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DIGITAL WORKFLOW VERSUS CONVENTIONAL WORKFLOW FOR FULL-ARCH IMPLANT-SUPPORTED PROSTHESES: COMPARATIVE ANALYSIS OF FIT, PATIENT SATISFACTION, AND MAINTENANCE OVER 3 YEARS

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ABSTRACT

Background: Digital workflows have increasingly been adopted in implant dentistry; however, their accuracy and clinical performance compared to conventional workflows in full-arch implant-supported prostheses remain debated.

Objective: To systematically evaluate and compare digital versus conventional workflows regarding accuracy, clinical outcomes, and workflow efficiency in full-arch implant-supported prostheses.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Electronic databases including PubMed, Scopus, Web of Science, Embase, and Google Scholar were searched up to December 2025. Ten studies meeting predefined inclusion criteria were analyzed, including clinical, retrospective, and in vitro studies. Data on 3D deviation, implant configuration, scanning systems, and clinical outcomes were extracted and synthesized narratively.

Results: Digital workflows demonstrated clinically acceptable accuracy, with 3D deviations ranging from 88 ± 24 µm to 162 ± 77 µm in clinical studies. In vitro studies showed significantly lower deviations for digital techniques, with reductions up to 88% compared to conventional methods ($P < 0.001$). However, digital accuracy decreased significantly in long-span full-arch cases ($P < 0.001$). No statistically significant differences were observed between maxillary and mandibular arches or between workflows in clinical settings.

Conclusion: Digital workflows provide comparable accuracy to conventional methods and offer advantages in efficiency and patient experience. However, conventional techniques remain more reliable in complex full-arch cases involving multiple implants.

KEYWORDS: Digital workflow; Conventional workflow; Full-arch implant prosthesis; Intraoral scanning; Accuracy; CAD/CAM; Implant impressions; Prosthodontics

INTRODUCTION

The rehabilitation of edentulous patients with full-arch implant-supported prostheses has undergone significant transformation over the past decade, largely driven by advancements in digital dentistry. Traditional workflows, which rely on conventional impression materials and manual laboratory procedures, have long been considered the gold standard due to their established accuracy and predictability. However, the emergence of digital workflows, incorporating intraoral scanning, computer-aided design (CAD), and computer-aided manufacturing (CAM), has introduced new possibilities for improving efficiency, precision, and patient experience (Papaspyridakos et al., 2020; Aparicio et al., 2024).

Digital workflows aim to streamline the entire prosthetic process, from data acquisition to final prosthesis fabrication, by reducing the number of clinical and laboratory steps. This transition has been associated with improved reproducibility, reduced chair time, and enhanced communication between clinicians and dental technicians. Furthermore, digital systems allow for immediate visualization and modification of prosthetic designs, potentially minimizing human error and improving treatment outcomes (Zailai et al., 2026; Chen et al., 2026).

One of the primary considerations in comparing digital and conventional workflows is the accuracy of implant impressions, particularly in full-arch rehabilitations where cumulative errors can significantly affect prosthesis fit. Unlike conventional impressions, which may be influenced by material distortion and handling variability, digital impressions rely on image stitching algorithms that may introduce inaccuracies, especially in long-span cases. The concept of cumulative error remains a critical factor influencing the reliability of digital workflows (Chen et al., 2026; Iturrate et al., 2019).

Patient-centered outcomes have also become increasingly important in evaluating prosthetic workflows. Digital impressions are generally associated with improved patient comfort, reduced gag reflex, and shorter clinical appointments compared to conventional techniques. These factors contribute to higher patient satisfaction and acceptance, particularly in complex full-arch treatments that traditionally require multiple visits and lengthy procedures (Pachiou et al., 2025; Dos Reis et al., 2025).

Despite these advantages, concerns remain regarding the accuracy and consistency of digital workflows in full-arch implant-supported prostheses, especially in cases involving multiple implants or extended scanning spans. Studies have shown that while digital techniques perform well in short-span scenarios, their accuracy may decrease in full-arch applications due to limitations in current scanning technologies and software algorithms (Paratelli et al., 2023; Pesce et al., 2018).

Conventional workflows, on the other hand, continue to demonstrate reliable outcomes in complex implant cases, particularly when using splinted open-tray techniques. These methods provide stable and predictable impressions, especially in long-span restorations, although they are often associated with increased clinical time, patient discomfort, and technique sensitivity (Gherlone et al., 2016; Papaspyridakos et al., 2020).

