JOURNAL OF HEALTHCARE SCIENCES
Volume 3 Issue 12 2023, Article ID: JOHS2023000788
http://dx.doi.org/10.52533/JOHS.2023.31220
e-ISSN: 1658-8967

Review

Evaluating the Efficiency of Complete Digital Workflow in Prosthodontics

Haitham Binhuraib[1*], Faisal Alreshidi[2], Saleh Bardi[3], Nada Alghamdi[4], Saeed Alhelali[5], Taher Althagafi[6], Reem Alsayegh[7], Fesal Alsalem[8], Abdulmajeed Aljathnan[9], Nasser Alshahrani[9], Muhannad Alhaqbani[10]

[1] *Department of Prosthodontics, North Jeddah Specialist Dental Center, King Abdullah Medical Complex, Jeddah, Saudi Arabia*
[2] *Medical Services Department, Ministry of Interior, Dammam, Saudi Arabia*
[3] *Advanced Education in General Dentistry, Prince Abdulrahman Advanced Dental Institute, Riyadh, Saudi Arabia*
[4] *General Dentist, Unique Care Clinic, Riyadh, Saudi Arabia*
[5] *College of Dentistry, Ibn Sina National College, Jeddah, Saudi Arabia*
[6] *College of Dentistry, Taif University, Taif, Saudi Arabia*
[7] *College of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia*
[8] *Advanced Education in General Dentistry, Prince Sultan Military Hospital, Riyadh, Saudi Arabia*
[9] *College of Dentistry, King Khalid University, Abha, Saudi Arabia*
[10] *College of Dentistry, King Saud University, Riyadh, Saudi Arabia*

Correspondence should be addressed to **Haitham Binhuraib**, Department of Prosthodontics, North Jeddah Specialist Dental Center, King Abdullah Medical Complex, Jeddah, Saudi Arabia. Email: hhuraib@moh.gov.sa

Received: 16 December 2023, Accepted: 22 December 2023, Published: 24 December 2023.

Abstract

In contemporary dentistry, tailored solutions for restoring partial or complete edentulous mouths are provided to meet individual needs. These solutions address specific dental challenges, offering opportunities for individuals to regain oral function, enhance aesthetics, and improve overall well-being. The emergence of digital technology, known as the complete digital workflow in prosthodontics, presents a modern and technologically advanced alternative to traditional approaches. This review aims to thoroughly examine existing literature, research studies, and outcomes related to the use of digital technologies in the entire prosthodontic process. By critically assessing the advantages and potential challenges associated with a complete digital workflow, the review aims to offer valuable insights into its overall effectiveness, precision, and impact on patient outcomes. Additionally, it will explore the influence of digital workflows on treatment planning, prosthetic design, fabrication processes, and long-term clinical success. The study, initiated on November 29th, 2023, was instigated after a comprehensive review of existing literature using various databases and search strategies, including PubMed, Web of Science, Cochrane, and manual searches on Google Scholar. The efficiency of a complete digital workflow in prosthodontics has been highlighted in several aspects, such as time effectiveness, ease of use, accuracy, precision, patient satisfaction, and long-term clinical success.

Keywords: Prosthodontics, digital workflow, effectiveness, challenges

Introduction

Tooth loss is a complex issue with various causes such as trauma, cavities, gum diseases, and other oral problems extending beyond physical discomfort to impact psychological, functional, and aesthetic aspects of life. Losing natural teeth can affect overall well-being, influencing psychological health, facial aesthetics, speech, and bite functionality (1). Immediate consequences include impaired oral function, making chewing and biting challenging, and potentially leading to dietary issues and health problems. Effective mastication is crucial for digestion and its disruption can result in nutritional deficiencies (2). Moreover, tooth loss also affects speech, causing pronunciation difficulties due to altered oral dynamics, impacting communication, and potentially leading to social and psychological consequences. Proper speech is vital in personal and professional interactions (3). Aesthetic concerns should not be underestimated, as missing teeth can alter facial appearance, leading to sunken cheeks or a sagging jawline. These changes can significantly impact self-esteem and confidence, causing self-consciousness in social situations and affecting self-image (2).

Fortunately, modern dentistry provides effective solutions for restoring partial or complete edentulous mouths, tailored to individual needs and preferences. These solutions address specific dental and oral health challenges, offering opportunities for individuals to regain oral function, improve aesthetics, and enhance overall well-being. Complete dentures, fixed partial dentures, removable partial dentures, crowns, bridges, and implants are a few types of dental prostheses well known for restoring the functionality of the oral cavity, which is compromised because of tooth loss (4). The selection of a prosthesis is influenced by factors such as the quantity and location of missing teeth, the state of neighboring teeth, and the patient's oral health objectives. Dental crowns and bridges, for example, are employed to either cover or substitute teeth that have experienced structural damage and are no longer able to withstand normal mechanical forces (2). On the other hand, dental bridges consist of artificial teeth (pontics) supported by crowns attached to neighboring natural teeth or dental implants, offering a reliable solution for replacing multiple adjacent missing teeth (4). Dental implants, which are surgically inserted into the jawbone, serve as a stable foundation for supporting crowns, bridges, or comprehensive arch restorations. In cases where cost or a preference for a removable dental solution is a consideration, partial or complete dentures present a practical alternative (5).

