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Digital Workflow in Implant-Supported Prostheses: Clinical Outcomes and Accuracy Evaluation

Abstract
Digital workflows have transformed implant-supported prosthodontics by integrating advanced technologies such as intraoral scanning, computer-aided design/computer-aided manufacturing (CAD/CAM), and guided surgery, aiming to improve accuracy, efficiency, and patient outcomes. To critically evaluate the current evidence on digital workflows in implant-supported prostheses, focusing on accuracy, clinical outcomes, and efficiency. A narrative review was conducted using literature from major databases including PubMed, Scopus, and Web of Science. Relevant clinical studies, in vitro investigations, and systematic reviews published in recent years were analyzed to synthesize key findings related to digital workflows. Digital workflows demonstrated comparable or superior accuracy to conventional methods in single-unit and short-span restorations, while full-arch rehabilitations showed variable outcomes due to cumulative errors. Intraoral scanning improved patient comfort and reduced treatment time. Clinical outcomes, including implant survival and prosthetic success, were favorable and comparable to conventional techniques. Additionally, digital workflows enhanced efficiency through reduced chairside time and streamlined laboratory processes, although high initial costs and technical complexity remain challenges. Digital workflows offer significant advantages in implant prosthodontics, including improved precision, efficiency, and patient experience. However, limitations in complex cases and the need for standardized protocols and long-term clinical evidence highlight the necessity for further research.

Introduction

Implement-retained prostheses have become a standard of modern oral rehabilitation and they have provided reliable functional and esthetic prognoses in partially and completely edentulous patients. Innovations in biomaterials, surgery, and prosthetic design have greatly enhanced the survival rates of the implants and patient satisfaction in the long run. Nevertheless, the ancient protocol of the implant prosthodontics, based on the conventional impressions, stone casts and hand-laboratory techniques, is still linked with various sources of inaccuracy, more time spent at the chairside, and patient discomfort [1]. These constraints have prompted the shift of turning to digital technologies that will improve preciseness, efficiency, and reproducibility.

Digital workflow in implant prosthodontics Digital workflow in implant prosthodontics is the connection of computerized systems at all points of the treatment process, such as the data acquisition, the virtual planning, the prosthesis design, and the fabrication. Intraoral scanners (IOS), computer-aided design/computer-aided manufacturing (CAD/CAM) and guided implant surgery have essentially changed the way clinical and laboratory processes are carried out. These technologies make it possible to build an entire digital chain and minimize the use of physical models as well as decrease the number of cumulative errors in the procedures [2]. The growing supply of digital systems has resulted in the extensive clinical uptake, yet inconsistency in accuracy and clinical outcomes are still a matter of concern.

Among the main benefits of a digital workflow, it is worth mentioning the fact that it enhances the patient experience. Intraoral scanning has been reported to save time in the treatment process and give greater comfort to the patient in comparison with the traditional method of impression that is usually linked with the problem of gag reflex and discomfort [3]. Moreover, digital impressions enable real-time visualization and confirmation of data, which minimizes chances of remakes and enhances the levels of communication between clinicians and dental technicians. In spite of these advantages, there are fears about the precision of the digital impressions, especially when full-arch implants are used in which the cumulative errors can affect the fit of the prosthetic.

The issue of accuracy is a key determinant of success in the use of implant-supported prostheses because inaccuracy may result in biological and mechanical failures, including the loosening of screws, fracture of the components, and loss of the peri-implant bone. The goal of digital workflows is to improve both trueness and preciseness during the treatment process but several factors can affect the results; these factors are scanner technology, operator skill, and implant distribution [4]. The effectiveness of digital systems when it comes to passive fit as compared to traditional modalities remains a controversial topic, particularly in more complicated rehabilitations that require multiple implants.

Besides its accuracy, time efficiency, and cost-effectiveness are also necessary in clinical practice. Online processes have been linked with less chairside and lab time, which may mean fewer visits and less time to get prostheses ready [5]. Nevertheless, the preliminary cost of the digital equipment and software may be very high, and one may question whether it is economically feasible, especially in the context of small clinics. Systematic reviews have shown that there are mixed results on cost-benefit balance that claim that long term benefits might be counterbalanced by initial costs but need to be implemented with a lot of care [6].