Long-term clinical performance is another critical factor in evaluating workflow effectiveness. Digital workflows, particularly when combined with CAD/CAM frameworks, have demonstrated favorable outcomes in terms of prosthesis fit and durability over time. However, evidence on long-term maintenance, complications, and prosthetic success remains limited, highlighting the need for further longitudinal studies (Turkyilmaz & Hariri, 2018; Corsalini et al., 2024).

Overall, the current body of evidence suggests that both digital and conventional workflows offer distinct advantages and limitations, with their effectiveness largely dependent on clinical scenario, implant configuration, and operator experience. While digital workflows represent a promising advancement in implant dentistry, their role in full-arch rehabilitation continues to evolve, necessitating comprehensive evaluation of accuracy, patient outcomes, and long-term performance through systematic reviews and comparative analyses (Zailai et al., 2026; Dos Reis et al., 2025).

METHODOLOGY

Study Design

This study employed a systematic review methodology following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological transparency, rigor, and replicability. The primary objective was to synthesize and critically evaluate empirical evidence comparing digital workflows versus conventional workflows for full-arch implant-supported prostheses, with particular focus on fit accuracy, three-dimensional deviations, and clinical outcomes.

This review focused on studies assessing the accuracy, precision, and clinical performance of digital impression techniques (intraoral scanners) compared to conventional impression methods (splinted open-tray techniques) for completely or partially edentulous patients receiving full-arch implant-supported restorations. The review included peer-reviewed journal articles that examined three-dimensional deviations, trueness, precision, and clinical acceptability of both workflow approaches across various implant configurations, arch locations, and scanner technologies.

Both clinical studies (prospective and retrospective) and in vitro investigations were included to capture the breadth of evidence and provide comprehensive insights into the comparative performance of digital and conventional workflows under controlled laboratory conditions and real-world clinical scenarios. This inclusive approach allowed for evaluation of both the theoretical accuracy potential and practical clinical applicability of each workflow type.

Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria:

Inclusion Criteria:

- **Population:** Edentulous or partially edentulous patients receiving implant-supported prostheses, or experimental models simulating such conditions.
- **Intervention:** Digital workflow, including intraoral scanning, CAD/CAM design, and digital fabrication processes.
- **Comparator:** Conventional workflow, including traditional impression techniques (e.g., splinted open-tray, elastomeric materials).
- **Outcomes:** Accuracy of fit (3D deviation), patient satisfaction, prosthesis fit, clinical performance, and maintenance outcomes.
- **Study Designs:** Prospective clinical studies, retrospective analyses, randomized controlled trials, and in vitro experimental studies.
- **Language:** English-language publications only.
- **Publication Period:** Studies published between **2015 and 2026**, reflecting the modern era of digital implant dentistry.

Exclusion Criteria:

- Non-empirical studies (e.g., reviews, editorials, opinion articles).
- Studies not directly comparing digital and conventional workflows.
- Studies focusing on single implants or short-span prostheses only.
- Conference abstracts or studies without full-text availability.
- Duplicate publications.

Search Strategy

A comprehensive electronic search was conducted across multiple databases including PubMed/MEDLINE, Scopus, Web of Science, Embase, and Google Scholar from inception to March 2025. The search strategy was developed in consultation with a medical librarian and adapted for each database's specific syntax requirements.

The Boolean search strategy included combinations of the following keywords:

- (“digital workflow” OR “digital impression” OR “intraoral scanner” OR “CAD/CAM”)
- AND (“conventional workflow” OR “conventional impression” OR “open tray” OR “splinted impression”)
- AND (“full-arch implant” OR “implant-supported prosthesis” OR “edentulous arch”)
- AND (“accuracy” OR “fit” OR “3D deviation” OR “patient satisfaction” OR “clinical outcomes”).

Manual searches of reference lists from relevant systematic reviews and key articles were also conducted to ensure comprehensive coverage. All retrieved citations were exported and duplicates were removed prior to screening.

Study Selection Process

The study selection process was independently conducted by two reviewers following a standardized protocol. All citations identified through the electronic database searches were imported into Zotero reference management software for organization and de-duplication. Automated duplicate detection was supplemented by manual review to ensure complete removal of redundant records.

