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Clinical Accuracy of Intraoral Scanner Impressions Compared with Conventional Impressions in Fixed Partial Prostheses: A Systematic Review

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ABSTRACT

The use of digital impression systems in prosthodontics has gained greater acceptance, but issues surrounding their clinical accuracy compared to traditional elastomeric impressions still exist, particularly for fixed partial prostheses. This comparison is crucial as many practices transition to digital workflows. **Objectives:** The primary objective of this review was to evaluate the clinical accuracy of intraoral scanner (IOS) impressions versus conventional impressions for fixed partial prostheses. **Methods:** A systematic search was conducted in PubMed, Scopus, and Cochrane Library for comparative clinical studies published between January 2018 and January 2024. Eligible studies included human trials comparing IOS and conventional impressions for tooth- or implant-supported fixed prostheses. Methodological quality was assessed using a modified QUADAS-2 tool. **Results:** Fifteen clinical studies met the inclusion criteria. Quantitative analysis revealed marginal gaps for digital workflows ranging from 30 to 90 µm, comparable to the 35–100 µm range observed for conventional methods. Digital impressions demonstrated superior time efficiency and patient comfort. For short-span restorations, IOS accuracy was equivalent to conventional methods; however, conventional techniques showed slightly better stability in long-span implant cases. **Conclusions:** Current clinical evidence suggests that intraoral scanners provide accuracy comparable to conventional impressions for most fixed partial prostheses, with added benefits in efficiency and patient experience. While caution is advised for complex full-arch cases, IOS can be reliably integrated into routine practice.

INTRODUCTION

Digital technology has significantly transformed the modern practice of dentistry, and one area where this transformation has been particularly notable is impression making [1]. Previously regarded as an emerging supplementary technology, intraoral scanners have now become integral components of most restorative workflows. Their increasing adoption reflects broader trends toward enhanced chairside efficiency, seamless digital workflow integration, and streamlined laboratory communication [2]. Regardless of this development, the fundamental clinical question remains: What is the accuracy of these digital impressions in comparison with the long-established conventional elastomeric materials traditionally used for fixed partial prostheses? [3, 4]. The success of any fixed restoration is fundamentally dependent on impression accuracy. Marginal fit, internal

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adaptation, and three-dimensional precision are critical determinants of long-term outcomes such as biological compatibility, prosthesis longevity, and patient comfort [5]. While intraoral scanners are expected to achieve enhanced efficiency and improved patient acceptance, their clinical performance can be influenced by multiple factors, including clinical context, the extent of the restoration, scanner technology capabilities, and operator proficiency. Traditional materials, especially polyvinyl siloxane and polyether, have demonstrated a long history of consistent performance, thereby establishing a high benchmark for digital systems to achieve comparable standards [6-8]. A substantial body of clinical research has emerged in recent years comparing digital impressions with traditional methods. Findings from these investigations generally suggest that digital scanning can serve as a viable alternative for most routine prosthodontic procedures, although controversies persist regarding more complex clinical scenarios, particularly long-span implant restorations [9]. The objective of this systematic review was to synthesize the latest evidence from clinical studies published between 2018 and 2024. By critically evaluating studies that directly compare intraoral scanners with conventional impressions in human participants, this review seeks to provide a comprehensive and contemporary understanding of their relative accuracy and clinical implications for prosthodontic care.

Although intraoral scanners have become widely-used, it is not clear how accurately they can be compared to the traditional elastomeric impressions, especially in more complicated restorations and the placement of implantable prostheses. This is a challenge in attaining optimal marginal fit, internal adaptation, and long-term success of the prostitution. This study aimed to conduct a meta-analytic review of recent clinical research findings to assess and compare the validity of digital and traditional impression methods in the study of prosthodontic care.