The increasing literature on a comparison of digital and conventional workflow throws light on the opportunities and constraints of digital dentistry. Randomized and comparative trials have also shown better efficiency and similar clinical outcome with one unit restorations but complete arch cases are more difficult as they are more prone to error [7]. On the same note, systematic reviews have pointed out the necessity of standard procedures and excellent clinical trials to determine conclusive results on the quality of digital procedures [8].

Improved scope Digital treatment planning has extended the range of prosthetic driven implant placement to prosthetically motivated implant placement. Virtual planning tools enable clinicians to factor in the consideration of prosthetic in surgical decision-making to enhance the positioning of implants and the overall predictability of the treatment [9]. Besides, digital impression methods have demonstrated good achievements in the edentulous patients, but there are still shortcomings in terms of accuracy, especially in the extensive cases of rehabilitation [10].

However, some obstacles exist, even though the rapid development of technologies is taking place. The inconsistency in the reported outcomes is caused by variability in the methodology of the studies, variability in digital systems, and the absence of long-term clinical data. Also, the learning curve of digital technologies will potentially affect clinical performance, especially at the initial phases of the change. These aspects demonstrate the necessity of a thorough review of the digital workflows, in terms of accuracy and clinical efficacy.

Consequently, this narrative review will critically evaluate the existing evidence on digital workflows in implant-supported prostheses, where accuracy and clinical outcomes are of special concern. This review aims to help clinicians have a better picture of the benefits, drawbacks, and real-life applications of digital technologies in implant prosthodontics by summarizing the results of recent research.

Digital workflow Conceptual Framework

Digital workflow In implant-supported prosthodontics, digital workflow is an organized application of digital technologies at the level of diagnostics, surgery, and prosthetic. In contrast to the traditional workflow, where the impressions of the analog system and the laboratory process of handling the material by hand are used, the digital workflow is built on the constant chain of data that allows moving through the process of collecting the data to the final delivery of the prosthesis [11]. Digital chain reduces the number of intermediate steps; this reduces cumulative errors and enhances greater predictability of treatment outcomes.

The process of digital workflow starts at the level of data acquisition, which in most cases is intraoral scanned data or extraoral digitized data. Such datasets are then combined with the radiographic data, including cone-beam computed tomography (CBCT) which enables full virtual treatment planning. Such integration has led to the creation of a so-called virtual patient that allows clinicians to test the outcomes of surgery and prosthetic prior to treatment [11]. Such strategy improves the decision making and makes it possible to place prosthetically driven implants.

This model of digital workflow can be classified into three interrelated areas, namely, data acquisition, digital planning, and computer-aided manufacturing. Planning It involves the use of specific software to plan positions of the implants, prosthetic frames and oculuse plans. This computerized planning is frequently associated with guided surgery procedures, in which the templates of surgical procedures are produced to guarantee the correct positioning of the implantation based on the plan that has been created [12]. This kind of integration eliminates variability due to operators and increases accuracy in surgery. Digital workflow in patients with edentulous is more complicated because there are no stable reference points. To overcome these obstacles, fully digital methods have been established where clinicians are able to reproduce the position of implants and the contour of the soft none of the tissue without the use of traditional impressions [13]. Also, there are introduced cast-free workflows, which do not require physical models, and the process is further simplified [14]. Such developments lead to the more efficient and reproducible workflow.

The other significant feature in the conceptual framework is the minimization of the steps of analog. The conventional processes have several handovers between laboratory and clinical processes, all of which can bring about inaccuracies. On the contrary, digital workflows also allow the immediate transfer of data, minimizing the probability of distortion and improving communication of clinicians and technicians [15]. This electronic communication enables changes in real-time and enhances the outcomes of treatment. Table 1 provides the general framework and phases of digital workflow in implant prosthodontics.