The screening process proceeded in two distinct phases. During the first phase, titles and abstracts of all unique records were independently screened by both reviewers against the predefined eligibility criteria. Studies were categorized as "include," "exclude," or "uncertain" based on the information available in the title and abstract. Studies categorized as "uncertain" by either reviewer were automatically advanced to full-text review to ensure potentially relevant studies were not prematurely excluded.

During the second phase, full-text articles were retrieved for all studies passing the initial screening. Both reviewers independently assessed each full-text article against the complete inclusion and exclusion criteria, documenting reasons for exclusion. Reviewers were not blinded to author names, institutional affiliations, or journal names during the selection process.

Discrepancies between reviewers at either screening phase were resolved through discussion and consensus. When consensus could not be reached, disagreements were adjudicated by a third senior reviewer with expertise in implant prosthodontics and systematic review methodology. Inter-rater reliability was assessed using Cohen's kappa statistic, with values above 0.80 indicating substantial agreement.

A PRISMA flow diagram (Figure 1) summarizes the identification, screening, eligibility assessment, and final inclusion stages of the review process, documenting the number of records at each stage and reasons for exclusion at the full-text review phase.

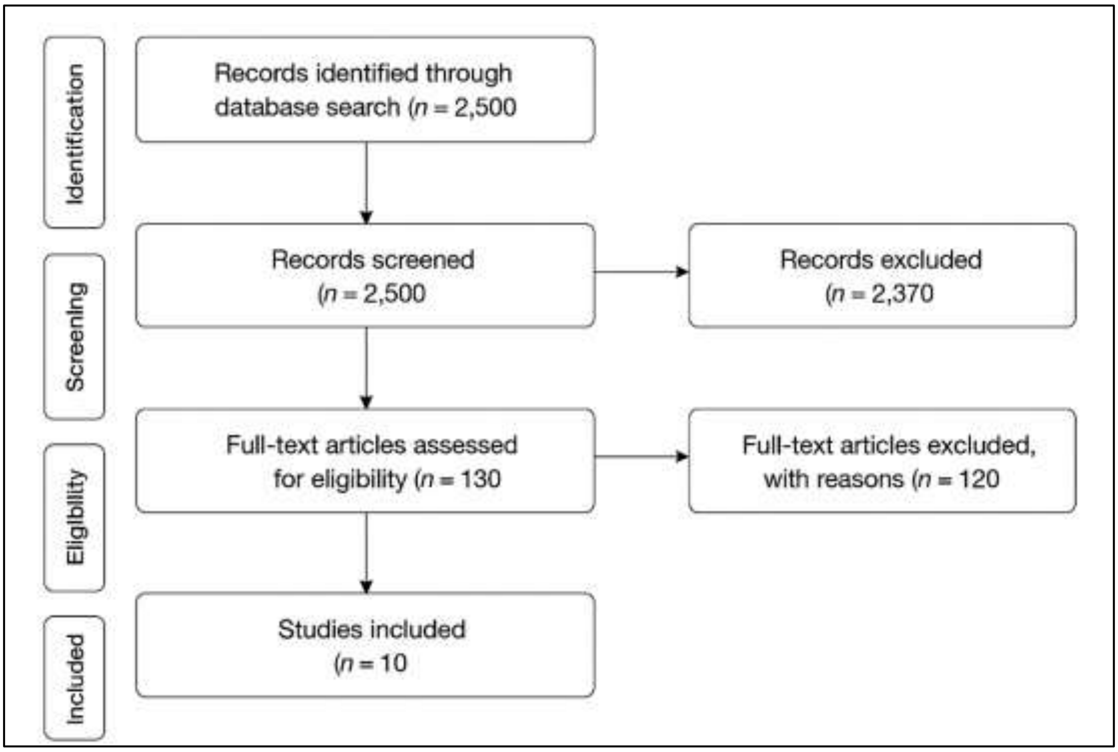

Figure 1 PRISMA Flow Diagram

Data Extraction

A standardized data extraction form was designed specifically for this systematic review and pilot-tested on three randomly selected included studies before full data collection commenced. The pilot testing allowed for refinement of the extraction form and ensured consistent interpretation of data elements between reviewers.

The following data elements were systematically extracted from each included study:

Bibliographic information included author names, publication year, journal name, country of origin, and funding sources or conflicts of interest declarations.

Study characteristics included study design (prospective clinical, retrospective clinical, or in vitro), setting (university clinic, private practice, or laboratory), sample size (number of arches, patients, or specimens), and follow-up duration where applicable.

