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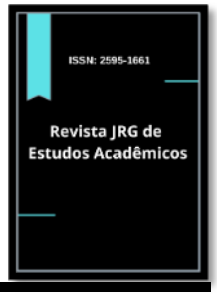

Comparative Analysis between Conventional Plaster Models and Digital Models in the Accuracy of Prosthetic Adaptation

Comparative Analysis between Conventional Gypsum Models and Digital Models in Prosthetic Fit Precision

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Abstract

The comparison between conventional plaster cast models and digital models in the accuracy of prosthetic fitting is a relevant topic in modern dentistry. Several studies have shown that digital models, obtained by intraoral scanning, have advantages in terms of accuracy, processing time, and patient satisfaction over conventional plaster models. While both methods can be effective, digital models offer greater flexibility, allowing for better fitting of prostheses, with fewer impression errors and greater reproducibility. However, it is important to consider the variations that may occur depending on the scanning technique and the region of the dental arch, which can influence the final results. This study aims to analyze the benefits and limitations of each method, in order to offer a clear orientation for dental professionals in choosing the best technique for prosthetic fitting.

Keywords: Conventional models. Digital templates. Prosthetic fitting. Precision.

1. Introduction

In recent years, dentistry has experienced major technological advances, especially with the introduction of digital models for the creation of dental prostheses (SAS Equipamento, 2023; Gondim Moura, 2020). Traditionally, the prosthesis molding process was performed using conventional plaster models, a technique that became the standard due to its reliability and effectiveness (Choi et al., 2019; Giménez et al., 2015). However, the growth of digital technology, including intraoral scanners and 3D printers, has brought new alternatives to this process. These digital models offer several advantages, such as greater measurement accuracy, reduced human error during impression-taking, and increased agility in the prosthesis production process (Chandran et al., 2019; Strasding et al., 2024).

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Furthermore, digital models allow for more efficient communication between the dentist and the prosthetic laboratory, since information can be easily shared in real time without the need to transport physical models. This improves workflow and reduces the risk of model damage or distortion during transportation (Guedes et al., 2021). Another important aspect is the reduction of patient discomfort, as many find plaster impressions to be unpleasant (Lima & Silva, 2020).

However, despite the clear advantages of digital models, there are still challenges regarding accuracy and prosthetic adaptation. Comparative studies between conventional plaster models and digital models have shown that while both offer good adaptation potential, several variables such as the scanning technique and the operator's experience can influence the results (Mehta et al., 2021; Launca Dental, n.d.).

Therefore, the aim of this study is to perform a comparative analysis between conventional plaster models and digital models, focusing specifically on the accuracy of prosthetic adaptation, and to discuss the advantages and limitations of each method. This study aims to provide a detailed view of how these two approaches impact dental practice, helping professionals choose the best technique to ensure effective and comfortable treatment for patients.

2. Methodology

This study was carried out through a literature review, with the objective of comparing the accuracy of prosthetic adaptation between conventional plaster models and digital models. Relevant articles and studies that address the comparison between these two methods, published in the last five years, were selected. The search for articles was carried out in the academic databases Google Scholar, PubMed, and SciELO, using keywords such as "digital models", "plaster models", "prosthetic accuracy" and "prosthetic adaptation". The selection was made based on the criteria of relevance and the methodological age of the studies.

Only studies that discussed the accuracy of conventional and digital models in the context of prosthetic adaptation, both in quantitative and qualitative aspects, were included. Most of the selected articles focused on comparing the results of adaptation of dental prostheses manufactured with these two approaches. The analysis of the articles was carried out on two fronts: the first stage involved the evaluation of conventional plaster models, discussing their limitations and common errors, such as distortions and failures in the reproduction of dental structures. In the second stage, the digital models were analyzed, highlighting the advantages, such as scanning accuracy and the speed in obtaining digital models, in addition to the limitations, such as dependence on technology and the need for specialized training for professionals.

Statistical analysis was performed to compare the accuracy of prosthetic adaptations between the two methods. Data were extracted from the reviewed articles, focusing on parameters such as marginal accuracy, production time and patient satisfaction, always supported by the studies cited. The review and comparison of results allowed the identification of trends and conclusions, which can guide clinical practice in choosing the most appropriate method for each type of prosthetic situation.

