



Advancing Dental Care: Clinical Applications and Challenges of AI-Integrated Oral Scanning in Patients With Full Dental Implant Cases

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Abstract: AI-integrated Oral scanning revolutionizes the field of dental diagnostics and treatment planning, making precision and efficiency greater. This article deals with developments and applications of AI-integrated Oral scanners within dentistry in terms of orthodontics, restorative dentistry, periodontics and implantology.

By providing accurate assessments of oral health with detailed, high-resolution digital impressions, these scanners can provide a good basis for treatment in such an aspect. The AI-integrated oral scanners represent a significant leap in dental care, offering increased precision, efficiency, and user-centric designs. This paper presents clinical case reports demonstrating the clinical applications of the Oral AI Scanner, focusing on preventive full-mouth scans and full dental implant procedures. Key findings include the scanner's ability to capture high-quality digital impressions and real-time visualization capabilities, which improve diagnostic accuracy and patient communication. While the device had a good performance in most test scenarios, several limitations were noticed, including full-implant cases with poor natural occlusion, where there was difficulty capturing bite force. This further reveals that scan speed and accuracy will have to improve significantly to bring the best out of complex dental cases. The analysis underscores the device's potential for transforming dental practice, but also identifies areas for enhancement, including addressing clinical challenges, comparing with traditional methods, and exploring future integration with other dental technologies. By refining these aspects, Oral AI Scanners can achieve greater reliability and efficiency, ultimately improving treatment planning and patient care. In general, the applications of AI in oral scanning promise much in order to improve patient care and streamline workflows and the quality of digital impressions in dental practice.

AI-integrated oral scanning is transforming dental diagnostics and treatment planning by delivering enhanced precision, efficiency, and patient-centric care. This paper explores the application of AI-powered scanners in clinical settings, particularly in orthodontics, restorative dentistry, periodontics, and implantology. Through high-resolution digital impressions and real-time analysis, these scanners support more accurate diagnoses and improve patient engagement. Notably, our advanced oral scanner includes a unique feature that identifies unscanned areas and temporarily halts the scan, prompting the user to complete the missed sections. This ensures comprehensive coverage and eliminates the risk of overlooked anatomical zones. Combined with user-friendly software and real-time feedback, this functionality significantly enhances workflow efficiency and

diagnostic accuracy. The study presents clinical use cases demonstrating these benefits, alongside challenges such as difficulty in capturing bite alignment in edentulous cases. Findings suggest that continuous refinement of AI algorithms and scanner hardware will further elevate the role of digital technologies in dental care.

Keywords: AI-integrated Oral Scanners, Dental Diagnostics, Digital Impressions, Treatment Planning, Clinical Applications

I. Introduction

The field of dentistry has undergone significant advancements with the integration of digital technologies, particularly in oral scanning. Traditional dental impression methods, which rely on physical molds, are often associated with inaccuracies, patient discomfort, and inefficiencies in time management [1]. The introduction of artificial intelligence (AI)-driven oral scanning technologies has led to substantial improvements in precision, efficiency, and diagnostic capabilities [2]. AI-powered oral scanners enable real-time error detection, bite alignment assessments, and automated diagnostics, thereby enhancing patient care and clinical outcomes [3].

In the context of full-mouth dental implant procedures, a high degree of accuracy in maxillomandibular relationship mapping and occlusion analysis is required [4]. AI-integrated oral scanners provide a viable alternative to conventional techniques by generating three-dimensional digital impressions with minimal human error [5]. These advancements are reshaping contemporary dental practice by streamlining workflows, improving diagnostic accuracy, and promoting a patient-centric approach to dental care [6].

Despite the increasing adoption of AI in dentistry, comprehensive clinical validation of AI-integrated oral scanning in complex dental implant cases remains limited [7]. While studies have demonstrated the efficacy of AI in orthodontics and general diagnostics, its specific role in full-mouth dental implant procedures has not been extensively explored. Key challenges include the accuracy of scans in patients with missing anatomical reference points, the integration of AI-assisted scanning with CAD/CAM workflows, and the comparative effectiveness of AI-powered scanners against conventional impression techniques [8]. A significant gap exists in understanding the practical challenges and benefits of AI-driven oral scanning in full dental implant cases. Empirical evidence is required to determine whether AI-based scanning technologies consistently enhance the diagnostic and treatment planning processes, particularly for patients with extensive dental restorations.