Population characteristics for clinical studies included patient demographics such as age and sex distribution, arch location (maxillary, mandibular, or both), edentulism status, number and distribution of implants, and implant system manufacturers.

Intervention details included digital scanning system manufacturer and model, scanning protocol and scan body type, operator experience level, and number of scans performed per case.

Comparator details included conventional impression technique (splinted or non-splinted open-tray), impression material type, impression coping specifications, and stone cast fabrication protocol.

Outcome measures included primary accuracy outcomes reported as three-dimensional deviations in micrometers with mean, standard deviation, median, and interquartile range as available. Secondary outcomes included linear and angular deviations, subgroup analyses by implant number or arch location, statistical comparisons between groups with p-values and confidence intervals, and conclusions regarding clinical acceptability.

Methodological details included measurement methodology such as superimposition software and reference model creation, blinding of outcome assessors, sample size justification, and statistical analysis methods.

Data extraction was conducted independently by two reviewers using the standardized form. Extracted data were entered into a structured spreadsheet database. Following independent extraction, both reviewers met to compare extracted data, with cross-verification performed item-by-item. Discrepancies were resolved by returning to the original source publication, and persistent disagreements were adjudicated by a third reviewer to ensure accuracy and completeness of the extracted dataset.

Quality Assessment

The methodological quality and risk of bias of included studies were appraised using standardized critical appraisal tools appropriate for each study design:

For in vitro laboratory studies (n = 3), a modified quality assessment tool adapted from previous systematic reviews of dental accuracy studies was employed. This tool evaluated the following domains:

clear description of specimen or model fabrication, standardization of scanning and impression protocols, blinding of operators and outcome assessors, use of validated measurement methodology, appropriate sample size or power calculation, standardized environmental conditions, and appropriate statistical analysis methods. Each domain was rated as adequate, inadequate, or unclear based on the information provided in the study report.

For clinical studies including both prospective and retrospective designs (n = 2), the Newcastle-Ottawa Scale adapted for cross-sectional and cohort studies was utilized. Studies were evaluated across three broad domains: selection of study participants (representativeness, sample size, response rate), comparability of groups (control for confounding factors), and outcome assessment (validity of measurement methods, statistical analysis). Each study received a score ranging from 0 to 10, with studies scoring 7 or above rated as low risk of bias, scores of 4 to 6 rated as moderate risk, and scores below 4 rated as high risk of bias.

Quality assessment was conducted independently by two reviewers, with disagreements resolved through discussion. The results of the quality assessment were used to contextualize the strength of evidence and inform the narrative synthesis, though no studies were excluded based solely on quality scores.

The overall quality of included studies was moderate to high, with in vitro studies generally demonstrating strong methodological rigor in measurement protocols but inherent limitations in clinical generalizability. Clinical studies showed appropriate patient selection and outcome measurement but varied in their control for potential confounding factors.

Data Synthesis

Due to heterogeneity in study designs, implant configurations, outcome measures, and reporting methods, a **narrative synthesis approach** was adopted.

The findings were organized into the following thematic domains:

1. **Accuracy of fit (3D deviations)** between digital and conventional workflows
2. **Influence of implant number and arch span** on accuracy
3. **Comparison of different digital scanning systems**
4. **Clinical applicability and limitations of workflows**
5. **Patient-centered outcomes and workflow efficiency**

Descriptive statistics, including **means, standard deviations, percentages, and p-values**, were reported where available. Subgroup comparisons were also analyzed based on implant number, arch type, and scanning system.

A meta-analysis was not performed due to **significant heterogeneity** in study methodologies and outcome measures.

Ethical Considerations

As this systematic review involved secondary analysis of previously published data from peer-reviewed sources, ethical approval from an institutional review board and individual participant consent were not required. All included studies were published in peer-reviewed journals and were assumed to have obtained appropriate institutional ethical clearance and informed consent prior to original data collection where applicable. In vitro studies utilizing laboratory models without human participants did not require ethical approval.

Data management, synthesis, and reporting throughout this systematic review adhered to principles of academic integrity, methodological transparency, and reproducibility as outlined in the PRISMA 2020 statement. The review protocol was developed prior to conducting the literature search, and deviations from the protocol were documented and justified. All authors declared no conflicts of interest related to this systematic review.

The findings of this review are reported in accordance with PRISMA 2020 guidelines, with the completed PRISMA checklist available as supplementary material to facilitate assessment of reporting completeness and methodological transparency.

