Yes	Yes
Wireless Option	No	No	No	No	No	No
Software Compatibility	Proprietary	Proprietary	Proprietary	Open System	Proprietary	Proprietary
Training and Support	Extensive	Extensive	Extensive	Moderate	Moderate	Extensive
Cost	High	High	High	Moderate	Moderate	High
Additional Features	Comprehensive software integration, high-resolution imaging	Near-Infrared Imaging (NIRI) technology, caries detection	Caries detection, AI features	Cost-effective, open system	Powder-free scanning, robust software	Ergonomic design, high-speed

DISCUSSION

The basic prosthodontic procedures incorporate the conventional technique of taking intraoral impressions, which are subsequently cast in dental stone.[13] In fixed restorations, achieving precision and stability in impressions is paramount. Ensuring the impression is accurate and maintains its form is essential for the success of the restoration. This ensures that the impression retains its original shape and characteristics, avoiding any alterations before the final model is created. The fit of the definitive prosthesis and the accuracy of impressions hinge on each stage of the scanning process. In traditional methods, achieving a precise fit requires meticulous execution of each step, from taking impressions to creating stone casts, wax patterns, investments, and castings. An ideal impression should not only offer accuracy and stability but also reduce clinical time and be safe for oral tissues. Despite the many benefits of traditional impression techniques and materials, there are some notable downsides. Conventional impressions can be messy, uncomfortable for patients with a strong gag reflex, and prone to inaccuracies caused by air bubbles during model fabrication.[6] Digital impressions offer a solution to many of the challenges posed by traditional impression methods. They are simpler to use, cause less discomfort for patients, and eliminate the mess associated with conventional techniques. Despite these benefits, their adoption in our country remains limited, probably due to higher costs. However, digital impressions are not without their own challenges. They can struggle with subgingival preparation and registration, where the adaptation of margins is often compromised by the gingival margin, potentially leading to unsuccessful outcomes.[14]

CONCLUSION

Prosthodontics stands to significantly benefit from the integration of digital technology across various facets of dentistry. Intraoral digital impression techniques have become a valuable tool in the CAD/CAM process, enhancing the accuracy of dental products compared to traditional methods. This technique offers clear advantages in terms of work efficiency and material conservation. As intraoral digital impression technology continues to advance, it is poised to become more widely used, contributing to high-quality dental care that effectively maintains and restores oral functions for patients.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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