Table 1: Overview of Digital Workflow in Implant Prosthodontics

Stage	Description	Key Technologies	Advantages	Limitations
Data Acquisition	Capture of intraoral structures and implant positions	Intraoral scanners, CBCT	Eliminates conventional impressions, immediate visualization	Accuracy affected by saliva, movement
Digital Planning	Virtual implant positioning and prosthetic design	Planning software, virtual articulators	Prosthetically driven placement, improved predictability	Requires expertise, software compatibility issues
Guided Surgery	Translation of digital plan into clinical execution	Static guides, dynamic navigation	Increased surgical precision, reduced deviations	Guide stability issues, cost
Prosthesis Fabrication	Design and production of restorations	CAD/CAM, milling, 3D printing	High precision, reproducibility	Material limitations, equipment cost

Although they have these pros, the digital workflow does not lack limitations. The reliability of the workflow could be affected by data acquisition errors, incompatibility of the software, and technical expertise requirement. Moreover, the precision of one step is dependent upon the others, that is, any mistakes made at the beginning of the process may be transferred into the other steps.

On the whole, the digital workflow conceptual framework is focused on integration, accuracy, and efficiency. This strategy can enhance the clinical outcome and optimize the management of workflow in the fields of implant prosthodontics through the replacement of conventional analog steps with digital processes.

Workflow Components

The digital flow of work with implant-supported prosthodontics involves a number of important elements, the functioning of each of which has an impact on the final quality and efficiency of care. These parts are intra oral scanning, computer aided implant cartography, computer aided surgical guidance, and the production of porcelain by CAD/CAM, producing the complete digital chain of diagnosis to manufacturing.

The first process of the digital workflow is intraoral scanning, which allows taking three-dimensional images of the mouth cavity. This technology will do away with the traditional impression materials, making the procedure less painful to patients and increase efficiency in data acquisition [16]. Digital impressions are also fast to obtain and verifiable, and this reduces the chances of mistakes that can be caused by traditional methods.

The following important step is to plan the digital implant, i.e., received data are combined with the radiographic images to generate a virtual treatment plan. The software platforms allow clinicians to position the implants as per the needs of the prostitute to achieve the best alignment and occlusiveness [17]. This type of prosthetically stimulated system of treatment allows to predict the outcomes of the treatment better and promotes easier communication between the surgical and the prosthetic teams.

Guided implant surgery is closely associated with digital planning, transfer of virtual plans into clinical practice. Physical templates that are used to guide the placement of implants are made in the form of a static guide via CAD/CAM or 3D printing and dynamic navigation systems offer guidance in real-time during the surgery [18]. Both methods are intended to enhance precision and minimize the errors in the positioning of planned implants, but each of them is limited in some ways.

Development of implant-supported prostheses is done by CAD/CAM which allows high precision in fabrication of restorations. Zirconia, lithium disilicate, and hybrid composites are some of the materials that are often employed in digital work processes because they have positive mechanical and esthetic characteristics [19]. The CAD/CAM systems enable reproducibility of the designs of the prosthetics to minimize variability that comes with the manual fabrication.

Also, for chairside fabrication of provisional restorations, digital workflows facilitate loading protocols in the selected cases immediately. The method is advantageous in increasing the satisfaction of the patient by decreasing the time of treatment and giving instant functional and esthetic value [20]. The digital technologies also promote the storage and retrieval of data which means that the prostheses could be easily modified or reproduced in case of necessity. Table 2 summarizes the main elements of the digital workflow and the ways of their clinical use.