3. Results and Discussion

The comparison between conventional plaster models and digital models in prosthetic adaptation is an area of great interest in modern dentistry, with direct implications for the quality of treatments performed. Accurate adaptation of

prostheses is essential to ensure treatment success and patient comfort. Although both methods show efficacy, the literature reveals that digital models often offer a more accurate adaptation and are less susceptible to common errors observed in conventional plaster models. In a study by Strasding et al. (2024), it was shown that the use of correctly selected materials and abutments for implant-supported fixed prostheses contributes to a more accurate adaptation in partially edentulous patients, especially when CAD/CAM technology is used to manufacture these prostheses.

3.1 Adaptation Accuracy:

Accuracy in the adaptation of dental prostheses is essential for the success of dental treatments. Comparative studies between digital and conventional plaster models have shown that digital models offer significant advantages in this regard. The use of intraoral scans allows the capture of more precise details of the dental arch, resulting in prosthetic adaptations that are more faithful to the patient's anatomy. In addition, digital models eliminate distortions associated with the plaster drying process, ensuring greater dimensional stability. In the study by Strasding et al. (2024), a significant reduction in common molding errors was observed when using customized abutments with CAD/CAM technology, demonstrating their superiority in the aspect of adaptation.

The accuracy of digital models is particularly evident in complex clinical cases where precision is crucial. The ability to capture minute details without the limitations of conventional impression materials makes digital models a preferred choice for treatments that require high fidelity in the reproduction of dental structures. Chandran et al. (2019) concluded that digital impressions exhibit comparable accuracy to conventional impressions, with no statistically significant differences, based on accuracy assessments, patient and operator preference.

Furthermore, CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) technology used to obtain digital models allows the manufacture of prostheses with high precision, contributing to a better fit and comfort for the patient. This technology integrates computer-aided design with computer-aided manufacturing, optimizing the process of creating and manufacturing dental restorations. In the study by Chandran et al. (2019), although digital impressions showed slight superiority, the differences were not statistically significant.

In contrast, conventional plaster models, although widely used, may present dimensional variations due to factors such as material handling and environmental conditions during the molding process. These variations can affect the accuracy of the final prosthesis, making digital models a more reliable alternative for accurate adaptations. Chandran et al. (2019) highlight that, although digital impressions have advantages, the differences in relation to conventional ones are not statistically significant.

3.2 Production Efficiencies

In addition to accuracy, digital models stand out for their speed of production. The time required for scanning and digital conversion of the dental arch is significantly less compared to the time spent on molding, drying and preparing a plaster model. This efficiency improves the process, allowing dentists to treat more patients in less time, without compromising the quality of treatment (Dental Speed, 2023).

With the advancement of technologies, this efficiency also results in lower long-term operating costs, as dependence on traditional impression materials

decreases. The reduction in spending on plaster materials, together with the reduced time invested in the prosthesis manufacturing process, positively impacts the finances of the dental office or laboratory, facilitating the adoption of digital technologies, especially in medium-sized practices (Dental Speed, 2023).

Greater efficiency is also reflected in the ease of modifying digital models, allowing for quick adjustments without the need for new moldings, as is the case with conventional plaster models. This not only saves time, but also reduces the need for repeated office visits, increasing patient satisfaction (Gondim Moura, 2020).

The agility of the digital process, combined with precision, represents a true innovation in dental practice, providing faster, more precise and lower-cost care. The use of digital technologies in dentistry has shown significant benefits for diagnosis, planning and execution of treatments, improving the efficiency of the prosthesis laboratory and reducing the need for rework (SAS Equipamento, 2023).

3.3 Communication between Dentist and Laboratory

Digitizing impressions significantly facilitates communication between the dentist and the dental laboratory. By using digital models, data can be sent instantly, without the need for physical transportation of the impressions. This eliminates the possibility of errors associated with the transportation of physical models, such as distortions or damage during transit, which can affect the accuracy of the final prosthesis. The digital transfer of information reduces the risk of interpretation errors, ensuring that the laboratory receives the data clearly and accurately, resulting in more efficient and higher quality work (Chandran et al., 2019).

Furthermore, digital communication allows for faster feedback between the dentist and the laboratory. If adjustments or modifications to the model are necessary, these changes can be made quickly in the digital system, avoiding the need for repeated physical impressions and speeding up the prosthesis production process. This optimized workflow contributes to faster service, allowing dentists to serve more patients with greater efficiency and satisfaction (Guedes et al., 2021).

