

Comparative study of intraoral scanners vs conventional molding: literature review

Comparativo da utilização do scanner intraoral frente a moldagem convencional: revisão da literatura

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ABSTRACT

This article discusses the importance of intraoral scanners in contemporary dentistry, focusing on their comparison with conventional molding. Traditionally, dentistry utilized molding methods to obtain precise dental impressions; however, these methods were uncomfortable for patients and could lead to inaccuracies. Intraoral scanners, being technologically advanced, have transformed this approach by enabling precise 3D scanning of the oral cavity, eliminating discomfort and enhancing efficiency and accuracy in the data capture process. The article explores the evolution and functionality of these devices, their clinical applications, advantages, disadvantages, and ethical considerations, aiming to provide a comprehensive understanding of their beneficial impact on contemporary dental practice.

Indexing terms: Cost Analysis. Dentistry. Methods. Patients. Technology.

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RESUMO

O artigo aborda a importância dos scanners intraorais na odontologia contemporânea, com foco no comparativo a moldagem convencional. Tradicionalmente, a odontologia usava métodos de moldagem para obter impressões dentárias precisas, mas estes eram desconfortáveis para os pacientes e podiam resultar em erros. Os scanners intraorais, tecnologicamente avançados, transformaram essa abordagem, permitindo digitalização 3D precisa da cavidade oral, eliminando desconfortos e proporcionando maior eficiência e precisão no processo de captura de dados. O artigo explora a evolução e funcionamento desses dispositivos, suas aplicações clínicas, vantagens, desvantagens e considerações éticas, visando oferecer uma visão abrangente de seu impacto benéfico na prática odontológica contemporânea.

Termos de indexação: Análise de Custo. Odontologia. Métodos. Pacientes. Tecnologia.

INTRODUCTION

In contemporary dentistry, the relentless pursuit of technological advancements and improved treatment methods drives the evolution of clinical practice. According to Neto [1], the application of this technology offers several advantages, including reduced clinical time, decreased errors caused by dimensional alterations in materials and impression techniques, enhanced communication between the clinician and the laboratory, and, in some cases, the elimination of a second clinical session. This literature review aims to explore the crucial importance of intraoral scanners in contemporary dentistry, specifically in the comparative context of conventional versus digital molding using intraoral scanners.

The use of intraoral scanner technology in dentistry enables precise and perfect adaptation in clinical applications, ensuring not only the intended objectives of the molding process but also proper masticatory function, aesthetics, and patient comfort. According to Tamin [2], inaccurate impressions can lead to inadequate marginal adaptation of restorations. The long-term durability of fixed restorations is directly influenced by marginal discrepancies, which play a crucial role in the degradation of the cement, one of the main factors contributing to restoration failure. Poor marginal adaptation can facilitate plaque accumulation, ultimately resulting in caries and periodontal tissue inflammation.

Intraoral scanners have revolutionized the way dentistry approaches data capture and the fabrication of single-unit crowns. The production of restorations using the CAD/CAM technique involves three phases: acquiring a three-dimensional image, designing the component in CAD software, and manufacturing the component using Computer-Aided Manufacturing (CAM) [3]. The excellence of restorations produced via the CAD/CAM system is intrinsically tied to the quality of the three-dimensional images used in the design process, which are destined for printing through CAM milling machines or printers [4].

The objective of this literature review is to deepen the understanding of the impact of intraoral scanners on dental practice compared to conventional molding. To achieve this goal, the history and evolution of this technology, its functionality, and relevant clinical applications were examined. Additionally, the review explores the advantages and disadvantages of intraoral scanners, as well as the ethical and practical considerations associated with their use. By the conclusion of this review, the aim is to provide a comprehensive perspective on the implications and benefits of this innovative technology in contemporary dental practice.

METHODS

This study employs a qualitative approach through an integrative literature review, allowing for the identification, synthesis, and comprehensive analysis of relevant information on a specific topic. The methodological steps involved defining the research topic and formulating the research question, establishing eligibility criteria, conducting a database search, categorizing and analyzing information, critically evaluating selected studies, and presenting the results with a critical analysis and synthesis of the review.

The guiding question of this review focused on investigating the advantages and disadvantages of intraoral scanners compared to conventional molding. To conduct this investigation, the databases BVS, SciELO, Science Direct, and Google Scholar were consulted. Inclusion criteria required articles to be published between 2013 and 2023, available in English or Portuguese, provide full-text access, address the research question, evaluate the use of intraoral scanners, compare intraoral scanners with other molding techniques, or involve studies conducted on humans. Articles without full-text availability, those irrelevant to the research topic, or duplicate entries were excluded.

