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Intraoral Scanners in Prosthodontics: A Review

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ABSTRACT

Intraoral scanners (IOS) have revolutionized the field of prosthodontics by offering a digital alternative to conventional impression-making techniques. They provide a faster, more comfortable experience for patients and are known for their accuracy and ease of integration into digital workflows. This review aims to explore the advancements, benefits, limitations, and future trends of intraoral scanners in prosthodontics. Twenty references are included to provide a comprehensive overview of their clinical utility.

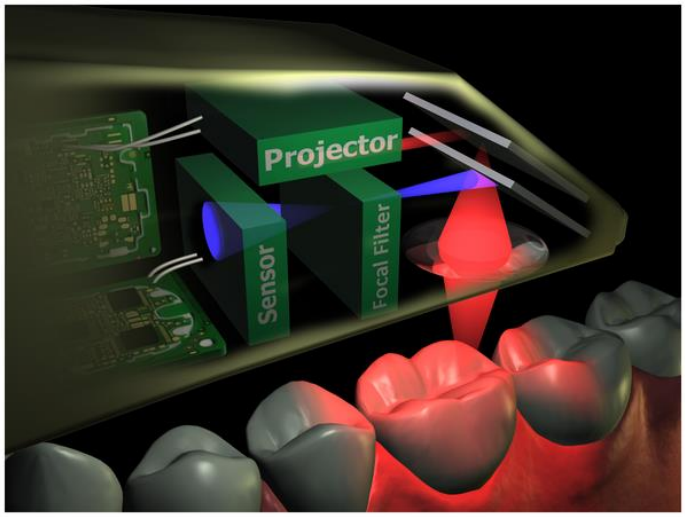
Introduction

Intraoral scanners (IOS) are rapidly becoming a standard tool in modern prosthodontic practice. Traditional impression-making techniques, while effective, are often cumbersome and can cause discomfort to patients[1]. The digital impression, facilitated by IOS, offers numerous advantages including improved accuracy, patient comfort, and workflow efficiency. This review will examine the role of intraoral scanners in prosthodontics, discussing their clinical advantages, limitations, technological advancements, and potential future developments[2].

(Fig.1: Intra oral Scanner)

Principles of Intraoral Scanning Technology[3]

Intraoral scanners utilize optical imaging technologies to capture a 3D representation of the dental arches. These devices emit a light source—such as laser or structured light—onto the surface of the teeth and soft tissues, which is then reflected back to the scanner's sensors. The captured data points are processed and converted into a digital 3D model using software algorithms. Some scanners use video or photographic methods to capture data in a continuous flow, while others rely on individual image stitching.



(Fig2: Principle of IOS)

Intraoral Scanning Procedure[8]

Intraoral scanning is a digital process that captures a detailed 3D representation of a patient's dental anatomy, including teeth, gums, and surrounding structures. The procedure is used to create digital impressions for various dental restorations, such as crowns, bridges, veneers, and implant-supported prostheses. Here's a step-by-step overview of the intraoral scanning procedure:

1. Patient Preparation

-Oral Hygiene: Ensure the patient's mouth is clean and free of debris. A pre-scan rinse or brushing may be recommended to remove any plaque or food particles.

-Drying the Area: Dry the teeth and surrounding tissues to minimize the presence of saliva, which can interfere with the scanner's ability to capture accurate images. Air syringes and cotton rolls can be used for this purpose.

2. Setting Up the Intraoral Scanner

- Calibration: Calibrate the intraoral scanner according to the manufacturer's instructions. This may involve adjusting the scanner's settings or calibrating the tip to ensure accurate imaging.

- Scanner Sterilization: Ensure the scanner tip or wand is properly sterilized or covered with a disposable sheath to maintain hygiene and prevent cross-contamination.

3. Scanning Technique

- Starting Point: Typically, the scanning process begins in the posterior region (usually the molars) of one quadrant and progresses to the anterior teeth. The clinician should have a systematic approach to scanning to ensure all surfaces are captured.