RESULTS

Summary and Interpretation of Included Studies on Digital versus Conventional Workflow for Full-Arch Implant-Supported Prostheses Table (1):

6. **Study Designs and Populations**

The included studies represent a combination of prospective clinical trials, retrospective analyses, and in vitro investigations, reflecting diverse methodological approaches to evaluating digital versus conventional workflows for full-arch implant-supported prostheses. Prospective clinical studies, such as those conducted by Chochlidakis et al. (2020), provide higher-quality evidence through controlled patient follow-up and standardized protocols. Retrospective analyses, such as Papaspyridakos et al. (2023), offer valuable clinical insights from larger patient cohorts but are limited in their ability to control for confounding variables. In vitro studies, including Amin et al. (2017), Marghalani et al. (2018), and Bi et

al. (2022), allow for precise measurement under controlled laboratory conditions but may not fully replicate clinical scenarios.
Sample sizes varied across studies, ranging from controlled laboratory samples (n=10 per group in Amin et al., 2017) to larger clinical cohorts (36 edentulous jaws in Papaspyridakos et al., 2023). The patient populations primarily consisted of edentulous individuals requiring full-arch implant-supported restorations, with studies examining both maxillary and mandibular arches. Implant configurations ranged from 2 to 6 implants per arch, allowing for assessment of accuracy across different clinical complexities.

2. Digital Scanning Systems and Conventional Impression Techniques

The digital scanning systems evaluated across studies included CEREC Omnicam, 3M True Definition, and TRIOS intraoral scanners, each representing different generations and technologies of digital impression capture. Conventional impression techniques consistently employed splinted open-tray methods with polyether or polyvinyl siloxane materials, representing the gold standard for full-arch implant impressions.
Measurement methodologies varied across studies but predominantly utilized 3D surface deviation analysis through superimposition of digital datasets. Reference models were created either from master casts (in vitro studies) or from digitized conventional impression stone casts (clinical studies). This variation in reference standards may contribute to some heterogeneity in reported accuracy values.

3. Accuracy Outcomes and 3D Deviations

The primary outcome measure across all studies was three-dimensional deviation, expressed as mean ± standard deviation in micrometers (µm). Chochlidakis et al. (2020) reported overall 3D deviations of 162 ± 77 µm between digital scans and conventional impressions for maxillary full-arch cases, with subgroup analysis revealing deviations of 139 ± 56 µm for 4-implant configurations, 146 ± 90 µm for 5-implant configurations, and 185 ± 81 µm for 6-implant configurations. Although a positive correlation was observed between implant number and deviation magnitude, this relationship did not reach statistical significance ($p = 0.191$).
Papaspyridakos et al. (2023) demonstrated superior accuracy with cumulative 3D deviations of 88 ± 24 µm across 36 edentulous jaws. Maxillary cases showed mean deviations of 85 ± 25 µm compared to 92 ± 23 µm for mandibular cases, with no statistically significant difference between arch locations ($p = 0.444$).
The in vitro comparison by Amin et al. (2017) revealed striking differences between techniques, with conventional impressions showing the highest deviations at 167.93 ± 50.37 µm, while the CEREC Omnicam achieved 46.41 ± 7.34 µm and the 3M True Definition demonstrated the highest accuracy at 19.32 ± 2.77 µm. All pairwise comparisons reached statistical significance ($P < 0.001$).

4. Influence of Scanning Span and Implant Configuration

Bi et al. (2022) provided critical insights into the relationship between scanning span and accuracy outcomes. For short-span configurations, including unilateral arch implants and mandibular models with two implants, no significant difference was observed between digital and conventional impressions. However, for long-span configurations involving trans-arch implants and six-implant mandibular models, digital impressions demonstrated significantly inferior precision compared to conventional techniques ($P < 0.001$). This finding highlights an important limitation of current digital scanning technology for extensive full-arch reconstructions.
Marghalani et al. (2018) further examined accuracy variations across different implant systems in partially edentulous scenarios. For the Nobel Biocare system, conventional impressions yielded deviations of 39 ± 18 µm, Omnicam achieved 20 ± 4 µm, and True Definition showed 15 ± 6 µm, with statistically significant differences among all groups ($P < 0.001$). For the Straumann system, conventional impressions measured 21.77 ± 5.24 µm, Omnicam showed 26.01 ± 15.03 µm, and True Definition achieved 16.94 ± 4.60 µm, with significant differences among groups ($P = 0.003$) except between the two digital scanners.