Table 2: Components of Digital Workflow and Their Clinical Applications

Component	Clinical Role	Materials/Systems Used	Clinical Benefits	Challenges
Intraoral Scanning	Digital impression of dentition/implants	IOS systems	Improved patient comfort, faster workflow	Reduced accuracy in full-arch cases
Implant Planning	Virtual implant positioning	CAD software, CBCT integration	Enhanced precision, better prosthetic outcomes	Learning curve
Guided Surgery	Accurate implant placement	Surgical guides, navigation systems	Reduced surgical errors	Cost, technique sensitivity
CAD/CAM Fabrication	Prosthesis production	Zirconia, lithium disilicate	High strength, esthetics	Equipment investment
Immediate Provisionalization	Early restoration placement	Chairside CAD/CAM systems	Reduced treatment time	Case selection critical

With such developments, there are still issues regarding optimal performance of all workflow components. Accuracy of scanners, software limitation and material properties among others can affect the end result. Moreover, full-arch rehabilitations are more difficult, and workflow design and implementation should be paid attention to. Overall, it can be concluded that the elements of digital workflow lead to increased efficiency, accuracy, and patient-centered care in implant prosthodontics. They need to be successfully integrated to obtain predictable clinical outcomes.

Intraoral Scanning and Scan Bodies

The intraoral scanning (IOS) has evolved as part of the digital process in the field of implant prosthodontics as the substitute of the traditional impression methods. The IOS systems record highly accurate three-dimensional images of the oral environment and allow the accurate digital representation of the hard and soft tissues. Scans bodies further augment this process since they give reference markers to accurately record the position of implants [21].

Scan bodies are equipments that are placed on implants during the scanning process, whereby software can recognize the orientation and position of the implant correctly. Their geometry, composition of materials, and design have a great effect on the precision of the impressions made digitally. The systematic reviews have also indicated that the difference between scan body design may result in variation in trueness and precision, so it is essential to choose the correct components [21].

The reason is that the accuracy of intraoral scanning is determined by a number of factors such as the technology of the scanners, the scanning protocol, and experience of the operator. Modern scanners make use of different principles of imaging, including confocal microscopy and structured light, to take data. As much as these technologies have been greatly enhanced, there are still issues of capturing very large edentulous regions since there are no reference points that are stable [22]. This has been improved with the introduction of auxiliary devices that help to enhance the accuracy of the scan by giving more landmarks in the acquisition of data.

The digitization of the location of implants and occlusal relationships involves the accuracy with which several datasets are aligned. Digital processes have been created to combine the position of the implants to jaw relation records to fix the correct design of the Prosthetic [23]. These methods minimize the use of traditional techniques of bite registration and efficiency of work.

Recent developments involve the application of photogrammetry systems that are used to record the positions of implants in full-arch restorations. The systems are also used to triangulate implant positions using many images with high accuracy that cannot be achieved in large cases with conventional IOS [24]. Photogrammetry applications based on smartphones have also been considered, which provide an economically viable alternative in acquiring digital data [25]. Figure 1 shows the intraoral scanning process.

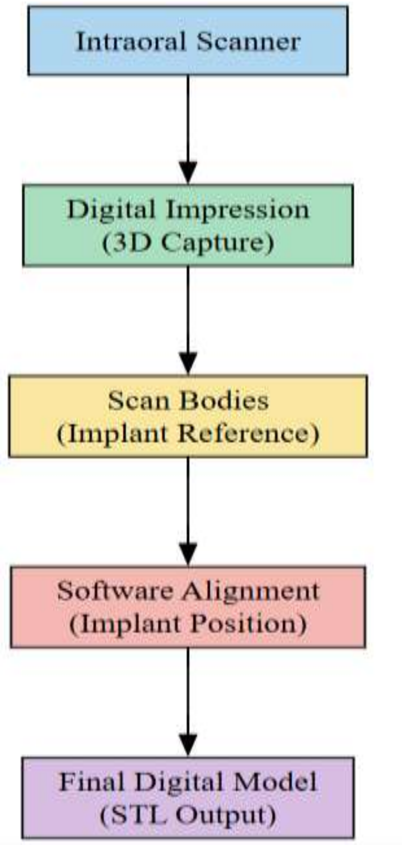

Figure 1: Intraoral Scanning Workflow

Intraoral scanning is not devoid of limitations in spite of these developments. There is a decrease in accuracy with a higher scan span, especially in a full-arch implant. Saliva, motion and reflective surfaces also may influence the quality of data. The ability of operators to reduce such errors is of paramount importance, and training and experience are important elements. On the whole, intraoral scanning and scan bodies become a part of the digital workflow allowing the acquisition of accurate data and the further steps in the treatment. Further developments of scanning technology and protocols should continue to enhance accuracy and increase the clinical use.