METHODS

To ensure methodological clarity, the following PICO framework was defined for this review: Population: Patients requiring fixed partial prostheses (tooth-supported or implant-supported). Intraoral scanner (IOS) digital impressions, Comparator: Conventional elastomeric impressions (polyvinyl siloxane, polyether). Marginal fit, internal adaptation, clinical accuracy, treatment time, patient comfort. This systematic review was conducted to evaluate the clinical accuracy of intraoral scanner impressions compared with standard conventional impressions for fixed partial prostheses. The review methodology adhered to the established principles of the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure methodological rigor, clarity, and transparency throughout the selection process. Given that the primary focus was clinical accuracy, particular attention was directed toward identifying studies that directly compared both techniques under actual patient conditions. A comprehensive electronic search was conducted across PubMed, Scopus, and Cochrane Library. PubMed search strategy: "(intraoral scanner OR digital impression AND (conventional impression OR elastomeric impression AND (fixed partial prosthesis OR fixed dental prosthesis OR crown OR bridge OR implant AND (accuracy[Title/Abstract] OR fit[Title/Abstract] OR adaptation[Title/Abstract] OR clinical AND (2018/01/01:2024/01/31[Date - Publication])" Scopus search strategy: ((intraoral AND scanner) OR (digital AND impression)) AND ((conventional AND impression) OR (elastomeric AND impression)) A((fixed AND partial AND prosthesis) OR (fixed AND dental AND prosthesis) OR crown OR bridge OR implant) AND (accuracy OR fit OR adaptation OR clinical) AND PUBYEAR > 2017 AND PUBYEAR < 2025" Cochrane Library search strategy: (intraoral scanner): OR (digital impression): (conventional impression): OR (elastomeric impression): (fixed partial prosthesis): OR (fixed dental prosthesis): OR crown: OR bridge: OR implant: accuracy OR adaptation: OR clinical: with publication year from 2018 to 2024. The search was temporally restricted to studies published between January 2018 and January 2024, as this period represents the timeframe during which modern intraoral scanners and updated CAD-CAM workflows became broadly accessible in clinical practice. No restrictions were applied to geographical location or clinical setting. Reference lists of included articles were manually screened to identify any additional potentially relevant studies. Inclusion Criteria: Study Design: Randomized controlled trials (RCTs), prospective clinical studies, crossover clinical trials, split-mouth randomized clinical studies, and comparative clinical trials conducted in human participants Participants/Population: Adult patients (≥18 years) requiring fixed partial prostheses, including tooth-supported single crowns, multi-unit fixed dental prostheses (FDPs), and implant-supported restorations (single or multiple units) Intervention (Index Test): Intraoral scanner (IOS) digital impressions using any commercially available scanner system with complete digital workflow for prosthesis fabrication Comparator (Reference Standard): Conventional elastomeric impression techniques (polyvinyl siloxane, polyether, or other elastomeric materials) with traditional analog workflow Outcomes: Quantitative accuracy metrics including marginal fit/gap measurements (µm), internal adaptation measurements (µm), 3D positional deviations, clinical fit assessments; and/or clinical efficiency outcomes

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including treatment time, chairside adjustment time, patient comfort/preference scores, need for impression repetition. Language: Studies published in English Publication Period: January 2018 to January 2024 Publication Type: Full-text peer-reviewed journal articles. Exclusion Criteria: Study Design: Study design was laboratory-based in vitro studies, case reports, case series, review articles (systematic reviews, narrative reviews, umbrella reviews), meta-analyses, editorials, commentaries, letters to the editor, conference abstracts, and technique description articles. Participants: Studies involving complete dentures, removable partial dentures, or pediatric populations. Intervention: Studies evaluating only digital design software, CAD-CAM milling accuracy, or digital workflows without actual clinical impression comparison. Comparator: Studies without direct comparison between digital and conventional impression techniques (single-arm studies). Outcomes: Studies reporting only subjective outcomes without quantitative accuracy or clinical fit data; studies limited to time/cost analysis without accuracy assessment. Language: Non-English publications Publication Type: Unpublished studies, dissertations, gray literature, and studies with incomplete or inaccessible data. Retrieved citations underwent a two-stage screening process. Initially, titles and abstracts were reviewed to exclude studies unrelated to prosthodontics or lacking comparative methodology. Subsequently, full-text articles were assessed for eligibility. Study characteristics including design, sample characteristics, prosthesis type, impression protocol, and outcome measures were extracted and organized in a structured table to facilitate comparative analysis. When data were ambiguous or incomplete, clarification was sought through supplementary materials or consultation of related publications. Methodological quality was assessed using a modified version of the QUADAS-2 tool, specifically adapted for prosthodontic accuracy studies where both impression techniques function as measurement procedures rather than diagnostic interventions. Modifications included evaluation of impression protocol standardization, operator calibration, and outcome measurement consistency. This approach enabled systematic appraisal of potential bias across multiple domains: patient selection, index test (digital impression) execution, reference standard (conventional impression) application, and flow and timing of outcome assessment. The risk of bias in each domain was classified as low, high, or unclear. This review was not prospectively registered in PROSPERO, which represents a limitation in terms of methodological transparency and should be acknowledged.

