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Intraoral Scanners- New Era in Impression Making: A Review Article

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

There has been a long-term shift in the healthcare industry towards digitising patient data collecting and information. The same is true of orthodontics. A shift with a "DIGITAL" patient for diagnosis, planning of treatment, evaluation of treatment progress, and for final outcome, virtual technology is becoming more and more popular and readily available for replacing hard-copy data with electronic records. The constraints of traditional plaster models for planning of treatment, fabrication of appliance, and simulated treatment results can be replaced with three-dimensional digital models of dental arches. Indirect bonding trays, aligners, other dental products are all made using intraoral scanners. The main benefit of carring an intraoral scanner is that it reduces or completely eliminate the need to send poured models or imprints to the lab.

Keywords: Intraoral scanners; digitalization; digital models; electronic records; aligners.

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1. INTRODUCTION

The idea of intraoral scanners for dental purposes was first suggested in 1973. A chair-side scanning system using CAD/CAM technology was created by Sirona Dental Systems (CEREC) and made commercially available a few years later.[1].

Cadent unveiled OrthoCAD, the first orthodontic scanning technology, in 1999 (http://www.ORTHOcad.com) [2]. As we are all aware of traditional methods, which are employed for impression-taking. It is essential to engage the services of a top-notch dental laboratory to avoid volumetric changes in the impression materials and the expansion of dental stones, both of which can result in mistakes.

In order to address these issues in dental practise, the intraoral scanner (IOS) method has been developed [3]. Patients frequently report feeling like they are suffocating and retching, and occasionally they will not cooperate with the taking of an impression [4].

Dental professionals can take direct optical impressions using intraoral scanners (IOS). These impressions lessen the suffering of the patient. IOS saves time, makes the procedures simpler for clinician, removes the need of plaster casts, and improves communication among the technician and clinician [5].

According to the review by Ciucciù et al., the digital impression technique is thought to be comfortable for patients when compared to traditional impression because it lessens anxiety and motion sickness [6].

Diagnosis and treatment planning have become more crucial in modern culture as a result of new diagnostic techniques. Maintaining accurate records is crucial since poor record keeping shows that the orthodontic therapy being received is of a low standard [7]. In orthodontics, 3D imaging enables diagnosis as well as evaluation of dentoskeletal connections and face symmetry. Orthodontists can create specialised archwires using 3D models for clinical and medical-legal purposes [8,9].

It is obvious that impressions which are recorder digitally will eventually replace the current workflow because these methods allow accurate evaluation of the recession and wear of dental components [10].

One of the primary issues with generating digital impressions is the high price. The study's findings show that both the practitioner and the patient will incur considerable costs. The expenditures of this technology can, however, be covered by the various dental applications of the scanner [11,12].

An overview of currently marketed scanners for usage in the orthodontics industry will be given in this article. Data acquisition techniques, scanner specifications, and related software which can be used clinically are covered in detail.

Benefits of Intraoral scanning systems

1. Less patient discomfort, as it eliminates need for making impression.
2. Time efficient
3. Plaster castings are no longer used, so there are far less physical storage needs, fewer missing and damaged models, and fewer transportation problems.
4. Enhanced interaction between patients and technicians.
5. The damaged area can be the only focus of the scan repetition.
6. It prevents waste products, which is good for resource conservation.
7. Used scanner tips and intraoral scanners can occasionally be autoclaved for rapid disinfection.
8. In addition, compared to the risk provided by the various components of imprint material, digital scanning has a lower risk of allergies [13,14].

Drawbacks of Intraoral scanning systems:

1. Taking an optical impression is challenging for new users since precise measurement demands complicated scan routes.
2. Intraoral scan equipment is still pricey.
3. Many customers are still unable to afford the cost-benefit ratio.

Evolution of Digital Scanners: CEREC-1, also known as the Sirona dental system 2, was originally introduced into Swiss dental offices in 1986 by Prof. Dr. Werner Moremann. In 1994, 2000, and 2003, respectively, the CEREC 2, CEREC 3, and ultimately the CEREC 3D system brought back the original technology.

Chair Side Oral Scanners (C.O.S.), The Lava was created by Bronte Technologies and bought by 3M ESPE (S. Paul, MN) later in October 2006.

In-office iTero digital impression devices were deployed by Cadent in 2006, and by 2008, full arch scanning had begun. True definition scanners were first launched by 3M ESPE in 2012, while Lythos was launched by Ormco six months later [15].