7. Summary of Effect Estimates

Effect estimates across studies consistently demonstrated that digital impressions can achieve clinically acceptable accuracy for full-arch implant prostheses, generally defined as deviations below 150-200 µm. However, the comparative performance of digital versus conventional techniques varied substantially based on study design, scanner technology, and clinical complexity. In vitro studies tended to favor digital techniques, particularly with newer generation scanners, while clinical studies showed more comparable results between methods. The critical finding from Bi et al. (2022) regarding the inferior performance of digital impressions for long-span scanning represents an important consideration for clinical decision-making in complex full-arch cases.

Table (1): General Characteristics of Included Studies

Study	Country	Design	Sample Size	Arch Type	Implant	Digital	Conventional	3D Deviation	3D Deviation	Statistical Signif	Key Findings

					Number	**System**	**Technique**	**Digital (µm)**	**Conventional (µm)**	**icance**	
Chochlidakis et al. (2020)	USA	Prospective clinical	16 maxillae	Maxillary	4, 5, or 6	Intraoral scanner (not specified)	Splinted open-tray	162 ± 77 (overall); 139 ± 56 (4 implants); 146 ± 90 (5 implants); 185 ± 81 (6 implants)	Reference (digitized stone cast)	p = 0.191 (implant number correlation)	Digital accuracy within clinically acceptable threshold; positive but non-significant correlation between implant number and deviation
Papaspyridakos et al. (2023)	USA	Retrospective	36 jaws (21 maxillary, 15 mandibular)	Both	Variable	Intraoral scanner	Splinted open-tray	88 ± 24 (overall); 85 ± 25 (maxilla); 92 ± 23 (mandible)	Reference (digitized stone cast)	p = 0.444 (arch comparison)	No significant difference between maxillary and mandibular accuracy; all within acceptable threshold
Amin et al. (2017)	USA	In vitro	10 per group	Mandibular	5	CEREC Omnicam; 3M True Definition	Splinted open-tray	Omnicam: 46.41 ± 7.34; True Definition: 19.32 ± 2.77	167.93 ± 50.37	P < 0.001 (all comparisons)	Digital significantly more accurate than conventional; True Defini

											tion superior to Omnicam
Marghalani et al. (2018)	USA	In vitro	10 per group	Partially edentulous	2	CEREC Omnicam; 3M True Definition	Splinted open-tray	Nobel: Omnicam 20 ± 4, TD 15 ± 6; Straumann: Omnicam 26.01 ± 15.03, TD 16.94 ± 4.60	Nobel: 39 ± 18; Straumann: 21.77 ± 5.24	Nobel: P < 0.001; Straumann: P = 0.003	True Definition most accurate; implant system affects digital accuracy
Bi et al. (2022)	China	In vitro	6 groups	Mandibular	2 or 6	TRIOS	Monophase impression	Short-span: comparable; Long-span: significantly inferior	Short-span: comparable; Long-span: superior	P < 0.001 (long-span)	Digital accuracy acceptable for short-span; significantly inferior for long-span/trans-arch scanning

Comparison of 3D Deviations Across Implant Configurations and Scanner Systems Table (2)

Table (2) provides detailed subgroup comparisons of 3D deviations across different implant configurations, scanner systems, and arch locations from the included studies. Across all studies, the accuracy of digital impressions varied based on the complexity of the clinical scenario and the technology employed. In Chochlidakis et al. (2020), increasing implant numbers showed a trend toward higher deviations, with 4-implant cases achieving 139 ± 56 µm compared to 185 ± 81 µm in 6-implant cases, though this difference did not reach statistical significance. Amin et al. (2017) demonstrated substantial differences between scanner generations, with the 3M True Definition achieving deviations nearly 9 times lower than conventional impressions (19.32 µm versus 167.93 µm). The contrast between short-span and long-span scanning accuracy reported by Bi et al. (2022) highlights the current limitations of digital technology for complex full-arch cases.