One of the novel ways to design these prostheses is by using digital technology, also known as complete digital workflow in prosthodontics (6). The traditional approach to designing and testing prosthodontic appliances is usually a method of trial and error, requiring the comprehensive involvement of multiple dental personnel and their time. However, choosing a complete digital workflow in prosthodontics offers several advantages, such as encompassing efficiency, precision, patient experience, and overall workflow improvement. Additionally, digital workflows facilitate seamless communication between dental professionals, allowing for quick sharing of digital files, treatment plans, and design modifications (7). Improved communication can lead to better collaboration among team members, including prosthodontists, dental technicians, and specialists. Digital workflows also more easily accommodate modifications to treatment plans or design changes, providing flexibility in response to evolving patient needs (8). While traditional approaches have their merits, the digital workflow in prosthodontics offers a modern and technologically advanced alternative that can significantly enhance the overall patient experience and satisfaction with dental prosthetics.

The rationale behind conducting a review article on the efficiency of a complete digital workflow in prosthodontics stems from the transformative impact that digital technologies have had on traditional dental practices. In recent years, there has been a rapid integration of digital tools, including intraoral scanners, computer-aided design (CAD) software, and computer-aided manufacturing (CAM) technologies, in prosthodontic procedures (7). This shift towards a complete digital workflow

http://dx.doi.org/10.52533/JOHS.2023.31220

has sparked considerable interest in assessing its overall efficiency in comparison to conventional methods (6). This review aims to comprehensively analyze existing literature, research studies, and outcomes about the use of digital technologies throughout the entire prosthodontic process. By critically examining the advantages and potential challenges associated with a complete digital workflow, this review seeks to provide valuable insights into the overall effectiveness, precision, and patient outcomes achieved through digitization in prosthodontics. Furthermore, the review will explore the impact of digital workflows on treatment planning, prosthetic design, fabrication processes, and long-term clinical success. Ultimately, the study aims to contribute to the evidence-based understanding of the efficiency of complete digital workflows in prosthodontics, informing practitioners, researchers, and decision-makers about the potential benefits and considerations associated with embracing digital advancements in this crucial field of dentistry.

Methods

The research, initiated on November 29th, 2023, was prompted by an extensive examination of existing literature. Various databases, including PubMed, Web of Science, and Cochrane, were employed for this literature review. The search strategy encompassed the use of diverse combinations of medical terminology, and manual searches on Google Scholar were carried out to identify pertinent research terms. The primary focus of this literature review was on several critical aspects, including the utilization and effectiveness of a complete digital workflow in prosthodontics. Keywords on precision, prosthetic design, treatment planning, efficacy, and patient outcomes associated with the complete digital workflow in prosthodontics were integrated into the search criteria. It is crucial to highlight that the inclusion of articles in this study was guided by multiple criteria to ensure a thorough and robust review process.

Discussion

A complete digital workflow in prosthodontics involves the integration of digital technologies and software throughout the entire process of planning, designing, and fabricating dental prostheses. The process starts with taking impressions from the oral cavity to initiate treatment planning. Traditional dental material impressions are replaced with intraoral scanners that capture a 3D digital model of the patient's teeth and soft tissues. Popular systems for digital impression-taking include TRIOS, iTero, and 3M True Definition. These systems also allow the accurate assessment of the occlusion and dynamic movements of the muscles, bones, and other structures present in the patient’s mouth. The impressions and movement mapping help tremendously in the treatment planning process, making the prosthetic treatment more efficient and hassle-free. Software like 3Shape and Exocad help prosthodontists analyze the digital models to assess the patient's condition (9). Once the treatment plan has been established, prosthetic designs are digitally created using CAD software. Once the digital design is finalized, the information is sent to a milling machine or 3D printer, such as CAM. Dental materials like ceramics, resins, metals, or combinations of these are used to fabricate the prosthetic restoration (10). On the other hand, cases involving dental implants can use a surgical guide using the digital workflow for precise and accurate implant placement. Using the previously made 3D imaging of the patient's oral tissues, virtual try-ins can also be planned to assess the aesthetics and fit of the prosthetic restoration before finalization. At last, the fabricated prosthetic restoration is delivered to the patient and adjustments can be made, if necessary. Moreover, the patient's digital record is updated to include the final prosthesis (11).