Initially, the search yielded 1,873 articles, of which 36 met the inclusion criteria. After removing duplicates, 25 articles remained. However, only 25 articles were ultimately selected after a thorough reading and critical analysis of the texts to compose this review.

RESULTS

The development of intraoral scanners represents a remarkable milestone in the evolution of modern dentistry. According to Rosero [5], over the past decades, dental treatments for patient rehabilitation have undergone a drastic transformation due to advancements in techniques, materials, and, most notably, technology. Impression-taking has long been a common practice in dentistry and plays a crucial role in oral rehabilitation, as an accurate record of dental preparations for prosthetics ensures the success of treatment. Techniques and materials, such as polyethers and silicones, have evolved as the industry introduced increasingly precise and reliable materials to the market. However, these methods are not free from errors associated with materials and, above all, operator-related issues.

Nucci [6] highlights that the digital revolution, which has spread across dental laboratories and clinics in recent years, has paved the way for the concept of the virtual patient. This innovation allows for the representation of all oral cavity tissues in a single 3D model, enabling the creation of digital impressions, the design of restorations using computer software, and the production of restorations with the aid of milling machines or 3D printers. This comprehensive digital workflow has integrated intraoral scanners as powerful tools for capturing digital impressions.

Through a literature review, it was possible to analyze intraoral scanners and their various applications, as summarized in Chart 1, showcasing how these devices have enhanced precision, efficiency, and comfort for both patients and oral health professionals.

Nucci [6] noted that, despite the accurate detection offered by conventional impressions, they present several disadvantages. For patients, discomfort arises from materials that are often poorly tolerated; for practitioners, there is material waste and susceptibility to imperfections in impressions, which demand greater professional expertise. Digital impression techniques minimize these drawbacks and are not only significantly more precise but also better tolerated by patients. They are easier to use, eliminate material

Chart 1. Clinical applications of intraoral scanners.

| | |
|--------------------|---|
| Single Crowns | The a daptation for single-unit crowns is superior when using an intraoral scanner, as it is not only more precise than scanning models or molds but also faster and more cost-effective by eliminating the need for an intermediate conventional step [7]. |
| Dental Prosthetics | The workflow becomes significantly faster, simpler, and more predictable with the application of digital treatment planning in the area of fixed prosthetics, further revolutionizing oral rehabilitation. However, additional research is still needed to complement existing studies and establish standardized protocols, whether conventional or digital. Ultimately, it is up to the professional to select the material (IOS and software) deemed most appropriate for each specific situation and aligned with their daily clinical routine [8]. |
| Orthodontics | The use of intraoral scanners in orthodontic planning demonstrates significant benefits, such as accurate capture of oral structures, agility in obtaining digital models, and improved patient communication. However, limitations remain, including high costs and handling difficulties, particularly for older professionals. Despite these challenges, intraoral scanner technology represents a major advancement in orthodontics, delivering more precise and personalized results [9]. |
| Implantology | The recent introduction of intraoral scanners in implantology offers new alternatives for treatment. These devices are undoubtedly here to stay; however, technological advancements are still needed to address limitations, reduce equipment costs, and expand the range of clinical applications. The possibility that they may one day fully replace conventional molding techniques cannot be ruled out [10]. |

waste, and remove many clinical and laboratory phases that could introduce errors in prosthetic work. With evident time reductions, digital impression techniques have become a valid, modern, and reliable option for dental practices.

According to Polido [11], the primary advantage of intraoral scanners for dental technicians and clinicians lies in eliminating many chemistry-based processes inherent to traditional methods. By virtually eliminating these processes, the cumulative error in treatment and fabrication cycles ceases to be a significant concern. Examples of such processes include the setting of impression materials, base gypsum, and die material for restorations, as well as shrinkage or contraction in conventional feldspathic ceramic materials. By replacing conventional impressions, clinicians no longer need to worry about errors stemming from air bubbles, material fractures, tray displacement or movement, insufficient material, inadequate adhesives, or distortions caused by disinfection procedures.

Moura [12] emphasized that with CAD/CAM technology, oral conditions are digitally recorded using a 3D intraoral scanner, and the captured information enables the creation of a virtual model. Definitive restorations are then fabricated based on this digital model. This approach offers notable advantages, including reduced patient discomfort, faster data transfer, enhanced communication between professionals and prosthetic laboratories, and a significant reduction in physical space required for model storage. Intraoral scanning provides speed, efficiency, and seamless storage and transfer of digital data. It is well-received by patients, minimizes distortions, and allows for a 3D preview of preparations.

The literature review facilitated the classification of the main advantages and disadvantages of intraoral scanners compared to conventional molding, their clinical applications, and other aspects. These findings are summarized in Chart 2, which presents the related studies and their primary results.