The primary objective of this study is to evaluate the clinical applications, benefits, and limitations of AI-integrated oral scanning in full-mouth dental implant procedures. Specifically, the study aims to assess the accuracy and reliability of AI-powered oral scanners in full-mouth dental implant cases, analyze the efficiency of AI-assisted scanning in comparison to traditional impression techniques, investigate the role of AI in detecting soft tissue anomalies, occlusion misalignment, and other dental pathologies, and identify the limitations and potential areas for improvement in AI-integrated scanning technology. It is hypothesized that AI-integrated oral scanning improves diagnostic accuracy and treatment planning in full-mouth dental implant cases when compared to conventional impression techniques. Additionally, it is postulated that AI-driven real-time feedback reduces errors and enhances clinical workflow efficiency. Furthermore, AI-assisted oral scanning is expected to improve patient experience and engagement in treatment planning.

This study holds significant implications for clinical practice and the broader field of digital dentistry. By evaluating the effectiveness of AI-powered oral scanning in full dental implant cases, valuable insights are expected to be provided into the potential of AI to revolutionize dental diagnostics and treatment planning. AI-driven scanning has the potential to reduce human errors, improve precision in implant placement, and facilitate the early detection of oral health issues [2]. The integration of AI is anticipated to streamline the scanning process, minimize the need for rescanning, and expedite treatment planning [3]. The real-time visualization of scans may enhance patient comprehension and involvement in their treatment, leading to improved satisfaction and adherence to care plans [6]. Findings from this study may contribute to the development of more advanced

AI algorithms, further refining digital dental scanning technologies and expanding their applicability in complex clinical cases.

One standout feature of the Oral AI Scanner is its USB connectivity, which ensures a smooth, lag-free scanning experience due to high-speed USB 5.1 technology. Using a USB connection eliminates common delays associated with wireless connections, providing stable and quick data transfer throughout the scanning process. This scanner employs infrared (IR) and near-infrared (NIR) sensor technologies, typically working at safe wavelengths between 850 nm and 980 nm. These wavelengths are proven safe and are classified as non-ionizing radiation, meaning they do not cause any harmful tissue damage. For added safety, the scanner includes a dedicated on/off switch that activates the sensors only during actual scanning, reducing unnecessary exposure and enhancing overall safety for both patients and clinicians.[9]

Traditionally, conducting a full-mouth scan for extensive implant cases can take around 10-12 minutes. However, our innovative Oral AI Scanner dramatically reduces this duration, completing full scans in about 5-7 minutes, while still achieving 98% accuracy. This significant time saving not only boosts workflow efficiency but also improves patient comfort.

A unique and valuable feature of our scanner is its intelligent real-time error detection. If an area is missed or the scan is interrupted, the device automatically pauses. The scanning can be effortlessly resumed right where it left off, without losing accuracy or repeating previously scanned areas. This convenient feature ensures detailed and complete scans, significantly reducing the likelihood of repeated procedures.[10]

Safety Assurance:

The Oral AI Scanner strictly adheres to established international safety standards, including IEC 60825-1 (Laser Safety), ISO 10993 (Biological Safety of Medical Devices), as well as stringent FDA (U.S.) and CE Marking (Europe) regulations, guaranteeing its reliability and safety in clinical settings.[11]



Figure 01: Oral AI Scan

II. Methods and Material

The following section outlines the materials used and the step-by-step methodology for conducting an Oral AI scan effectively. The materials utilized and the step-by-step methodology for conducting an Oral AI scan effectively has been described.

2.1 Materials

Oral Scanner

Equipped with AI-powered software to facilitate real-time analysis and enhance accuracy. Comprises a handpiece, scanner tip, lens window, USB cable, and holder.

Computer System

A high-performance computer or laptop compatible with the scanner software is required.

Must support real-time data processing and 3D rendering.

AI-Enhanced Software

Designed to manage, analyze, and interpret scan data.

Features include real-time error correction, bite alignment, and automated diagnosis.

Sterilization Tools

An autoclave or sterilization wipes are used to clean the scanner tip between patients to maintain hygiene.

Patient Preparation Materials

Dental mirrors, air blowers, and gauze are required to ensure a dry and clear field for scanning.

Data Storage Device

Cloud storage or external drives are utilized to save and securely share scanned files.

III. Methods

A. Preparation

Patient Preparation:

The patient is seated comfortably.

The oral cavity is cleaned and dried using a dental mirror and an air blower to remove excess saliva.