Efficiency of Complete Digital Workflow

The efficiency of a complete digital workflow in prosthodontics has been a subject of growing interest and investigation within the dental field. This digital approach, encompassing various technologies such as intraoral scanners, CAD and CAM aims to streamline and enhance the entire process of prosthodontic care. One key aspect contributing to the efficiency of a complete digital workflow is the elimination of traditional physical impressions. Intraoral scanners provide a more

http://dx.doi.org/10.52533/JOHS.2023.31220

comfortable and quicker method for capturing precise 3D images of the patient's oral structures. Evidence suggests that patient discomfort was reduced in digital workflow, along with lesser time consumption in impression-taking and treatment planning was observed (12). Moreover, the integration of CAM technologies facilitates the automated fabrication of prosthetic restorations. Whether through milling machines or 3D printers, the digital design is translated into a physical restoration with a high degree of precision and accuracy (13). Another study highlighted that patient outcomes related to perception were comparable between conventional and digital workflow patterns, showing high satisfaction levels in patients undergoing digital workflow for prosthodontic treatment. The patients were found to be highly satisfied with the function, aesthetics, as well as cleanability of the prosthesis produced through the digital method after 3 years of use (14). Patient outcomes are further enhanced through virtual try-ins, where patients and practitioners can visualize and evaluate the proposed prosthetic restorations before finalization. This not only improves patient satisfaction but also reduces the likelihood of adjustments or remakes, contributing to overall time and resource efficiency (15).

The reduction in turnaround time to produce prostheses benefits both the patient and dental health professionals. Moreover, dental professionals with less experience were also able to fabricate similar quality prostheses as experienced dental professionals by using digital workflow software (12). In addition to experienced handling, dentists and prosthodontists can also visualize the proposed restorations in a virtual environment, adjusting as needed before the fabrication process begins. This digital planning further enhances precision and contributes to better outcomes. The digital workflow also supports improved communication and collaboration among members of the dental team. Digital files can be easily shared, allowing for seamless coordination between prosthodontists, dental technicians, and other specialists. This collaborative aspect contributes to more efficient decision-making processes (13, 16). While the initial investment in digital technologies can be substantial, the long-term benefits in terms of time savings, precision, and patient satisfaction underscore the increasing adoption of complete digital workflows in prosthodontics. Ongoing research and advancements in technology continue to contribute to refining and optimizing the efficiency of digital processes in prosthodontic care.

Challenges

While complete digital workflows in prosthodontics offer numerous advantages, they also come with certain challenges that need to be addressed for optimal implementation and success. Although the overall procedure is more cost-effective as compared to conventional techniques for the patient (17), the upfront cost of acquiring digital equipment, such as intraoral scanners, CAD/CAM systems, and 3D printers, can be substantial. This initial investment may pose a barrier for some dental practices (18). Moreover, digital equipment requires regular maintenance, software updates, and occasional upgrades. Ensuring that all components are functioning optimally is essential to prevent disruptions in the workflow (6). Additionally, transitioning from traditional methods to a complete digital workflow requires training for dental professionals. Learning to use new software and equipment effectively may have a learning curve, impacting the efficiency of the dental team during the introduction of this technology (9, 19). Due to the steep learning process, integrating digital processes into existing workflows may be challenging. Ensuring seamless communication and collaboration among team members, including prosthodontists and dental technicians, is crucial for a smooth workflow (20).

Additionally, the dental industry is still working on standardizing digital formats and ensuring interoperability between different digital systems. Compatibility issues between hardware and software from different manufacturers can also be an anticipated challenge (19). While digital workflows offer precision and efficiency, there's a risk of overreliance on technology. Dental professionals must maintain their clinical skills and judgment even in a digital environment. Another

http://dx.doi.org/10.52533/JOHS.2023.31220

concern can be adherence to regulatory standards and compliance requirements, especially concerning digital patient records and data storage, which adds complexity to the implementation of a digital workflow. Managing and securing digital patient data is a critical consideration. Dental practices need to implement robust cybersecurity measures to protect patient information from potential breaches (21). In certain regions, like low-middle-income countries, patients may not have easy access to advanced digital technologies, especially in remote or underserved areas. This can limit the widespread adoption of complete digital workflows. Moreover, some patients may be unfamiliar with or uncomfortable with the use of digital tools in their dental care. Communication and education are crucial to ensuring patient acceptance and understanding (22).

Addressing these challenges involves a combination of ongoing training, robust cybersecurity measures, collaboration among industry stakeholders for standardization, and effective communication with patients. As technology continues to advance, these challenges are likely to evolve and the dental community will need to adapt to ensure the successful integration of complete digital workflows in prosthodontics.

Conclusion

The advent of complete digital workflows in prosthodontics represents a transformative shift in dental practices, offering unprecedented advantages in terms of precision, efficiency, and patient outcomes. The integration of intraoral scanners, CAD/CAM technologies, and 3D printing has revolutionized treatment planning, prosthetic design, and fabrication processes. Despite these significant benefits, challenges exist that require careful consideration for successful implementation.

Disclosure

Conflict of interest

There is no conflict of interest

Funding

No funding

Ethical consideration

Non applicable

Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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