Another important point is the possibility of customizing digital models even before they are manufactured. The dentist can send detailed specifications to the laboratory, which can make adjustments to the digital model, avoiding rework. This collaboration between professionals ensures greater precision in the prosthetics and improves the relationship between the dental office and the laboratory. With digitalization, the process becomes more dynamic and less prone to errors, in addition to optimizing production time (Giménez et al., 2015).

3.4 Advantages for the Patient

For patients, digital models offer a more comfortable and less invasive experience compared to conventional plaster impressions. The plaster impression process can be uncomfortable, especially for patients with gag reflexes or sensitivity to the feel of the material in the mouth. Digital scanning, on the other hand, is quick and does not involve inserting materials into the mouth for long periods, which contributes to a less distressing and more pleasant process for the patient (Lima & Silva, 2020).

Furthermore, digital scanning offers an efficient solution for patients who require frequent impressions, since the process is faster and less prone to errors. The patient can benefit from quick adjustments to the digital model, which eliminates the need for new physical impressions and reduces the time spent in the office (Oliveira & Pereira, 2021). This agility in the process improves the overall patient

experience, providing more efficient care without the frustration of multiple visits (Guedes et al., 2021).

Another important benefit is the reduction of discomfort during the impression process. Many patients report discomfort during conventional plaster impressions due to the time the material remains in the mouth and the risk of swallowing or inhaling the material. With the use of digital scanning, the patient experiences a faster and more comfortable process, which can increase overall satisfaction with dental treatment (Pereira et al., 2020). This factor is crucial to increase the acceptance of dental treatments, especially among more anxious patients (Pereira & Lima, 2022).

3.5 Challenges of Plaster Models

Despite their limitations, plaster models continue to be widely used in dental practice, mainly due to their affordable cost and professionals' familiarity with this technique. Plaster, as a traditional material, has been a viable choice for many dentists, especially those in practices that do not have the resources to invest in digital technologies. The simplicity and reduced cost make the plaster model a popular alternative, especially in regions or contexts where digital technology is not yet widely available (Guedes et al., 2021).

However, one of the main challenges of plaster models is the possibility of deformations during the drying process. Plaster is highly sensitive to environmental factors, such as temperature and humidity, which can cause dimensional changes in the final model. These distortions can compromise the accuracy of the prosthesis fit, generating the need for new impressions or additional adjustments, which increases treatment time and operating costs (Silva et al., 2020). This factor represents a significant limitation in situations that require high precision (Guedes et al., 2021).

In addition to deformation, plaster models are also fragile and susceptible to damage during handling. The risk of breakage or wear is high, especially when models need to be transported or manipulated multiple times for adjustments. This problem can result in wasted time and additional costs, as well as creating frustration for professionals and patients, who may need to perform the impression procedure again. Giménez et al. (2015) highlight that digital models offer greater precision and resistance, significantly reducing rework costs and improving the patient experience.

3.6 Limitations of Scanning

Although digitalization offers significant advantages, there are also challenges that may limit its widespread adoption in dentistry. One of the main obstacles is the high initial cost of intraoral scanning equipment, which can be prohibitive for many professionals, especially in regions where the cost of equipment and maintenance is high. This factor may restrict the use of digital models in smaller practices or clinics with more limited budgets, which do not have access to these cutting-edge technologies (Nogueira, 2023).

In addition to the cost of equipment, the need for specialized training to operate digital scanning technologies also represents a challenge. Professionals who are accustomed to traditional impression-taking methods may find it difficult to adapt to new technologies, which may require additional time and training costs. Full mastery of CAD/CAM technology and intraoral scanners requires practice and understanding of digital systems, which can be a significant obstacle to the effective implementation of this technology in clinics that do not have specialized professionals or that have a limited support team (Launca Dental, nd).

The constant evolution of digital technology also implies the need for regular updates and investment in equipment maintenance. This can represent a challenge for those who already face financial difficulties to initially invest in scanning systems. Therefore, the maintenance of digital technologies can become an ongoing burden, impacting the cost- benefit of their adoption in certain clinics or dental practices (eapgoias, 2023).

3.7 Accessibility and Cost

Although digital models offer a number of benefits, the initial costs associated with purchasing digital equipment and scanning software still represent a significant limitation for many dental professionals. The high price of these systems can be a significant obstacle, especially for independent dentists or small practices that do not have the capital to invest in these devices. The high initial cost, combined with the need for ongoing maintenance and software updates, makes digital models an affordable option only for larger practices or those with greater financial capacity (Nogueira, 2023).