Chart 2. Research studies on intraoral scanners.

1 of 2

| Author | Study Type | Title | Findings |
|-----------------------|------------------------|--|--|
| Fagundes [7] | Dissertation | Precision of Intraoral Scanners for CAD/CAM Prostheses | Intraoral systems demonstrate superior accuracy compared to extraoral systems, especially for single-unit crowns. They are faster, more economical, and eliminate conventional intermediate steps. |
| Polido [11] | Article | Digital Impressions and Model Handling: The Future of Dentistry | Digital impressions reduce treatment errors and improve efficiency. Patients benefit from greater comfort, and the workflow in dental practices becomes faster and more consistent, marking a digital revolution in dentistry. |
| Moura [12] | Literature Review | The Use of Intraoral Scanners in Dentistry | Intraoral scanners reduce clinical time and eliminate molding processes. Despite high costs and limited application in extensive rehabilitations, they offer a modern, efficient approach with a quick return on investment. |
| Feitosa et al. [13] | Literature Review | Intraoral Scanning in Oral Prosthetic Rehabilitation | Intraoral scanning shows precision similar to conventional molding techniques in most areas, though distortions persist in some. It is viable and increasingly used in various areas of dentistry. |
| Alves et al. [14] | Bibliographic Research | Advantages and Disadvantages of the CAD/CAM System | The CAD/CAM system is a valuable option for producing high-quality prosthetic restorations with various restorative materials. While challenges like space and high costs remain, new technologies enhance these systems. |
| Silva and Mourão [15] | Dissertation | Marginal Discrepancy in Crowns Made Using Conventional vs Digital Techniques | No statistically significant differences in marginal discrepancies were found between ceramic crowns made using conventional and digital impressions. However, further standardized clinical studies are needed. |
| Loiola et al. [16] | Literature Review | Intraoral Scanning: The End of the Gypsum Model Era | Digital models from intraoral scanning are reliable and acceptable alternatives, offering patient comfort and efficient procedures. High costs remain a barrier for many professionals. |

Chart 2. Research studies on intraoral scanners.

2 of 2

| Author | Study Type | Title | Findings |
|---------------------|-------------------|--|---|
| Gozzano [17] | Literature Review | Use of Intraoral Scanners in Rehabilitative Dentistry | Intraoral scanners provide excellent quality and comfort for patients compared to conventional methods. Digital registrations outperform conventional methods in precision, particularly with higher resolutions. |
| Cardoso et al. [18] | Literature Review | Digital Molding in Dentistry: Perspectives Compared to Conventional | Digital molding offers significant technological advantages and is expected to become integral in most dental practices. It surpasses conventional techniques in several aspects. |
| Dos Santos [19] | Monograph | Marginal Adaptation of Single Porcelain Crowns: CAD/CAM vs Pressed Methods | CAD/CAM and pressed porcelain crowns show similar quality. CAD/CAM is faster but requires consideration of equipment costs. Marginal adaptation is comparable between methods. |
| Bósio et al. [20] | Systematic Review | Contemporary Digital Dentistry \u2013 Digital Intraoral Scanners | Scanning methods provide reliable data storage and, when necessary, printed models. Professionals must weigh cost-benefit factors, as the field evolves with continuous innovations. |
| Ferreira [21] | Case Report | Single-Unit Crowns Fabricated Using CAD/CAM | CAD/CAM technology offers significant benefits, including reduced costs, time efficiency, and material availability, making it ideal for prosthetic treatments. |
| Generoso [22] | Case Report | Monolithic Single Zirconia Crown Restoration | Zirconia restorations using CAD/CAM achieve high aesthetic results for posterior teeth with minimal adjustments and fewer clinical sessions compared to conventional techniques. |
| Araujo [23] | Literature Review | Use of Intraoral Scanners in Dentistry | Intraoral scanners provide advantages like reduced clinical time, easier sharing and storage, and high precision. The main limitation remains high costs, but this is expected to decrease with wider adoption. |

According to the literature review, it is evident that intraoral scanners are a revolutionary tool in dentistry, replacing traditional gypsum models to create detailed and accurate representations of the patient’s oral anatomy. These scanners offer high precision in capturing and refining impressions, significantly accelerating the molding process. Unlike conventional methods, digital images eliminate the

need for drying gypsum models and can be promptly shared between dental clinics, prosthetic laboratories, and other specialties, fostering collaboration and enhancing treatment planning.