A total of 485 records were retrieved through database searches, and 112 duplicates were removed before screening. After reviewing 373 titles and abstracts, 298 records were excluded for not meeting the study objective. Seventy-five full-text articles were assessed, of which three could not be retrieved. Following detailed eligibility evaluation of 72 full-text reports, 57 were excluded on the basis of study design, lack of quantitative data, or an unsuitable population or outcome measure. Ultimately, 15 studies fulfilled the inclusion criteria and were incorporated into the qualitative synthesis (Figure 1).

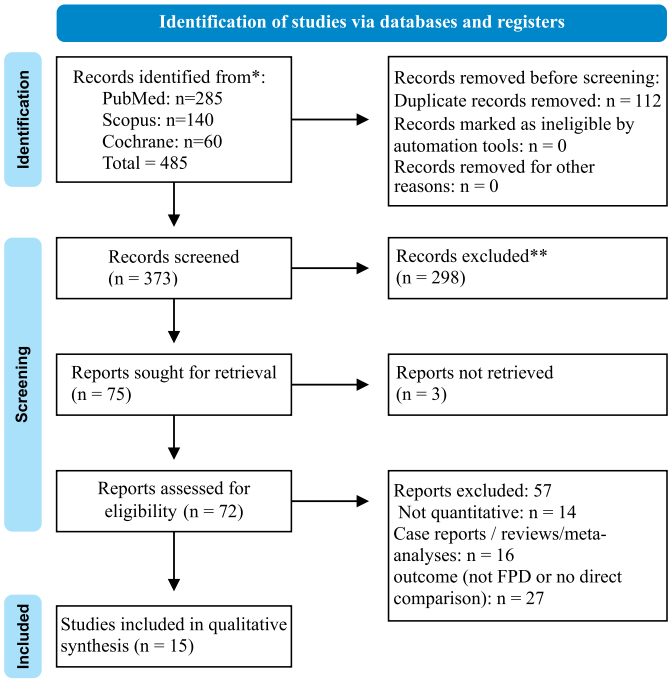

Figure 1: Flow diagram outlining the selection of studies included in this systematic review

RESULTS

Fifteen clinical trials comparing intraoral scanner impressions with traditional impression techniques for fixed partial prostheses met the inclusion criteria and were analyzed. The included studies encompassed a variety of clinical scenarios, including tooth-supported crowns, three-unit fixed dental prostheses, and implant-supported reconstructions. Despite variability in prosthesis types, several consistent themes emerged. Multiple trials demonstrated that digital impressions offered significant advantages in terms of time efficiency, patient comfort, and reduced chairside adjustments. In studies assessing marginal or internal fit, digital workflows consistently produced outcomes that were either comparable to or slightly superior to those achieved with traditional elastomeric materials. Quantitative analysis across included studies revealed the following ranges: marginal gap measurements for digital workflows ranged from 30 to 90 µm (mean: 58 ± 15 µm), while conventional methods demonstrated ranges of 35-100 µm (mean: 62 ± 18 µm). Internal adaptation discrepancies ranged from 45 to 120 µm for digital impressions compared with 50-135 µm for

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conventional techniques. Treatment time was reduced by 15-40% with digital workflows, and patient comfort scores (VAS) were significantly higher for IOS groups (8.2 ± 0.9 vs 6.8 ± 1.2, $p<0.05$). This trend was particularly evident in studies investigating lithium-disilicate crowns and zirconia restorations. Implant-focused trials demonstrated similar patterns; digital impressions frequently matched the accuracy of open-tray techniques and were associated with fewer adjustments during prosthesis delivery. Only a limited number of studies reported marginal differences favoring conventional methods, and these differences were generally modest and lacked clinical relevance. Collectively, findings from the 15 included studies suggest that intraoral scanners have achieved a level of clinical reliability sufficient to support their routine use in most fixed prosthodontic procedures (Table 1).