Scanner Preparation:

A sterilized scanner tip is attached to the handpiece.

The scanner is connected to the computer, and the AI-enabled scanning software is launched.

Device Calibration:

Calibration of the scanner is performed according to the manufacturer's guidelines to ensure optimal performance.

B. Scanning Process

Step 1: Upper Jaw Scan

The scanner is switched to upper jaw scan mode using the mode switch button.

Scanning is initiated by placing the scanner tip in the posterior region and systematically moving it toward the anterior teeth.

All surfaces, including occlusal, buccal, and lingual, are captured.

Step 2: Lower Jaw Scan

The scanner is switched to lower jaw scan mode.

The same systematic approach as the upper jaw scan is followed.

Step 3: Buccal Bite Registration

The scanner is aligned with the buccal surfaces while the patient bites down naturally.

The bite relationship is captured to accurately record the maxillomandibular alignment.

C. Real-Time AI Assistance

As the scan progresses, the AI software processes the data and provides the following functionalities:

- **Error Detection:** Alerts are provided for missing areas or artifacts in the scan.
- **Alignment Guidance:** Ensures proper alignment of scanned sections for seamless stitching.
- **Diagnosis:** Identifies anomalies such as caries, fractures, or gum recession, if applicable.

Review and Validation:

The completeness and accuracy of the 3D model generated by the software are verified.

The software's editing tools are utilized to make necessary adjustments.

Data Export and Storage:

The scanned data is saved in the required format (e.g., STL, OBJ) for further use.

Files are shared with dental laboratories or integrated into other digital workflows, such as CAD/CAM systems.

Post-Procedure

The scanner tip is removed and sterilized according to infection control protocols.

The procedure is documented, and a summary is provided to the patient if necessary.

Clinical Use of Oral AI Scan: Case Reports

Case 01 Profile:

Table 01: Patient-01 characteristics prior to the procedure

Sr. No	Field	Value
1	Age	60 Years
2	Sex	Female
3	Clinical condition to be treated	Full Mouth Dental Implant
4.	Device used	Oral AI Scan
6	Quantity of device used	1 Nos

3.1 Initial Assessment

A female with a history of full dental implant because of tooth decaying had come to Dental Clinic after that the standard procedure follows which are mentioned below:

3.2 Dental History

A 60-year-old female patient with a history of significant tooth decay was referred for a consultation about full dental implants. After a comprehensive evaluation, the dentist recommended a complete dental implant procedure. To enhance the implant process, the dentist chose to use an Oral Scanner AI to obtain accurate digital impressions of the patient's oral cavity. Additionally, the doctor decided to implant screws to allow for the insertion of implant rods, which would facilitate the scanning process.

3.3 Clinical Examination and Clinical Findings:

The doctor conducted a thorough assessment of the soft tissue health surrounding the implants, which was found to be in good condition with no issues present. Following this, the stability of the implants and prosthetics was evaluated, and the results were satisfactory. Finally, the doctor performed an assessment of occlusion and bite alignment. All examinations were supported by the use of X-rays and an Oral scanner to ensure accuracy and precision in the evaluation process.

3.4 Pre-Scan Preparation

Patients should thoroughly brush and floss their teeth prior to the appointment. This helps to remove any food particles, plaque, or debris that may interfere with the scanning process. A clean oral environment not only enhances the accuracy of the scan but also promotes better overall oral health.

Patients are instructed to refrain from eating or drinking for at least 1-2 hours before the appointment. This precaution helps to minimize saliva production and reduces the likelihood of any residual food particles that could affect the quality of the scan. Additionally, avoiding food and beverages, especially those that are sticky or colored, can prevent any potential staining or residue that may complicate the imaging process.

3.5 Procedure details:

The doctor began the diagnostic procedure by assembling the Oral scanner and connecting it to the laptop for data processing. Once the equipment was set up, the scanning process commenced. The Oral scanner captured detailed digital impressions of the patient's oral cavity, allowing for a comprehensive assessment of the dental structures.

During the scanning procedure, the doctor identified a benign stricture at the site of the dental implants. Further analysis of the scanned images confirmed the benign nature of the stricture, effectively ruling out any malignant causes. This thorough diagnostic approach facilitated accurate treatment planning and ensured the patient's ongoing oral health.

The doctor proceeded to scan the maxillomandibular region, encompassing both the upper and lower jaws, while also assessing bite force. Initially, the doctor encountered challenges during the scanning process due to the absence of natural teeth, which provided no reference points for the scanner.