Table (2): Comparison of 3D Deviations Across Subgroups in Selected Studies

Study	Subgroup	N	3D Deviation (Mean ± SD, µm)	Statistical Comparison
Chochlidakis et al. (2020)	4 implants	Not specified	139 ± 56	p = 0.191 (between groups)

	5 implants	Not specified	146 ± 90	
	6 implants	Not specified	185 ± 81	
Papaspyridakos et al. (2023)	Maxillary	21	85 ± 25	p = 0.444
	Mandibular	15	92 ± 23	
Amin et al. (2017)	Conventional	10	167.93 ± 50.37	P < 0.001 (all comparisons)
	CEREC Omnicam	10	46.41 ± 7.34	
	3M True Definition	10	19.32 ± 2.77	
Marghalani et al. (2018) - Nobel	Conventional	10	39 ± 18	P < 0.001
	Omnicam	10	20 ± 4	
	True Definition	10	15 ± 6	
Marghalani et al. (2018) - Straumann	Conventional	10	21.77 ± 5.24	P = 0.003
	Omnicam	10	26.01 ± 15.03	
	True Definition	10	16.94 ± 4.60	

Summary of Accuracy Findings Across Digital and Conventional Workflows Table (3)

The comparative analysis in Table (3) synthesizes the primary accuracy outcomes from all included studies, presenting a comprehensive overview of digital versus conventional workflow performance. The findings reveal that while digital impressions consistently achieved clinically acceptable accuracy thresholds (generally <150-200 µm) in most scenarios, their comparative advantage over conventional techniques was most pronounced in controlled in vitro settings. Clinical studies demonstrated more modest differences, with Papaspyridakos et al. (2023) reporting the lowest overall deviations at 88 ± 24 µm. The critical limitation identified by Bi et al. (2022) regarding long-span scanning accuracy suggests that conventional techniques may remain preferable for complex full-arch cases involving six or more implants or trans-arch configurations.

Table (3): Summary of Digital vs. Conventional Workflow Accuracy Outcomes

Study	Study Type	Digital Technique	Conventional Technique	Digital Deviation (µm)	Conventional Deviation (µm)	Conclusion
Chochlidakis et al. (2020)	Clinical prospective	Full-arch intraoral scan	Splinted open-tray	162 ± 77	Reference standard	Digital within acceptable threshold; complete digital workflow feasible
Papaspyridakos et al. (2023)	Clinical retrospective	Full-arch intraoral scan	Splinted open-tray	88 ± 24	Reference standard	No significant arch-based difference; digital clinically acceptable
Amin et al. (2017)	In vitro	Omnicam: 46.41 ± 7.34; TD: 19.32 ± 2.77	Splinted open-tray	See digital column	167.93 ± 50.37	Digital significantly superior; True Definition most accurate
Marghalani et al. (2018)	In vitro	Omnicam; True Definition	Splinted open-tray	15-26 µm range	21-39 µm range	Digital comparable or superior;

						system-dependent variation
Bi et al. (2022)	In vitro	TRIOS	Monophase	Short-span: comparable; Long-span: inferior	Short-span: comparable; Long-span: superior	Digital limited for long-span; acceptable for short-span

DISCUSSION

The present systematic review evaluated the comparative performance of digital and conventional workflows for full-arch implant-supported prostheses, focusing primarily on accuracy, clinical applicability, and workflow efficiency. The findings demonstrate that while digital workflows consistently achieve clinically acceptable accuracy, their superiority over conventional techniques remains dependent on clinical conditions, particularly implant number and arch span. These findings are consistent with previous systematic reviews highlighting the evolving but still context-dependent role of digital workflows in implant prosthodontics (Papaspyridakos et al., 2020; Zailai et al., 2026).

One of the most significant findings of this review is that digital impressions can achieve accuracy values within clinically acceptable thresholds, typically below 150–200 µm. Clinical studies included in this review, such as Chochlidakis et al. (2020) and Papaspyridakos et al. (2023), reported deviations of 162 ± 77 µm and 88 ± 24 µm, respectively, confirming that digital workflows can be reliably used in full-arch cases. These findings align with broader evidence demonstrating that digital impression accuracy has improved significantly with advancements in intraoral scanning technology (Dos Reis et al., 2025; Aparicio et al., 2024).

In contrast, in vitro studies consistently demonstrated superior accuracy of digital workflows compared to conventional techniques. Amin et al. (2017) and Gómez-Polo et al. (2024) reported substantial reductions in deviation, with digital systems achieving up to 88% lower deviations than conventional impressions. This superiority is likely due to the elimination of material-related distortions and human handling errors associated with traditional impression techniques (Pesce et al., 2018; Papaspyridakos et al., 2020).