Efficiency in the Digital Workflow

The parameter of accuracy is a crucial factor to define the level of efficiency of digital workflows in implant-supported prostheses. It covers trueness that is defined as how close a measurement is to the true value and also covers precision that is defined as the ability to reproduce measurements. High accuracy is required to guarantee passive fit of prostheses in order to avoid both biological and mechanical complications.

Digital workflows also strive to avoid cumulative errors by decreasing the number of steps in the middle between the traditional methods. Nevertheless, every phase of the digital process, scanning, data processing, and fabrication, brings possible points of error. The experiments comparing digital models have proven their variability in terms of accuracy based on the workflow and materials employed [26].

It has been demonstrated that the production of restorations with marginal and internal fit levels of acceptable quality is possible through the fabrication of prostheses with the support of digital workflows. Experiments on digital workflows show that in some clinical environments, they can be as accurate or more accurate than traditional techniques [27]. Nonetheless, inaccuracies can be created by scanning technology or computer programme.

Another issue that should be considered is the accuracy of seating the implant-supported prostheses. It has been reported that in vitro studies have demonstrated that digitally manufactured provisional restorations can realize a clinically acceptable seating accuracy in case guided surgery guidelines are followed [28]. The techniques that are based on photogrammetry have also enhanced the accuracy in full-arch cases by minimizing mistakes that are linked with the combination of scan images [29].

The factors affecting accuracy are the number of implants, the distribution, and angulation, and the type of the restoration under fabrication. The full-arch rehabilitations are especially prone to inaccuracies since the minor variance is compounded over a longer distance. These errors can be alleviated by using digital guides and auxiliary aids, which will allow another reference point during the scanning and fabrication processes [30]. Table 3 shows the key aspects that impact the accuracy of digital workflows.

Table 3: Factors Influencing Accuracy in Digital Workflow

Factor	**Influence on Accuracy**	**Clinical Impact**	**Mitigation Strategies**
Scanner Technology	Determines resolution and data capture	Affects trueness and precision	Use high-resolution scanners
Scan Body Design	Influences implant position recording	Errors in implant angulation	Standardized scan bodies
Implant Number/Distribution	Increased span leads to cumulative error	Misfit in full-arch prostheses	Use photogrammetry systems
Operator Skill	Affects scanning technique	Variability in outcomes	Training and calibration
Software Algorithms	Data processing accuracy	Errors in prosthetic design	Updated software systems

Even with improvement, perfect passive fit is difficult to attain especially in complicated cases. Flexibility of the measurement procedures and non-standardized evaluation procedures also hinder the cross-study comparisons. Also, the majority of the evidence is in vitro based and therefore it may not be a complete reflection of the clinical situation. To sum up, digital workflows present a promising accuracy to implant-supported prostheses, although they are affected by several factors. To come up with conclusive guidelines necessary to use in clinical practice, more research and standardization is needed.

Clinical Outcomes

Clinical outcomes are a primary outcome of the efficacy of digital processes in implant-supported prostheses, which includes not only the survival of implants, the functioning of prosthetic joints, and patient-centric outcomes. As digital technologies are becoming more and more popular, many studies have been conducted and established whether the workflows can deliver the same or even better results than the traditional methods.

The most important measure of the success of treatment is the implant survival rates. The findings of retrospective and prospective research indicate that prostheses developed based on the digital workflow as implant supports show great survival rates when examined in the short-term and the medium-term follow-ups [31]. Such findings point to the conclusion that digital workflows do not negatively affect the biological integration in cases of adherence to due procedures. Longitudinal studies have also affirmed the stable peri-implant conditions, which prove the clinical dependability of the digital methods.