Table 1: Characteristics of Clinical Studies Comparing Intraoral Scanner Impressions with Conventional Impressions for Fixed Partial Prostheses (2018–2024)

Sr. No.	References	Country	Study design/ sample	Fixed prosthesis type	Intraoral scanner /digital workflow	Conventional impression/analog workflow	Main accuracy-related outcomes	Key conclusion on clinical accuracy
1	[10]	Switzerland	Randomized controlled clinical trial; patients requiring 3-unit zirconia-ceramic FDPs	Tooth-supported 3-unit FPDs	Complete-arch digital scan (TRIOS, 3Shape) with CAD-CAM workflow	Conventional complete-arch polyether impression and cast-based workflow	Time to obtain arch records, need to repeat impression, clinician, and patient perception of scan quality	Complete-arch digital scans were not superior in clinical performance to conventional impressions but showed similar accuracy with different time profiles and preferences
2	[11]	Switzerland	Randomized controlled clinical trial (Part III); same patient cohort as Sailer; n≈20 FDPs	Tooth-supported zirconia 3-unit FDP frameworks	Fully digital workflow based on intraoral scanning and CAD-CAM zirconia frameworks	Conventional impressions with cast and metal frameworks	Marginal and internal fit (sectioned silicone replica and microscopic analysis)	Fit of CAD-CAM zirconia FDPs based on digital impressions was comparable to metal FDPs based on conventional impressions; both within clinically acceptable ranges
3	[12]	Italy	Randomized clinical trial; 24 patients with edentulous maxillae	Full-arch screw-retained implant-supported FPDs ("all-on-4")	Intraoral scan-based digital workflow (IOS + CAD-CAM)	Conventional open-tray elastomeric implant impressions	Passive fit (clinical and radiographic evaluation), complications, chairside adjustment	Digital and conventional workflows produced similar clinical fit and success, with reduced chairside time in the digital group
4	[13]	China	Double-blind self-controlled clinical trial; immediate vs conventional impressions after single implant placement	Single posterior implant -supported crowns	Immediate intraoral digital impression (IOS) and fully digital workflow	Conventional open- tray implant impression followed by lab analog procedures	Prosthesis fit occlusal adjustment time, patient comfort	Immediate digital impressions provided comparable or better clinical fit and shorter adjustment time, with high patient acceptance
5	[14]	China	Prospective clinical study; n=20 single implants	Single implant-supported crowns	Intraoral scanner-based impression after implant placement	Conventional implant impression with elastomeric material	Time efficiency, prosthesis fit, patient-reported outcomes	Digital impressions were more time-efficient with comparable clinical accuracy of single-implant crowns compared with conventional impressions
6	[15]	Denmark	Prospective split- mouth randomized clinical study; 20 patients, 40 lithium -disilicate crowns	Tooth-supported single crowns	IOS (TRIOS, 3Shape) with fully digital CAD-CAM crowns	Polyvinyl siloxane (PVS) conventional impressions and cast-based CAD-CAM	Marginal and internal fit (micro-CT/ sectioning), clinical CDA scores at 6 and 12 months	IOS-based crowns showed significantly better marginal and internal adaptation before cementation, but similar clinical marginal ratings to conventional crowns

