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Specific features of current intraoral scanners: A literature review

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Abstract
Introduction: The precision of data collected by intraoral scanners plays a crucial role in the success of final treatment in today's digital dentistry world.
Objective: This study aimed to compile the most relevant information on different oral scanners in the market, such as their advantages, scanning accuracy, scanning methods, and scanning speed.
Methodology: A search for scientific literature articles was conducted on virtual databases PubMed, Google Academic, and EBSCO. Keywords used in the search included "intraoral scanner," "Digital dentistry," "Digital impression," and "oral scanner accuracy."
Results: The use of intraoral scanners provides dentists with the ability to streamline work, making it more comfortable for patients without compromising impression quality. Accuracy varies depending on the scanner, operator experience, and patient characteristics. Scanning speed is influenced by factors such as environmental light, scanning strategy, and equipment used.
Conclusions: Scanner technology is an indispensable tool in current workflows, aiming to achieve quality work efficiently and comfortably for patients.

Keywords: "Dental Scanner," "Digital dentistry," "Accuracy," "Scanning strategy," "Digital impression"

1. Introduction
The precision of data collected by intraoral scanners is crucial for the success of final treatment in today's digital dentistry world [1]. Digital impressions with intraoral scanners significantly impact dental treatment, with expanding applications, including capturing the final color of restorations [2].

Their use allows for digital workflows even in implant procedures [3]. Despite widespread use, there is limited data on the accuracy of digital impressions with different scanner parameters and scanning techniques [4]. Scanner-related uncertainties include the impact of full-arch scanning strategies on scanning accuracy[5] and the limited accuracy of heavy scans for clinical use [6].

As digital advancements in dentistry continue, the decision to invest in an intraoral scanner is significant for dentists, requiring key information for informed choices. This study aims to compile essential information on intraoral scanner characteristics, including scanning accuracy, scanning speed, scanning methods, and ease of use.

2. Methods
A literature search focused on intraoral scanner use and its various characteristics. Articles from 2000 to 2023 were retrieved from virtual databases PubMed, Google Academic, and EBSCO, using keywords such as "intraoral scanner," "digital dentistry," "digital impression," and "oral scanner accuracy." Additional searches included related subtopics. Selected studies included *in vitro* designs, case studies, and literature reviews, totaling 30 articles.

3. Results
3.1 Advantages of Scanner Use
Intraoral scanners have transformed dental imprisoning, offering a reliable tool for high-

quality impressions used in various restorations [7]. Veracity and precision values for restorations are comparable to analog impressions, ensuring accuracy [8].

Current intraoral scanners are considered more comfortable than traditional impressions using irreversible hydrocolloids or elastomers [9]. Patient satisfaction with intraoral scans is generally higher due to their comfort and speed compared to conventional impression procedures [10]. Restorations and fixed dental prosthetics created with current printing software and intraoral scanners meet acceptable marginal space standards, whether for direct or indirect procedures [11].

While edentulous patients pose challenges, intraoral scanners demonstrate comparable accuracy to conventional materials for scanning edentulous arches, regardless of the concepts used to express accuracy and precision [12].

With diverse applications in modern dentistry, having an intraoral scanner has become a requirement, facilitating faster patient care without compromising quality.

3.2 Scanning Accuracy
Scanning accuracy is influenced by operator experience, scanner type, and scanning size. Experienced operators and smaller scan sizes result in more accurate scans [13]. Literature suggests that scans with a smaller tip may show less fidelity than those with a regular tip, a factor to consider [14].

Among available options, the Prime Scan (Dentsply Sirona) has demonstrated the highest accuracy for single crowns in a past study [15]. However, full-arch scans emphasize the importance of the scanner used and the scanning sequence for accuracy [16].

Digital impressions from different intraoral scanners are suitable for partial arch impressions, but challenges remain for full-arch impressions. Certain devices meet the required clinical quality for proper treatment, but more *in vivo* studies are needed to confirm these results [17].

Significant differences in digital impression accuracy exist between intraoral scanners and scanning sequences for removable prostheses. Trios scanner's accuracy and precision of Trios, Primescan, and iTero scanners are significantly superior to others [18]. For edentulous patients, Prime Scan outperforms scanners like i500 or Trios 3 [19].

Additional information indicates that digital impressions for inlays are less accurate than those for crowns, and the presence of adjacent teeth decreases scanning precision [20].

Despite various intraoral scanners, their accuracy is comparable to traditional methods, emphasizing the operator's need for precise handling.

3.3 Scanning Methods
Literature suggests that fast scanning speed and S-shaped scanning patterns result in less accurate scans compared to regular or slow scanning speeds and occlusal-first scanning patterns [14].

Specific methods for each scanner increase the accuracy of full-arch scans, as shown by studies comparing scanning strategies for Primescan and Omnicam [21].

Following appropriate scanning techniques makes equipment handling more comfortable and reduces scanning time [22]. Extracoronal preparations are more accurate than intracoronal ones. The conicity of the axial wall directly affects IOS scan fidelity [23]. Scanning methods for edentulous arches appear to be a new focus, requiring techniques that expand possibilities for edentulous patient care [24].

Determining the best scanning method requires consideration of manufacturer indications and literature recommendations,

with the chosen technique reflected in the obtained scan.

3.4 Scanning Speed
There is no ideal scanner with the best combination of accuracy and scanning speed. For instance, in a study comparing Medit700 and Trios3, Medit i700, using triangulation acquisition, showed lower fidelity and precision but higher scanning speed [25].

The scanning pattern affects accuracy and precision in some scanners, with differences in scanning speed for full arches, fidelity, and precision for each scanner. The scanning pattern plays a significant role in digital impression success [26], influencing the speed of digital impressions [27].

Ambient light is a consideration, influencing scanning time for different scanners. Optimizing ambient light illuminance for each scanner is necessary to maximize scanning accuracy and efficiency [28].

Intraoral conditions and patient-specific factors may affect scanning speed. Dental professionals need to understand these patient factors to maximize scanner accuracy [29].

Operator skills and clinical decisions significantly influence intraoral scanning precision and speed, as seen previously[30]. Full-arch scans may take longer if specific difficulties in the mouth or patient scanning are encountered [31].

While speed is a priority in dental care, various factors play a key role in quickly obtaining a digital model, requiring maximum control for efficient use of time.

Conclusions
Thanks to oral scanning technologies, we can now offer patients more comfortable and less invasive methods for impressions, reducing the time for impressions while obtaining the necessary quality for delivering high-quality work. Although limitations exist, the current pace of technology development suggests that the use of scanners will soon be a necessity rather than a luxury for dentists.

Conflict of Interest
Not available

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