The outcomes of the prostitutes such as mechanical stability and complication rates are also critical. Digital processes have been linked to foreseeable prosthetic performances especially in single-unit and short-span restorations [32]. CAD/CAM-fabricated materials (monolithic zirconia and lithium disilicate) have led to an increase in fracture resistance and a decrease in technical complications [33]. Nevertheless, full-arch rehabilitations are more difficult to perform because of the intricacy of passive fit in multiple implants.

The rates of complications in the digital process of work seem to be similar to those in the traditional methods. Mechanical complications, which are the most frequent ones reported, involve screw loosening, and prosthetic fracture, whereas biological ones, like peri-implantitis are more affected by patient factors rather than the workflow itself [34]. Case series analyses of model-free digital workflows have yielded positive results with a limited number of complications and the methods have the potential of finding their way into clinical practice [35].

The importance of patient-reported outcomes has been growing in the determination of treatment success. Digital workflows have a number of benefits which would lead to patient experience improvement in terms of less time spent on treatment, number of clinical visits decreased and better comfort during impression procedures. Provisionalization protocols, which can be provided immediately due to the use of digital technologies, contribute to the improvement of patient satisfaction even more since they offer quick functional and esthetic healing. The clinical outcome domains that relate to the digital workflows are listed in Figure 2.

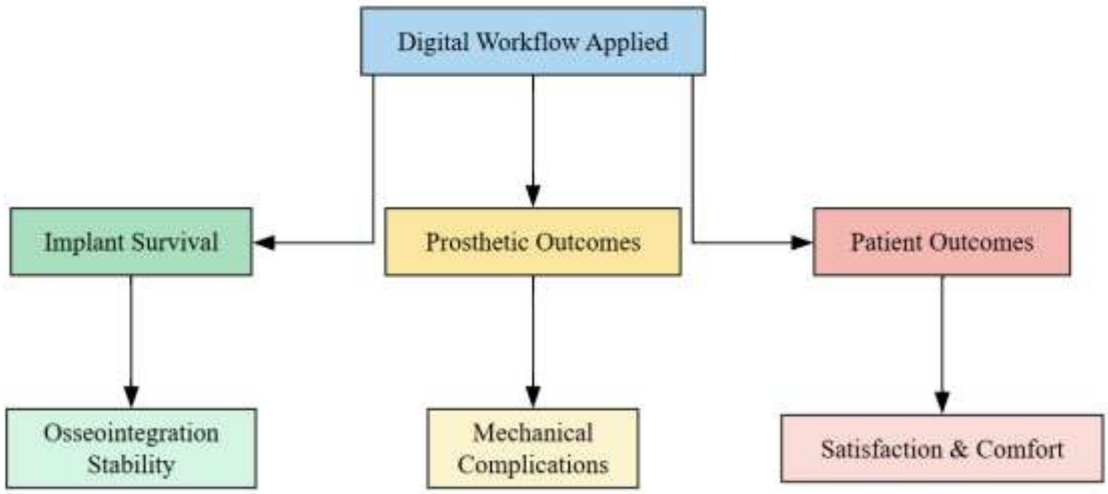

Figure 2: Clinical Outcomes

Although these results were positive, there are some shortcomings in the existing evidence base. Short follow-up and small population are limitations of many studies especially on full-arch rehabilitation. Moreover, due to the differences in the study design and outcome measures, the direct comparisons became difficult. There is still a gap in the literature in terms of lack of long-term randomized controlled trials. On the whole, the clinical results of implant workflow digitization in implant prosthodontics are positive, with high implant survival rates, predictable performances of prosthetics, and reduced patient satisfaction. Future studies are however required to confirm these findings over an extended period of time and in varying clinical conditions.

Efficiency and Cost Consideration

The efficiency and cost-effectiveness are some of the most important factors that affect the use of digital workflow in implant-supported prostheses. Digital technologies have been depicted to simplify clinical and laboratory processes and it may lead to reduction in the duration of treatment and overall efficiency of the workflow.