Furthermore, the cost of implementation goes beyond the purchase of the equipment itself. The specialized training required to use these systems also represents an additional investment. Professionals who are not familiar with digital technologies may need courses or ongoing training, which adds indirect costs to the process. These factors can be deterrents for those who already face budgetary limitations in their practices (Silva, 2022).

However, it is expected that, with the continued advancement of technology and the popularization of digital systems, the costs associated with acquiring equipment and maintaining these systems will decrease over time. As manufacturers improve their technologies and gain greater production scale, prices will likely become more affordable, allowing a wider range of professionals to adopt digital models in their practices. This may also contribute to the democratization of access to this technology, making it a viable option for a larger portion of the dental population (Costa, 2022).

3.8 Model Durability

Regarding durability, plaster models still have advantages in terms of resistance to mechanical damage. Plaster, when compared to digital models, is a more robust material that can withstand physical impacts and frequent manipulations without deteriorating easily. This makes plaster models a favorable choice in situations that require prolonged durability during transportation or storage, since they do not depend on electronic equipment for maintenance (Choi et al., 2019).

On the other hand, digital models rely on specialized equipment, such as intraoral scanners and 3D printers, which may be susceptible to technical failures or damage during the scanning process. Although the accuracy and quality of digital models are superior in many cases, the durability of these models can be affected by the fragility of the devices used to create and store digital data. The need for proper care of the devices and technologies involved represents a limitation in terms of durability for the use of digital models (Mehta et al., 2021).

However, the durability of digital models is expected to improve as 3D printing and scanning technologies evolve. As these technologies improve, the resistance of digital models to damage will increase, making them increasingly durable and reliable for long-term use. The increased accessibility of equipment will also allow more

professionals to adopt these technologies, making durability an even more positive characteristic for digital models in the future (Zhermack, 2023).

4. Conclusion

A comparison between conventional plaster models and digital models in prosthetic adaptation reveals that, despite the traditional advantages of plaster models, digital models have become the preferred choice for many dental professionals. The accuracy of digital models is notably superior, with a lower risk of distortion during the manufacturing process, resulting in more precise and satisfactory adaptations for patients. These models have also proven to be more efficient, since they significantly reduce processing time and allow for rapid adjustments, providing more flexibility in the planning and execution of prostheses.

Although the accuracy of digital models has been widely proven, plaster models are still widely used, especially in cases that require less complexity or when costs must be reduced. In addition, professionals' familiarity with plaster molding techniques also contributes to their continued use. However, with the advancement of technologies and the reduction in the costs of digital equipment, digital models are expected to become even more accessible and widely adopted in dental practice.

In summary, the choice between conventional and digital models will depend on several factors, such as the complexity of the clinical case, the costs involved and the experience of the professional. Prosthetic adaptation must be carefully planned, taking into account the advantages and limitations of each approach. Although digital models offer clear benefits in terms of precision, efficiency and comfort for the patient, it is essential that the professional assesses the clinical conditions of each patient to ensure the best possible results. The continuous evolution of technology and the training of professionals will be decisive for digital models to become the norm in modern dentistry.

Furthermore, the impact of digital models in dentistry goes beyond prosthetic fitting. They also have the potential to transform the way professionals communicate with their patients and dental laboratories. The ability to instantly share digital models facilitates collaboration, improves the accuracy of treatments and makes the work process more fluid and efficient. This significantly improves the patient experience, providing faster and less invasive care, which can lead to an increase in overall satisfaction.

In the future, widespread adoption of digital models could result in the modernization of dental care in clinics and practices of all sizes. The reduction in operating costs as technology becomes more accessible will allow more professionals to adopt these systems, leading to improvements in the quality of care provided. However, for this to happen, it is crucial that professionals continue to invest in their education and adapt their practices to effectively incorporate these innovations.

Finally, it is important to emphasize that digital transformation in dentistry is not limited to the use of new technological tools, but also involves a paradigm shift in how professionals approach treatment and interaction with patients. Continuous adaptation of clinical practices and acceptance of new technologies as partners in the care process will be fundamental to the success of this evolution, establishing new standards of excellence and efficiency in modern dentistry.

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