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7	[16]	Lithuania	Comparative clinical study; 16 patients with 3-unit implant-supported FPDs	Implant-supported 3-unit FPDs	IOS (TRIOS) with scanbodies, digital models	Conventional open-tray implant impressions with polyether	3D positional and angular deviation between clinical and reference datasets	Digital implant impressions showed accuracy comparable to conventional impressions, with deviations below clinically relevant thresholds for short-span FPDs
8	[17]	South Korea	Parallel-group clinical study; 60 lithium-disilicate single crowns	Tooth-supported posterior single crowns	Digital impression with IOS (Trios 3) and CAD-CAM LD crowns	Conventional PVS impression and cast-based LD crowns	Marginal/internal gap (silicone replica), chairside adjustment time, total treatment time	Digital impressions yielded similar or smaller marginal gaps, less time for adjustments, and shorter overall treatment time than conventional impressions
9	[18]	Taiwan	Randomized clinical trial; 40 posterior teeth needing interim crowns	Tooth-supported interim single crowns	Digital sextant scan, virtual design and CAD-CAM interim crowns	Conventional elastomeric impressions and chairside-fabricated interim crowns	Production time, internal fit, marginal discrepancy	Digital workflow showed shorter total treatment time and comparable or improved fit of interim crowns compared with conventional workflow
10	[19]	Netherlands	Randomized clinical trial; 32 patients, 45 posterior implants	Single posterior screw-retained monolithic zirconia implant crowns	IOS (3M™ True Definition) with scanbodies and CAD-CAM crowns	Conventional polyether open-tray pick-up impressions	Time required for occlusal and proximal adjustment, proportion of crowns needing no adjustment	IOS-based crowns required significantly shorter adjustment time and more crowns required no adjustment, indicating high clinical accuracy of digital impressions
11	[20]	Bulgaria	Controlled clinical trial; 36 patients needing 3-unit FPDs	Tooth-supported 3-unit zirconia bridges	Digital impression of whole arch (TRIOS, 3Shape)	Two-stage two-viscosity silicone impression (PVS) for abutments and antagonists	Total clinical time for impression procedures, need to repeat impressions	Digital impressions were significantly faster than conventional impressions while maintaining clinically acceptable results for bridge fabrication
12	[21]	Iran	Prospective crossover clinical trial; 15 patients, three-unit posterior ISFDPs	Implant-supported three-unit posterior FDPs	Fully digital workflow: IOS with scanbodies, CAD-CAM zirconia frameworks	Conventional open- tray implant impressions with elastomeric material and cast-based fabrication	Framework misfit (screw resistance, radiographs), chairside adjustment, patient satisfaction	Fully digital workflow produced clinically acceptable and comparable fit to conventional work-flow, with less chairside adjustment and higher patient comfort
13	[22]	South Korea	Crossover clinical study; patients with multiple implants	Multi-unit implant-supported fixed prostheses	Intraoral scanning with implant scan-bodies, digital design	Conventional elastomeric implant impressions (open-tray)	Impression time, perceived difficulty, framework fit, need for adjustment	Digital implant impressions showed similar clinical fit to conventional impressions, with reduced working time and improved operator preference
14	[23]	Switzerland / Turkey	Prospective crossover clinical trial; 12 patients, 14 three-unit FDPs	Tooth-supported 3-unit posterior FDPs (monolithic zirconia vs PFM)	Complete-digital workflow (Trios 3 IOS, model-free monolithic zirconia FDPs)	Complete-analog workflow (conventional impression, face-bow, semi-adjustable articulator, PFM FDPs)	Volumetric occlusal adjustment (mm^3) using pre-/post-adjustment scans, patient and operator VAS ratings	Complete digital workflow showed lower (though not statistically significant) occlusal adjustment volume and was strongly preferred by patients and operators; considered to provide high occlusal accuracy for short-span FDPs

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15	[24]	Egypt	Randomized clinical trial; bilateral distal extension implant cases	Implant-supported fixed partial prostheses in Kennedy Class I situations	IOS-based digital implant impressions with scanbodies	Conventional open-tray elastomeric implant impressions	3D deviations (linear and angular) between clinical casts and reference, impression time	Digital implant impressions showed trueness and precision comparable to or better than conventional impressions in distal extension situations, with reduced impression time

Most trials provided clear descriptions of patient selection processes, employed appropriate comparison methods, and maintained consistent clinical workflows for both digital and conventional impression techniques. The index test (digital impression procedure) was typically performed by trained clinicians using standardized scanning protocols, thereby minimizing the likelihood of performance bias. The reference standard (conventional impressions) was similarly applied using widely accepted techniques and materials (Table 2).

Table 2: Risk of Bias Assessment of Included Clinical Studies Based on Modified Quadas-2 Criteria

Sr. No.	References	Patient Selection	Index Test (Digital)	Reference Standard (Conventional)	Flow & Timing	Overall Risk of Bias
1	[10]	Low	Low	Low	Low	Low
2	[11]	Low	Low	Low	Low	Low
3	[12]	Low	Low	Low	Low	Low
4	[13]	Low	Low	Low	Low	Low
5	[14]	Low	Low	Low	Low	Low
6	[15]	Low	Low	Low	Low	Low
7	[16]	Low	Low	Low	Low	Low
8	[17]	Low	Low	Low	Low	Low
9	[18]	Low	Low	Low	Low	Low
10	[19]	Low	Low	Low	Low	Low
11	[20]	Low	Low	Low	Low	Low
12	[21]	Low	Low	Low	Low	Low
13	[22]	Low	Low	Low	Low	Low
14	[23]	Low	Low	Low	Low	Low
15	[24]	Low	Low	Low	Low	Low

