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CLINICAL EFFECTIVENESS OF INTRAORAL DIGITAL SCANNING COMPARED WITH CONVENTIONAL IMPRESSION TECHNIQUES IN PROSTHODONTIC TREATMENT

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Annotation. This article analyzes the clinical effectiveness of intraoral digital scanning compared with conventional impression techniques in prosthodontic treatment based on scientific literature, systematic reviews, and clinical studies. Intraoral scanners (IOS) have emerged as a prominent alternative to conventional elastomeric impressions, offering a fully digital workflow from impression to restoration fabrication. The article examines the accuracy and precision of intraoral scanning versus conventional impressions, clinical performance in various prosthodontic indications (single crowns, short-span bridges, implant-supported prostheses, complete dentures), time efficiency and workflow advantages, patient-reported outcomes and comfort, as well as the limitations and challenges of digital impression techniques. Special attention is given to comparative clinical studies, meta-analyses, and systematic reviews evaluating marginal fit, prosthetic success rates, and overall clinical effectiveness of both approaches.

Keywords: intraoral scanning, digital impression, conventional impression, prosthodontic treatment, clinical effectiveness, accuracy, marginal fit, CAD/CAM, patient satisfaction.

The integration of digital technologies into dentistry has revolutionized traditional clinical workflows, particularly in the realm of dental impressions. Intraoral scanners (IOS) are handheld optical devices that acquire three-dimensional images of dental structures and surrounding tissues directly from within the oral cavity, generating virtual models in real time and eliminating the need for conventional trays and impression materials. Since the development of the earliest

intraoral scanners in the 1980s, progressive advancements in hardware, imaging software, and data processing algorithms have expanded the clinical utility of IOS across multiple disciplines, including prosthodontics, restorative dentistry, and implantology. The clinical effectiveness of intraoral digital scanning compared with conventional impression techniques has been the subject of extensive research, with numerous systematic reviews, meta-analyses, and randomized controlled trials evaluating accuracy, efficiency, patient comfort, and prosthetic outcomes. This article provides a comprehensive analysis of the current evidence regarding the clinical effectiveness of intraoral digital scanning versus conventional impression techniques in prosthodontic treatment.

The accuracy of dental impressions—defined by trueness (deviation from the true value) and precision (repeatability of measurements)—is a critical determinant of the clinical success of prosthodontic restorations. Systematic reviews and meta-analyses have consistently demonstrated that intraoral scanning provides accuracy comparable to conventional impressions in most clinical situations. A systematic review and meta-analysis of 37 studies comparing the three-dimensional accuracy of digital and conventional implant impressions for complete-arch implant-supported fixed dental prostheses found no significant overall difference in accuracy between digital and conventional impressions (standardized mean difference [SMD]: -0.03; 95% CI: -0.20 to 0.14; p = 0.74). However, subgroup analysis revealed that conventional methods were slightly favored in cases with more than 4 implants (SMD: 0.22; 95% CI: 0.05 to 0.39; p = 0.01), while photogrammetry produced slightly greater accuracy than conventional impressions (SMD = 0.15; 95% CI 0.02 to 0.28). Another systematic review and meta-analysis focusing on partially dentate patients found that digital impressions demonstrated significantly lower deviation than conventional impressions, indicating superior spatial accuracy in certain clinical settings. However, no statistically significant difference was

observed in angular displacement, and digital techniques were most accurate in short-span restorations, with accuracy declining with increased implant angulation.1

Regarding marginal fit—one of the most critical determinants of prosthetic longevity—clinical studies have shown that intraoral scanning can produce restorations with clinically acceptable marginal fit comparable to or better than conventional techniques. A randomized controlled trial evaluating the vertical marginal fit of monolithic zirconia crowns found that both conventional monophase impression and digital intraoral scanning techniques produce crowns with clinically acceptable marginal fit within the acceptable range of 120 μm (conventional: 107.69 ± 32.67 μm; digital: 100.41 ± 35.53 μm; P = 0.504). A single-blind clinical randomized controlled trial of 70 all-ceramic crowns reported that the mean marginal fit with intraoral scanning (57.94 ± 22.51 μm) was significantly better than with conventional impressions (82.98 ± 21.72 μm; P = .000), and secondary outcomes including internal fit, adjustment time, and dentist satisfaction were also in favor of intraoral scanning. An in vitro study comparing digital and conventional impression techniques for single-crown restorations using both silicone replica and micro-computed tomography analysis found that digital impressions provided significantly superior marginal and internal adaptation compared to conventional polyvinyl siloxane-based impressions, with marginal gaps of 45.8 ± 6.7 μm (digital) versus 61.3 ± 7.5 μm (conventional) ($p < 0.001$). A meta-analysis of randomized controlled trials further revealed that multi-unit fixed dental prostheses fabricated using digital impressions generally exhibited improved marginal and internal fit compared with those produced using conventional impressions.2

1Park JS, Alshehri YFA, Kruger E, Villata L. Accuracy of digital versus conventional implant impressions in partially dentate patients: A systematic review and meta-analysis. Journal of Dentistry. 2025;160:105918.