-Scanning Motion: The scanner is moved slowly and steadily across the surfaces of the teeth and gingiva. A zigzag or circular motion is often used to capture the occlusal, buccal, lingual, and interproximal surfaces. The goal is to maintain a consistent distance between the scanner tip and the tooth surfaces to capture clear images.

-Overlapping Scans: Overlapping the scanned areas slightly ensures that no part of the dental arch is missed. It also helps the software to stitch the images together more accurately.

4. Real-Time Visualization and Feedback

-Immediate Feedback: The scanner provides real-time visualization on a monitor, allowing the clinician to see the digital model as it is being created. This feature helps identify any missed areas or inaccuracies, which can be corrected immediately.

-Color Coding: Some scanners use color coding (e.g., green for captured areas and red for missed spots) to guide the clinician in achieving a complete scan.

5. Capturing Additional Details

-Scan Refinement: After the initial scan, the clinician can refine specific areas that require more detail or have artifacts. This step ensures high accuracy, particularly in areas critical for prosthesis fabrication, such as margins and contact points.

-Bite Registration: To capture the patient's occlusion, the clinician asks the patient to bite down, and a scan is taken of the occlusal surfaces of the upper and lower arches in contact. This helps record the bite relationship for accurate articulation of the digital model.

6. Post-Scanning Adjustments

-Inspection and Editing: Once the scan is complete, the digital model is reviewed on the software platform. The clinician can trim any unnecessary data, smooth out rough edges, or add additional scans to fill in gaps.

- Verification: The software may offer tools to measure distances and check for undercuts, adequate clearance, and proper preparation margins. This step ensures the scan meets the necessary criteria for fabrication.

7. Data Processing and Transfer

-Saving the Scan: The final digital impression is saved in the appropriate format (e.g., STL, PLY, OBJ). It is essential to ensure the file is compatible with the CAD/CAM software and any third-party milling centers.

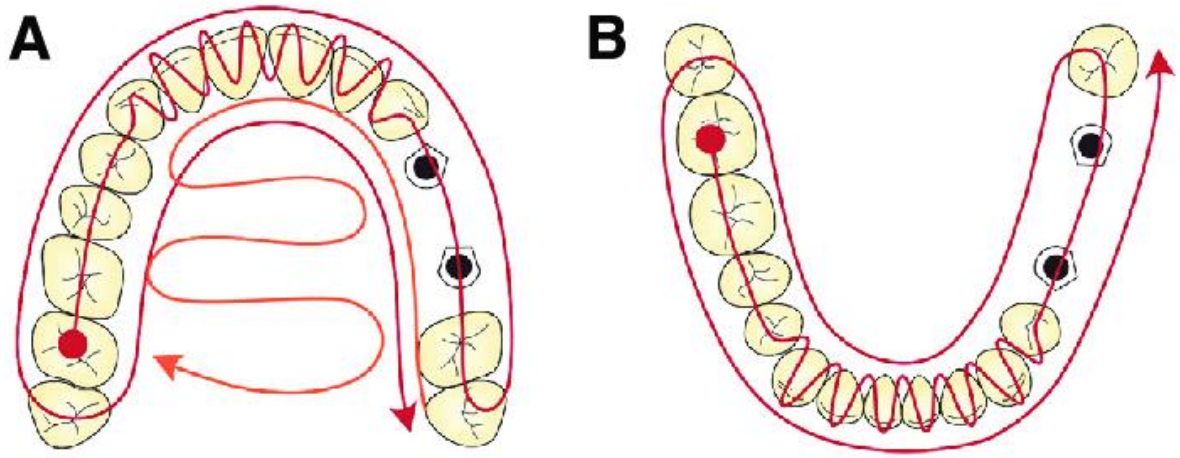
-Transfer to Lab: The digital file is then securely transmitted to a dental laboratory or in-office CAD/CAM system for designing and fabricating the final prosthesis. The transfer can be done via email, cloud-based platforms, or directly through integrated software systems.