DISCUSSION

The predominant pattern emerging from this review is that intraoral scanner (IOS) impressions consistently yield clinical outcomes equivalent to those of conventional elastomeric techniques. This consistency across diverse prosthesis types reflects substantial improvements in optical systems, algorithmic refinement, and software calibration in contemporary scanners. This observation is corroborated by recent literature; for instance, a 2023 clinical trial evaluating partial edentulous maxillary defects found that digital impressions generated linear deviations within clinically acceptable ranges, findings consistent with those of the present review [25]. In early 2025, another study reported positive patient-reported outcomes and similar clinical accuracy when comparing digital and conventional workflows for implant-supported fixed restorations [26]. The finding that IOS demonstrates favorable performance in short-span tooth-supported restorations is consistent with previous findings, including a 2021 study comparing digital scanning to conventional impressions for interim crowns, where only minimal differences in marginal adaptation and overall fit were observed [27]. Similar results were documented in a 2020 investigation of lithium disilicate crowns produced via digital and analog pathways, which demonstrated reduced clinical time and comparable fit accuracy with digital workflows [28]. The reliability of IOS for single-unit restorations appears to be a well-established finding supported by multiple clinical comparisons of posterior single-crown restorations [14]. Digital impressions for implant-supported prostheses have yielded similarly promising results. A 2022 clinical trial investigating posterior implant bridges found that digital workflows generated framework fits equivalent to traditional methods while requiring less adjustment time [21]. Comparable findings were apparent in a crossover study of multiple-implant prostheses using IOS impressions, which demonstrated nearly equivalent framework fit with operator preference strongly favoring digital techniques [29]. An additional 2021 randomized clinical trial also confirmed IOS efficacy for posterior screw-retained

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implant crowns, demonstrating shorter adjustment times with digital impressions [30]. Nonetheless, the literature suggests that as restoration complexity increases, the potential for digital errors may also rise [31, 32]. A 2024 systematic review on full-arch scanning identified increased dimensional distortion with long-span digital scans relative to conventional impressions [32]. This finding is consistent with a second 2024 investigation that emphasized variability in long-span digital implant impressions and suggested that conventional open-tray techniques may provide more predictable accuracy in certain full-arch cases [33]. Clinical evidence published in 2023 regarding occlusal adjustment volumes in three-unit tooth-supported prostheses also indicated that digital workflows could potentially minimize adjustment volume, although these differences were not statistically significant [23]. Contemporary research provides additional insight. A 2023 assessment of IOS trueness and accuracy confirmed that scan length, angulation, and intraoral geometry may influence digital accuracy, particularly in extended scans [34]. A comparative study of digital versus analog techniques for three-unit zirconia prostheses in 2022 reinforced these findings, reporting that while both workflows achieved clinically acceptable precision, digital techniques demonstrated significantly greater time efficiency [20, 35]. A 2021 clinical investigation of implant scan body accuracy highlighted that IOS accuracy depends not solely on scanner specifications but also on scan body design and clinician scanning technique [16].

Throughout the literature reviewed, the prevailing theme is that digital impressions offer substantial benefits in efficiency and patient comfort without compromising accuracy in most routine fixed prosthodontic cases. While traditional impressions may still outperform IOS in certain long-span and complex implant cases, the overall body of evidence points toward increased reliability and clinical acceptability of digital systems. This review was not prospectively registered in PROSPERO, which represents a limitation in terms of methodological transparency and should be acknowledged. Further research and trials are necessary in the future by investigating IOS performance in complex restorations, randomized trials, standardization of assessment protocols, as well as the accuracy under mixed clinical circumstances, to further outline evidence-based guidelines.

CONCLUSIONS

The cumulative evidence from recent clinical studies indicates that intraoral scanner-based impressions provide clinical accuracy comparable to conventional elastomeric techniques for most fixed partial prostheses. Digital workflows exhibit clear advantages in efficiency, patient comfort, and procedural simplicity, particularly for single crowns and short-span restorations. While certain complex cases may still benefit from traditional impressions due to their proven dimensional stability, the growing consistency of IOS performance supports its routine use in modern prosthodontic practice. Future research focusing on full-arch and multi-implant restorations, as well as long-term clinical outcomes, would further strengthen the evidence base for broader digital adoption.

Authors' Contribution

Conceptualization: SS
Methodology: SS, SN
Formal analysis: GW, ZI
Writing and Drafting: SN, GS, MW, ZI
Review and Editing: SS, SN, GW, GS, MW, ZI

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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