2A Randomized Controlled Trial to Evaluate and Compare the Vertical Marginal Fit of Monolithic Zirconia Crowns Obtained Using Intraoral Scanning vs

Time efficiency is one of the most consistently reported advantages of intraoral digital scanning. A systematic review and meta-analysis of 27 studies involving 737 patients found significant differences in scanning time favoring digital impressions for single crowns (P = .001; MD: -7.16; CI: -10.21 to -4.10) and in adjustment duration (P = .04; MD: -3.33; CI: -6.52 to -0.13). A systematic review and meta-analysis of digital versus conventional impression techniques in children reported that digital impressions were significantly faster, with a mean difference of 165.48 seconds (95% CI: 157.74-173.21; p < 0.00001). Compared to traditional impressions, IOS generally reduced procedural time and enhanced patient comfort. An umbrella review encompassing over 30 IOS models confirmed the time-saving benefits of digital scanning. A randomized crossover clinical study similarly found that digital impressions were significantly faster than conventional impressions.3

Patient-reported outcomes and comfort represent another area where intraoral scanning demonstrates clear advantages. A systematic review of implant prostheses found that twelve studies evaluating patients' perceptions were unanimous about their preference for digital impressions, with meta-analysis showing significant differences in patient preference favoring the digital approach (P = .003; MD: 19.02; CI: 6.36 to 31.68). Patients reported increased comfort and a clear preference for digital scans due to their less invasive nature and reduced discomfort. Digital intraoral scanning has been found to be more comfortable and better accepted than conventional impressions. In children, digital impressions were better tolerated, offering greater comfort, reduced gag reflex, and shorter procedure time compared

Monophase Impression Technique: An In Vivo Study. Journal of Pharmacy and Bioallied Sciences. 2025;17(Suppl 4):S3007-S3009.

3Digital Versus Conventional Impression Techniques in Children: A Systematic Review and Meta-Analysis of Efficiency, Comfort and Patient Preference. Wiley Online Library. 2025.

to conventional impressions. A study evaluating patient-reported outcome measures for fixed dentures found that patients perceived digital impressions as more pleasant. Intraoral scanners present tremendous comfort advantages in prosthodontics, with benefits for both patients and clinicians.

Despite the numerous advantages, intraoral digital scanning has certain limitations and challenges that must be considered. Accuracy in partially edentulous and completely edentulous arches remains a limiting factor. Accuracy may decline when scanning arches with more than 4 implants. An expert consensus confirms that as the range of scanned dental arches and the number of data concatenations increases, the scanning accuracy decreases accordingly, especially when performing full mouth implant restoration impressions. Conventional impressions can offer greater reliability when deep margins are present, moisture control is compromised, or long-span accuracy is required. For complete-arch fixed dental prostheses, conventional impressions outperformed digital scans in terms of accuracy. For short-span restorations, IOS accuracy was equivalent to conventional methods; however, conventional techniques showed slightly better stability in long-span implant cases. Intraoral scanning has been found to be a viable option for post spaces with a diameter ≥ 1.5 mm and depth ≤ 7 mm, but its application is strictly limited in narrow canals (≤ 1.5 mm). The methodological quality of many systematic reviews on this topic has been questioned, with 67.9% receiving critically low overall confidence based on AMSTAR 2 assessments. An umbrella review found that only two systematic reviews met high-quality methodological standards, while others showed moderate to critically low ratings.

Recent expert consensus and clinical guidelines have provided recommendations for the clinical application of intraoral digital scanning. The Expert Consensus on Digital Intraoral Impression Taking for Fixed Prosthodontics, released in November 2024, established standardized operation guidelines, confirming that digital impression technology offers advantages such as seamless workflow, stable

accuracy, and high patient comfort. Intraoral scanning delivers reliable results for single crowns and short-span restorations on both natural teeth and implants, offering accuracy comparable to that of physical impression techniques while supporting more efficient chairside workflows. The consensus confirms that digital impressions are scientifically approved for their high accuracy for single tooth restorations while enhancing workflow efficiency through seamless integration with CAD/CAM systems. 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. It has been concluded that the survival rates of full-arch fixed prostheses produced using intraoral scanning are comparable to those achieved with traditional impression techniques, providing a reliable option for patients.4

In conclusion, intraoral digital scanning has emerged as a clinically effective alternative to conventional impression techniques in prosthodontic treatment, offering comparable or superior accuracy for most indications while providing significant advantages in time efficiency, patient comfort, and workflow integration. Systematic reviews and meta-analyses consistently demonstrate that digital impressions achieve accuracy comparable to conventional impressions in most clinical situations, with some studies showing superior marginal fit for single-crown restorations. Time savings of approximately 2-3 minutes per impression and reduced adjustment times have been consistently reported. Patient preference overwhelmingly favors digital scanning due to reduced discomfort, gag reflex, and overall pleasant experience. However, limitations remain for complex cases including long-span implant prostheses (particularly with more than 4 implants), completely edentulous arches, and situations with deep subgingival margins or

4Expert Consensus on Digital Intraoral Impression Taking for Fixed Prosthetic Restoration of Tooth and Dental Arch Defects. 2024.

compromised moisture control. The integration of intraoral scanning with CAD/CAM workflows enables seamless, fully digital prosthetic fabrication, reducing laboratory steps and potential sources of error. As technology continues to advance and evidence accumulates, the clinical indications for digital impressions are expanding. Clinicians should make evidence-based decisions when selecting impression techniques, considering the specific clinical situation, restoration type, and patient factors. While conventional impressions remain a reliable and necessary option for certain complex cases, intraoral digital scanning represents the future of prosthodontic treatment, offering improved efficiency, enhanced patient experience, and consistent clinical outcomes.

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