8. Post-Procedure Care

-Patient Feedback: After the scanning procedure, check in with the patient to address any discomfort or questions. Provide instructions on oral hygiene and care while waiting for the final restoration.

-Cleaning and Maintenance: Clean the intraoral scanner according to the manufacturer's guidelines. Disinfect the scanner body and sterilize or dispose of the scanner tips to maintain hygiene standards.

Scanning sequence[4]:



(Fig3: Scanning sequence with IOS: (A) upper jaw, (B) lower jaw.)

Advantages of Intraoral Scanners in Prosthodontics[5]

1. Accuracy and Precision: Several studies have confirmed that intraoral scanners provide comparable, if not superior, accuracy to traditional impression materials (Ender et al., 2013; Güth et al., 2013).

2. Patient Comfort: Digital impressions eliminate the need for impression trays and materials, which can cause gagging and discomfort in some patients (Yuzbasioglu et al., 2014).

3. Time Efficiency: The use of IOS can reduce the time required for impression-taking and minimize the number of clinical appointments needed (Burhardt et al., 2016).

4.Improved Communication with Laboratories: Digital files can be easily shared with dental laboratories, facilitating better communication and reducing the chances of errors in prosthesis fabrication (Mangano et al., 2016).

5. Integration with Digital Workflow: IOS is easily integrated into a complete digital workflow that includes CAD/CAM systems, which streamlines the fabrication of prostheses and improves the predictability of outcomes (Lee et al., 2019).

6. Immediate Feedback: The digital nature of IOS allows clinicians to review the impression in real-time, immediately identifying and correcting any errors (Joda et al., 2017).

Limitations of Intraoral Scanners[7]

1.Learning Curve: Mastering the use of intraoral scanners can require a significant learning period, particularly for older practitioners accustomed to traditional methods (Henkel, 2014).

2.Initial Cost and Maintenance: The initial investment for intraoral scanners is relatively high, and they require regular software updates and maintenance (Patel, 2010).

3.Limitations in Scanning Edentulous Areas: IOS may struggle to accurately capture soft tissue details in fully edentulous patients or undercuts, which can affect the fit of dentures (Yoon et al., 2019).

4.Artifacts and Errors: Errors such as image stitching artifacts can occur, especially if the scanner is moved too quickly or if there is inadequate moisture control in the oral cavity (Richert et al., 2017).

Clinical Applications of Intraoral Scanners in Prosthodontics[6]:

1.Fixed Prosthodontics: IOS is widely used for capturing digital impressions for crowns, bridges, inlays, and onlays. Their accuracy has been validated for single-unit restorations and short-span fixed partial dentures (Tsirogiannis et al., 2016).

2.Removable Prosthodontics: While there are challenges in capturing fully edentulous arches, digital impressions for partial dentures and implant-supported overdentures are increasingly common (Imburgia et al., 2017).

3.Implantology: IOS provides accurate scans for implant placement and restoration, facilitating guided surgery and precise abutment fabrication (Mangano et al., 2017).

Technological Advances and Future Directions[8]:

Recent advancements in IOS technology have focused on improving speed, accuracy, and ease of use. Some scanners now incorporate artificial intelligence to assist in margin detection and soft tissue management. Future trends may include further integration with augmented reality for real-time visualization of prosthetic outcomes and enhanced software algorithms for better accuracy in challenging clinical scenarios (Zimmermann et al., 2017).

Conclusion

Intraoral scanners are an invaluable tool in contemporary prosthodontics, offering numerous benefits over traditional impression techniques. Despite some limitations, ongoing advancements in technology are likely to overcome these barriers, leading to broader adoption and more widespread use in various prosthodontic applications. The digital revolution in dentistry, spearheaded by IOS, promises enhanced patient outcomes, streamlined workflows, and improved prosthetic accuracy.

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