Feitosa et al. [13] underline that intraoral scanning delivers accuracy comparable to conventional molding in most cases, although some areas still show distortion. Intraoral scanning is considered highly viable and effective within the dental field. Similarly, Alves et al. [14] describe the CAD/CAM system as an innovative approach in dentistry, enabling dentists to produce high-quality prosthetic restorations such as crowns, veneers, bridges, and dentures. While challenges such as space requirements and high costs persist, this technology results in restorations with superior adaptation to the patient's oral anatomy, providing enhanced aesthetics and functionality compared to conventional techniques.

Silva et al. [24] reports no significant differences in marginal discrepancies between ceramic crowns made using conventional and digital impressions, with both methods falling within clinically acceptable limits. However, further standardized clinical studies with larger samples are needed to identify the most precise method for recording oral tissues.

Loiola et al. [16] emphasize that intraoral scanning produces reliable digital models and offers a clinically comfortable option for patients. Benefits include reduced storage requirements and enhanced information security. However, high costs pose a barrier for many professionals. Gozzano [17] concurs, noting that intraoral scanners provide superior quality and comfort compared to traditional methods. While digital and conventional registrations yield similar results, fully digital scans stand out for their precision, particularly with high-resolution images. Additionally, intraoral scanners are praised for their ease of use and efficient communication with prosthetic laboratories.

Cardoso et al. [18] affirm that digital molding is an essential technological advancement in dentistry, expected to become a standard in most clinics due to its numerous advantages over conventional techniques. [9] compares pressed porcelain crowns to CAD/CAM-produced crowns, noting that while both have similar quality, pressed crowns are more time-consuming. CAD/CAM crowns, although faster, require consideration of equipment costs. The precision of marginal adaptation between manual and CAD/CAM processes is comparable.

Moura [12] showcase that intraoral scanners save time and eliminate the need for traditional molding processes. Despite challenges in extensive rehabilitations and high costs, broad adoption could quickly offset these drawbacks, making scanners an asset in dental practices. CAD/CAM technology provides state-of-the-art services for patients and benefits dental professionals. Similarly emphasize that intraoral scanning methods, whether direct or indirect, aim to store information and create printed models when necessary [20,25]. Different brands and equipment offer distinct advantages and disadvantages, which professionals must consider. The field continues to evolve, requiring ongoing attention to emerging solutions.

Fagundes [7] highlights that intraoral scanning systems generally provide greater accuracy than extraoral systems. Particularly for single crowns, intraoral scanners offer superior adaptation, precision, and efficiency, eliminating the need for intermediate conventional steps. Ferreira [21] adds that CAD/CAM systems in dentistry reduce costs, time, and effort for professionals. These systems simplify production, automate workflows, and offer high-resistance materials, making them ideal for prosthetic treatments.

Generoso [22] notes that zirconia restorations using CAD/CAM achieve excellent aesthetic outcomes for posterior teeth, requiring minimal adjustments and fewer clinical sessions than conventional techniques. Araujo [23] underscores advantages such as time savings, easy sharing, storage, security, and precision.

However, high costs limit its widespread use, though increasing adoption is expected to normalize this technology in dental practice.

The adoption of digital molding, as noted by Polido [11], is likely to reduce returns and rework, making treatments more efficient. Patients benefit from greater comfort and a more positive experience at the dentist. Additionally, digital molding improves the consistency of prostheses and reduces chair time for placement. This digital revolution in dental practices is anticipated to enhance planning efficiency, reduce discomfort, and improve treatment outcomes over the coming years.

While many professionals still opt for conventional elastomeric molds, these materials often fall short of laboratory standards due to poor reproduction of prepared margins, risk of tearing, impregnation residue, gaps in critical areas, and material distortion. Precision is paramount in dentistry, requiring careful selection of molding materials and trays suitable for each situation [26].

CONCLUSION

The literature review on intraoral scanners in dentistry highlights the radical transformation this technology has brought to contemporary dental practice. Intraoral scanners provide clear advantages, including precision, efficiency, and patient comfort, compared to traditional molding methods. They have become an essential tool for dental procedures such as prosthetics, crowns, orthodontics, and more.

However, adopting these devices requires ethical considerations, such as patient privacy and informed consent, as well as practical challenges like initial costs and team training. It is crucial for dental professionals to adhere to strict ethical standards and ensure that this technology is used to enhance the quality of care and patient satisfaction.

As intraoral scanner technology continues to evolve, it promises a future of more precise, efficient, and patient-centered dentistry. The outlook for this field is exciting, and its positive impact on oral health and patient quality of life is undeniable.

Conflict of interest: The authors declare that there are no conflicts of interest.

Collaborators

DC Ramirez, JDB Bez, conceptualization, resources, writing – original draft, writing – review & editing. A Kraemer, KG Ramirez, resources, supervision, visualization, writing – original draft, writing – review & editing.

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