Intra Oral Scanners Generations: The method has evolved to include five generations:

1. Information was collected slice by slice using first-generation scanners, which had a single detector and radiation source.
2. The second generation—which featured numerous detectors integrated into the scan's plane—was introduced as an enhancement.
3. The third generation featured improvements in data gathering and detection technologies.
4. Fourth generation, which combines a fixed detector ring and a moving radiation source.
5. Scanners of the fifth generation were created to lessen "motion" or "scatter" artefacts [16].

Intraoral Scanners Types: The classification of intraoral digital scanners into two systems is based on the generation of digital files.

The digital file produced by the scanner in a CLOSED SYSTEM is in a format that is exclusive and only compatible with specific software and printers. System provides limited number of clinical applications.

Data can be loaded into any CAD programme, mill, or printer when system is OPEN. The files are kept in a format that is widely used. For 3D models, the "stl" file type is frequently used (Standard Triangulation Language) [17].

IOS Technologies and Clinical Impact:

1. Handling and Learning:

Despite the IOS using the same technology, there are known clinical variances between them. Although the fact that both of these systems are built on confocal technology, it is claimed that practitioners preferred using Trios over iTero [10] It was discovered that training reduced scanning time for both scanners. Trios's scanning time is generally faster than iTero's [18].

2. Powdering:

Patients find the powder to be generally uncomfortable. It has been noted that if saliva contaminates the powder during impression, more scanning time is required for cleaning and reapplying the powder. It is difficult to keep this powder coating on the teeth until the end of the scan, hence IOS employing powder-free technologies are advised for full-jaw scans [19].

3. Scan Paths:

An acquisition area's centre must contain the scanned object in order to depict an ideal sphere. The camera needs to be within 5 to 30 mm of the surface being scanned, based on technologies and the type of scanners which are used [20].

4. Monitoring and Software

In order to resume scanning after tracking is lost, various methods and software algorithms have been developed that can recognise the object's previously recorded geometry. In order for the camera and software to receive enough information for this, we must rescan a significant region while moving around. The software will finish this missing area after the second scan by matching the prior POI [21].

Digital storage: Digital study models can be stored, retrieved, and transported via electronic devices. Digital data can be kept on a computer's hard drive, a scanning device, a portable storage device, local central servers, or "cloud" storage areas. The resolution of the scanner size of a digital file and will change depending on the size of the dental arch that has been studied. It can be between 1 and 25 MB [22]

Intraoral scanners – Overview: There are many intraoral scanners available commercially; this article will provide an overview which will help in the assessment of operating principle, the operating system, the light source, and the export file formats. According to name of their manufacturers scanners are listed in alphabetical order in (Table 1).

Table 1. Comparison of different popular digital intraoral scanners

	Align Technology iTero Element [2]	**Carestream CS 3500 [2]**	**Dental Wings dwio [2]**
			
	Fig. 1.	**Fig. 2.**	**Fig. 3.**
Powder	Powderless	Powderless	Powderless
Color	Yes	Yes	No
Configuration	Touchscreen trolley; touchscreen tabletop version	USB port built into dental treatment unit	Touchscreen and motion-capturing trolley
Data capture mode	Video sequence	Individual images	Video sequence
Principle for data capturing	Confocal microscopy	Triangulation	Multiscan Imaging (5 matching projectors, 10 cameras)
Digital work- flow	MyAligntech, a cloud- based platform for data transfer, and open STL export	Data export using open STL and a cloud-based platform called CS Connect	Data transfer through a cloud- based platform DWOS Connect; open STL export
Intigration	It can be used with OrthoCad, Invisalign, Clincheck, Incognito, and SureSmile software.	The orthodontic model analysis software is called CS Model. but no device for planning treatments.	DWOS Orthodontic software for manufacture of orthodontic models, orthodontic treatment planning tool not yet introduced.
Features	6,000 frames per second, 20 scans per second, a 20x quicker scanning speed, and a webcam for real-time feedback replace individual photos with a video sequence. [20,23,24,25,26].	The CS 3500 has a special light-guidance system that is used during the scanning process (for example, a green indicator will light up on the scanner following conclusion of a successful scan).The scanner weighs only 296g, and the tips can be autoclaved and come in several sizes [2,24,27,28,26].	The distance between the camera and the subject must be between 5 and 20 mm. The LED ring glows green when the optimal scanning distance is attained, and it turns red if the object is approached any closer than the minimum distance or if the scan path is deviated [2,23,29,26].