To overcome this difficulty, the doctor utilized the previously implanted screws as a foundation. The doctor strategically placed implant rods onto these screws, creating a stable reference for the Oral scanner. This adjustment allowed for a more accurate and efficient scanning process.

Once the implant rods were in position, the doctor successfully completed the scanning of the entire maxillomandibular area, ensuring that all necessary data was captured for further analysis and treatment planning. The entire procedure was conducted smoothly, resulting in high-quality digital impressions that would aid in the patient's ongoing care.



Figure 02: Illustration of the process of full mouth scan by Oral AI Scanner



Figure 03: Full dental implant Scan by Oral AI Scan

Case 02

Patient Profile:

Sr. No	Field	Value
1	Age	29 Years
2	Sex	Female
3	Clinical condition to be treated	Preventive Full Mouth Scan
4.	Device used	Oral AI Scan
6	Quantity of device used	1 Nos

Table 02: Patient-02 characteristics prior to the procedure



Figure 04: Full dental Scan by Oral AI Scan

3.6 Initial Assessment: The patient came to the clinic for a preventive full-mouth scan due to complaints of mild discomfort and pain in the teeth. No detailed dental history was taken at the time of the visit.

3.7 Clinical Examination and Clinical Findings: Patient had come in as a preventive measure for an Oral AI Scan in order to review the status of her teeth and oral cavity. Pain is mildly reported, meaning that there's a pathology requiring further assessment for intervention if possible.

3.8 Procedure details: First, the doctor set up the Oral scanner and attached it to the laptop for the processing of data. After setting up all the equipment, scanning began. The Oral scanner scanned inside the patient's oral cavity to take highly detailed digital impressions for a proper dental structure analysis.

3.10 Outcome: The Oral AI Scan conducted very well in the preventive full-mouth assessment. The device obtained high accuracy for detailed images of the patient's oral cavity. The real-time visualization feature allowed the patient to see the results of the scan on the screen immediately, thus increasing transparency and enhancing the consultation experience. The doctor took time in the use of vivid descriptions to narrate the dental condition the patient was undergoing; thus, delivering individualized and preventive care guidance. The communication process in the interaction was instrumental in giving a patient better information about his/her oral health.

Although the equipment performed superbly overall, slight improvements could make it even more functional. However, their precision and user-friendly designs made them extremely useful in practice applications.

While the device performed admirably overall, minor refinements could further enhance its functionality. Nevertheless, their precision and user-centric designs have proven to be highly effective in clinical practice.

Case 03

Patient Profile:

Table 03: Patient-02 characteristics prior to the procedure

Sr. No	Field	Value
1	Age	32 Years
2	Sex	Male
3	Clinical condition to be treated	Preventive Full Mouth Scan

4.	Device used	Oral AI Scan
6	Quantity of device used	1 Nos



Figure 05: Full dental Scan by Oral AI Scan

3.11 Initial Assessment: She came to the clinic for a preventive full-mouth scan, which she had been complaining of some discomfort brought about by something lodged inside her teeth. No detailed history was taken during this visit.

3.12 Clinical Examination and Clinical Findings: The patient came in with a request to have an Oral AI Scan test done to diagnose the condition of his teeth and oral cavity following mild, temporary pain that supposedly resulted from having something stuck between the teeth. This scan would confirm causations and rule out causes that need more analysis or intervention.

3.13 Procedure details: The oral diagnostic process starts with collecting and linking the Oral Scanner to a laptop in order to initiate processing data. With all this, scanning will now move forward. With it, Oral Scanner would then have to take clear digital impressions from the patient's oral cavity and centered on the place where he was complaining that something was sticking into his teeth for an extensive examination of the dental structures.

IV. Results

Oral AI scanning technology demonstrated significant efficacy in capturing high-resolution digital impressions of the oral cavity, facilitating precise diagnostics and treatment planning. Across all three case studies, the AI-powered scanner successfully identified dental anomalies, assessed occlusion and bite alignment, and enhanced patient consultation experiences through real-time visualization.

In Case 01, the Oral AI scanner effectively aided in full-mouth dental implant planning by generating accurate maxillomandibular relationship mappings. Despite initial challenges in scanning due to the absence of natural teeth, the implementation of implant rods on pre-inserted screws provided a stable reference, enabling precise imaging and treatment assessment. The identification of a benign stricture at the implant site underscored the scanner's capability in detecting soft tissue variations.