The main benefit of digital workflow is the decrease in chairside time. Digital impression methods do not require any traditional impression materials and trays, which makes it possible to acquire data much faster and verify the results in real-time. Randomized controlled trials established that digital workflows can save much time in the course of treatment in comparison with traditional methods especially in single-unit restorations [36]. Such a decrease in clinical time leads to high productivity and the patient experience.
Digital workflows are also used to improve efficiency in the laboratory. The CAD/CAM systems allow rapid precision in the fabrication of the prostheses and eliminates the use of manual operations and the possibility of human error. This is ensured by the use of digital data transfer between clinicians and labs, which enables quicker communication and enables real-time changes to be made, which in turn enhances efficiency [37]. Moreover, storage and reusing of digital information also makes it unnecessary to repeat impressions, which saves time in case of re-impressions of the prosthesis.
There is, however, a more complicated situation in terms of costs. As much as digital workflows can save on costs of operation in the long run by enhancing efficiency and minimizing material waste, the cost of equipments and software used is high in the first place. The intraoral scanners, milling units, and software licenses are generally very expensive and hence might not be accessible to everyone especially in small practices. The research states however indicate that these initial costs may be countered by long term gains based on lower costs of labor and augmented labor output.
Efficiency also stands to be enhanced with the integration of digital technologies which allow innovative solutions. As an example, 3D-printed instructions and templates help to place implants correctly and produce prostheses and make them properly, eliminating the waste of time on corrections and remakes [38]. The complete-arch rehabilitations were successfully applied with the implementation of fully digital workflows, which enabled completing the treatment in fewer appointments [39]. Moreover, computerized methods of overdenture manufacture have shown effective working procedures with minimal clinical intricacies [40]. Table 4 gives a comparative description of digital and traditional workflows.

Table 4: Comparison of Digital vs Conventional Workflow

Parameter	**Digital Workflow**	**Conventional Workflow**	**Clinical Implication**
Treatment Time	Reduced chairside time	Longer procedures	Increased efficiency
Patient Comfort	High (no impression material)	Moderate to low	Better patient experience
Accuracy	High in short-span cases	Reliable but technique-sensitive	Comparable outcomes
Cost	High initial investment	Lower initial cost	Long-term cost benefit
Reproducibility	High (digital storage)	Limited	Easier remakes and adjustments

Regardless of these benefits, discrepancies persist in the high level of efficiency in clinical settings devoid of any situation. Even more complex works, including full-archrehabilitations, can still utilize extra steps and checks, which can cancel out time management. Moreover, the digital technologies learning curve may also lower efficiency at the beginning of the learning process until the competence level is reached. Overall, the digital workflows have substantial benefits with efficiency and optimizing the workflow, and long-term cost benefits may be possible. Nevertheless, these benefits should be capitalized by paying close attention to the first investment, complexity of the case, as well as the experience of the clinicians.

Developed Techniques and Future Projections

Improvement in digital workflows in the field of implant prosthodontics has resulted in the emergence of sophisticated methods that can be utilized to enhance accuracy, efficiency, and clinical predictability. These innovations are the further development of digital dentistry that combines new technologies with the proven clinical guidelines.
Among the developments that have been made is the introduction of new surgical and prosthetic designs that help to improve predictability in treatments. It has also brought techniques like the STAR concept which are aimed at optimizing implant placement and immediate loading protocols and especially in edentulous arches [41]. These methods focus on the specific planning and performance, using digital solutions to reduce the deviations and enhance performance.
Digitization of the conventional dentures to a fixed implant-supported design has also not been left out. The digital methods allow a precise copying of the current prostheses that helps them pass to the implant-supported restorations easily and maintain the esthetic and function parameters [42]. In the same manner, the digital process of fabricating overdentures has been optimized to enhance accuracy and shorten the complexity of clinical procedures that can provide predictable results requiring fewer appointments [43].
Digital workflow capabilities have been further extended as a result of the integration of guided surgery technology with 3D printing technology. Wholly digital protocols with guided positioning of the implants, direct loading, and 3D-printed implants have been effectively introduced to clinical practice [44]. These strategies will allow treating patients quickly and ensuring a high degree of accuracy and patient satisfaction.
The future of digital dentistry of the implant could be majorly credited to the advancements in