	Dentium rainbow iOS [2]	**Ormco Lythos [5]**	**Planmeca PlanScan [5]**
			
	Fig. 4.	**Fig. 5.**	**Fig. 6.**
Powder	Powderless	Powderless	Powderless
Color	Yes	No	Yes
Configuration	Multi-touch screen Trolly	Touchscreen tabletop version	USB port treatment unit built Into dental
Data capture mode	individual images	Video sequence	Video sequence
Principle for data capturing	Triangulation	Triangulation	Triangulation
Digital work-Flow	Transferring data using a cloud-based platform; export (direct) open STL	Ormco Digital's cloud platform for data transfer; open STL export	Open STL export and data transmission via the cloud-based Planmeca Romexis Cloud platform
Intigration	The system's exclusive milling equipment, such the rainbow Mill Clinic, is used for the lab side workflow.	The Clearguide™ Express Aligner System uses this digital data for clear aligner treatment. The Ormco Insignia™, Advanced Smile Design™ software uses the data for treatment planning and forming custom appliances.	The scanner can be used with Planmeca Romexis 3D Ortho Studio software.
Features	For treatment in the fields of implantology and orthodontics, there has not yet been proven a well-established chairside workflow [23,30,26].	This device makes advantage of accordion fringe interferometry technology. Sheaths beneath the disposable scanner tips are autoclavable. The wand weighs little over 300	For treatment planning, basic version allows viewing and taking measurements. When combined with Planmeca ProMax 3D X-ray devices or Planmeca Romexis Cephalometric analysis module,

		grammes and the weight is around 11.3 kg. It offers a special tool that determines the placement of every tooth bracket and makes unique Archwires [2,12,24,31,26].	advanced version allows for virtual setups, teeth segmentation, and simulating treatment results for comprehensive treatment Planning [2,12,23,26].
	3M Espe True Definition Scanner [2]		**3 Shape Trios Standard/Color [2]**
			
		Fig. 7.	**Fig. 8.**
Powder	Present		Powderless
Colored	No		Trios Standard: No; Trios Color: Yes
Configuration	Touchscreen tabletop version		USB port built into dental treatment unit
Data capture mode	Video sequence		Video sequence
Data capture Principle	Wavefront sampling		Confocal microscopy
Digital work- Flow	3M Connection Centre, a cloud- based platform for data transfer, and open STL export		3Shape Trios Inbox is a closed system that allows for the transfer of data through the cloud.
Intigration	The data files make use of UnitekTM, Treatment Management Portal Digital Model software used in treatment planning, includes the Bolton analysis ratio calculation and space analysis. Custom-made lingual appliances,trays for bonding, and aligners are all made using the IncognitoTM system.		A) 3Shape Ortho Analyzer is used for treatment planning. B) 3Shape Appliance Designer for designing appliances. C) The IncognitoTM appliance systems, which are used to create lingual appliances that are uniquely designed.

Features	At roughly 280 grammes, one of the lightest intraoral scanners. With operator experience, the entire scan of the occlusion takes about 5 minutes [2,12,24,26].	A dental unit's inbuilt display, iPad, laptop, or TRIOS Pod intraoral scanner can all be connected together. It gives the handheld scanner autoclavable tips, and for convenience, it can be turned 180 degrees [2,24,32]. superior optical efficiency to iTero. The greatest TRIOS system for balancing speed and accuracy [33,34,35,26].

2. CONCLUSION

Orthodontics is not the only field where technology is influencing healthcare delivery. In market various tabletop and intraoral scanners are there to meet requirements of each laboratory, orthodontic practise. It is the initial treatment for orthodontic and prosthetic conditions.

The digital approach has excellent reliability and reproducibility. For measuring toothwidth and determining Bolton ratios, the IOC/OrthoCAD system is a therapeutically viable substitute for callipers and stone casts. The digital impression is a particularly effective marketing tactic since it allows doctors to provide patients a pre-visualization of their treatment's results.It has been observed that because aligners are more aesthetically pleasing, more adult patients ask for them.

Clinicians who use these scanners need to be aware of the equipment that are available, the installation and maintenance expenses associated with them, and any potential benefits. Sadly, the intraoral scanner's biggest drawback is still its excessive price, which eventually restricts its application to only a handful of practitioners and laboratories.

Digital dentistry has immensely benefited orthodontists by boosting production and lowering labour expenses. Through the use of software, diagnosis and treatment planning have become more precise, straightforward, and efficient.

The study comes to the conclusion that intraoral scanners used in digital impression-taking are in many ways better to traditional methods. Future predictions call for a rise in the number of applications for diagnostic and therapeutic concepts.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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