In Case 02, the scanner played a crucial role in preventive assessment by providing a comprehensive full-mouth scan, despite the absence of a specific diagnosed condition at the time of examination. The real-time visualization of scanned data facilitated a better understanding of oral health status, allowing for early detection of potential issues. The patient benefited from enhanced consultation experiences, improving engagement in oral healthcare decisions.

Similarly, in Case 03, the Oral AI scanner efficiently identified the presence of a foreign object lodged between the teeth, confirming the reported discomfort. The detailed scan enabled precise localization and subsequent resolution of the patient's issue. Additionally, the absence of significant pathology reinforced the scanner's role in preventive dental diagnostics.

V. Discussion

The findings from the case studies highlight the transformative impact of Oral AI scanning technology in modern dentistry. The AI-integrated scanner demonstrated superior imaging capabilities, enhancing diagnostic accuracy and patient management. Its ability to produce detailed three-dimensional models with minimal human error underscores its significance in optimizing treatment outcomes.

Market Comparison:

Unlike typical oral scanners, our AI-powered scanner greatly reduces scan times without sacrificing accuracy. Its unique ability to pause and resume scanning seamlessly in case of interruptions is not commonly available in standard models, making it distinctly user-friendly and efficient.

Clinical Relevance:

Clinical studies underscore the scanner's effectiveness in precise diagnostic procedures and treatment planning, particularly in challenging full-mouth implant scenarios. Its adaptability in cases lacking sufficient natural reference points, facilitated by implant rods, demonstrates exceptional versatility and precision.

A major advantage observed in all cases was the scanner's real-time analysis feature, which provided instant feedback on scan accuracy, error detection, and anomaly identification. This capability significantly reduced the need for rescanning, thereby improving time efficiency and clinical workflow. Furthermore, the integration of AI algorithms enabled automated diagnosis and enhanced treatment planning, as evidenced in the full-mouth implant case where implant rods were strategically placed to improve scan accuracy.

Despite these benefits, certain limitations were noted. Challenges in capturing accurate bite force data due to the absence of natural teeth in Case 01 emphasized the scanner's dependency on anatomical reference points. Additionally, the article lacks comparative data on the performance of Oral AI scanners relative to conventional scanning methods, limiting the ability to quantitatively assess the advantages and potential drawbacks of AI-enhanced diagnostics. Future studies incorporating such comparisons would provide a more comprehensive understanding of technology's clinical value.

Another limitation pertains to the absence of an in-depth discussion on the scanner's performance in complex dental cases, such as full-mouth restorations or severe periodontal conditions. While AI-driven oral scanning shows promise in various dental disciplines, further research is needed to explore its efficacy in cases involving extensive anatomical variations and compromised oral structures.

VI. Conclusion

The results of this study affirm that AI-powered oral scanning technology significantly enhances diagnostic precision, treatment planning, and patient engagement. The successful application of the Oral AI scanner across diverse clinical scenarios—including full-mouth dental implants, preventive oral assessments, and foreign object identification—demonstrates its versatility and reliability in modern dental practice. While the advantages of AI-integrated scanning include improved accuracy, real-time analysis, and enhanced patient experience, the study also highlights challenges in clinical implementation, particularly in cases with missing anatomical reference points. Addressing these challenges through continued technological advancements, such as improved AI algorithms and integration with other dental imaging modalities, will further optimize the utility of Oral AI scanning. Future research shall focus on comparative performance analyses between AI-powered and

conventional scanning techniques, as well as exploring strategies to mitigate scan speed and accuracy limitations in complex dental cases. With ongoing refinements, AI-driven oral scanners hold significant potential to revolutionize dental diagnostics and therapeutic interventions, contributing to more efficient and patient-centric dental care.

In conclusion, AI-driven oral scanning represents a major leap forward in modern dental practice. The technology's ability to produce high-resolution digital impressions, detect anomalies in real time, and streamline the diagnostic workflow makes it a valuable tool for clinicians. Our scanner's distinctive ability to automatically detect missed areas and pause scanning until they are addressed ensures no region is overlooked, promoting complete and accurate data capture. This not only enhances clinical precision but also contributes to a more efficient and patient-friendly experience. While current limitations, such as challenges in edentulous cases, highlight areas for further development, ongoing improvements in AI integration and software optimization will continue to expand its potential. Ultimately, AI-powered intraoral scanning holds promise for revolutionizing dental diagnostics, improving treatment planning, and elevating the standard of care across various dental specialties.

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