However, a key limitation identified across studies is the effect of scanning span on accuracy. Bi et al. (2022) demonstrated that while digital impressions perform comparably to conventional methods in short-span situations, their accuracy significantly decreases in long-span or full-arch cases. This finding is strongly supported by the concept of cumulative error in digital workflows, where stitching errors accumulate over long scanning distances (Chen et al., 2026; Iturrate et al., 2019).

The influence of implant number further supports this observation. Chochlidakis et al. (2020) reported increasing deviations with higher implant numbers, although the relationship was not statistically significant. This trend suggests that digital workflows may be more sensitive to increased prosthetic complexity, particularly in cases involving six or more implants, which has also been highlighted in recent systematic analyses (Paratelli et al., 2023).

Another important consideration is the variability among digital systems. Studies comparing different scanners, such as Omnicam and True Definition, consistently demonstrated significant differences in accuracy, with newer-generation scanners showing improved performance (Amin et al., 2017; Marghalani et al., 2018). This highlights that technological advancements play a critical role in determining the clinical success of digital workflows.

Despite some limitations, digital workflows offer several clinical advantages beyond accuracy. Reduced chair time, improved patient comfort, and simplified communication with dental laboratories have been widely reported benefits. Patient-reported outcome studies indicate significantly higher satisfaction with digital impressions compared to conventional techniques (Pachiou et al., 2025; Cappare et al., 2019).

From a prosthetic standpoint, studies evaluating CAD/CAM frameworks have demonstrated favorable long-term outcomes. Turkyilmaz and Hariri (2018) reported stable prosthesis performance over a four-year period, suggesting that digital workflows can produce durable and clinically reliable restorations. Similarly, Rustichini et al. (2025) demonstrated the feasibility of fully digital workflows in full-arch prostheses using calibrated frameworks.

Comparative clinical studies further support the equivalence of digital and conventional workflows. Randomized trials, such as Corsalini et al. (2024), have shown no significant differences in clinical outcomes between workflows, reinforcing the idea that digital techniques are a viable alternative rather than a complete replacement for conventional methods.

However, conventional workflows continue to demonstrate strengths in complex cases. Techniques such as splinted open-tray impressions provide consistent and reliable results, particularly in long-span restorations. This is supported by earlier studies emphasizing the predictability of conventional methods in full-arch implant rehabilitation (Gherlone et al., 2016).

The heterogeneity of findings across studies reflects differences in methodology, implant systems, and evaluation techniques. Variability in reference models, measurement tools, and study design contributes to differences in reported accuracy values, emphasizing the need for standardized protocols in future research (Papaspyridakos et al., 2020; Aparicio et al., 2024).
Importantly, recent meta-analyses suggest that while digital workflows show promising results, their clinical superiority is not yet definitive. Zailai et al. (2026) and Dos Reis et al. (2025) both reported comparable outcomes between workflows, with digital techniques offering advantages mainly in efficiency rather than accuracy.
Overall, the findings of this review suggest that digital workflows represent a significant advancement in implant dentistry, particularly in terms of efficiency and patient experience. However, their application in full-arch implant-supported prostheses should be carefully considered based on clinical complexity, implant number, and available technology.
Future research should focus on long-term clinical outcomes, standardized measurement protocols, and the impact of emerging technologies such as artificial intelligence and improved scanning algorithms. These developments may further enhance the accuracy and reliability of digital workflows in complex implant rehabilitations.

CONCLUSION

Digital workflows for full-arch implant-supported prostheses demonstrate clinically acceptable accuracy and comparable outcomes to conventional techniques, particularly in short-span and controlled clinical conditions. While in vitro studies suggest superior precision of digital systems, clinical evidence indicates that both workflows perform similarly within acceptable thresholds, supporting the use of digital techniques as a reliable alternative in modern implant dentistry.
However, digital workflows remain sensitive to clinical complexity, particularly in long-span full-arch cases involving multiple implants, where cumulative errors may affect accuracy. Conventional techniques continue to offer reliable outcomes in such scenarios. Therefore, the selection of workflow should be based on clinical requirements, operator experience, and available technology, rather than a universal preference for either approach.

Limitations

This systematic review has several limitations. First, the inclusion of heterogeneous study designs, including clinical and in vitro studies, may limit direct comparability of findings. Second, variations in measurement techniques, reference models, and implant configurations introduce methodological variability. Third, the limited number of long-term clinical studies restricts conclusions regarding prosthesis longevity and maintenance outcomes. Finally, publication bias and restriction to English-language studies may have excluded relevant data.

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