photogrammetry and artificial intelligence (AI). Photogrammetry systems also offer a high level of precision in the data of implant position, especially in full-arch cases, and they overcome shortcomings related to the traditional intraoral scanner. The AI-based software can also be used to automate the planning of the treatment, to optimize the design of the prosthetics and advance the process of decision-making [45].
In spite of such encouraging trends, there are still some difficulties in the popularization of sophisticated digital methods. The cost, complexity in technology and, special training might restrict its accessibility. Also, the absence of standardized procedures and the absence of long-term clinical support makes them cautious [46]. The next steps in research need to be done in the field of measuring the long-term results of the advanced digital workflow and creating standardized rules regarding their application. The combination of new technologies and clinical practice has great potential to enhance the reference, effectiveness, and predictability of implant-supported prostheses. Figure 3 shows emerging technologies and direction.

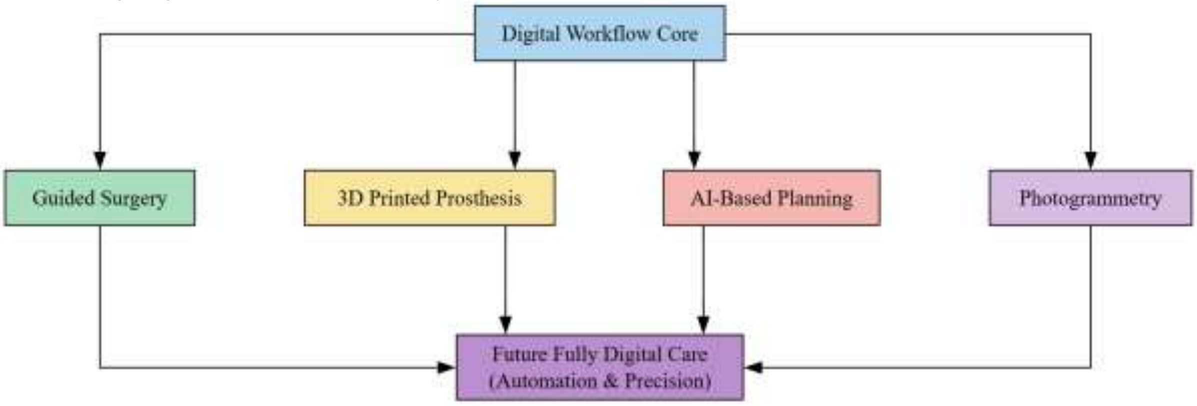

Figure 3: Representation of advanced digital techniques in implant prosthodontics

To sum up, state-of-the-art digital technologies can be viewed as a revolutionary move in the field of implant prosthodontics as they may provide new solutions to the current issues. Further development and enhancement of patient care and treatment outcomes are anticipated to be improved with the continued technological progress and clinical validation.

Conclusion

Implant-supported prosthodontics Digital working processes have changed the modern clinical practice through the implementation of a data-driven diagnosis, planning, and prosthesis production process. Intraoral scanning, CAD/CAM technology and guided surgical protocols have enhanced accuracy and minimization of variability in the process of procedure as opposed to the traditional workflow. There is evidence that digital methods are both able to make clinically acceptable accuracy and good results, especially with single-unit and short-span restorations, as well as improve patient comfort and minimise time treatment. Nonetheless, the accuracy of digital processes when working with complicated situations, including complete rehabilitation of the arches, is determined by the aggregate errors of a series of processes in the digital chain. Issues such as scanner constraints, allocation of implants, and experience of operators still influence general accuracy and prosthetic fit. Also, the lack of standardized procedures and absence of long-term clinical evidence limits the possibility of drawing specific conclusions about the superiority over traditional procedures. The adoption is also due to economic factors and learning curve of digital technologies. Initial cost of investment is very high but their introduction in clinical practice might be justified in long run. Altogether, digital workflows can be viewed as a major development in implant prosthodontics, as they have the potential of improving the predictability of the treatment and patient outcomes. More studies are necessary on the aspect of standardization and long-term validation to prove their conclusive role in clinical care.

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