

CLINICAL PERFORMANCE OF FULLY DIGITAL
PROTOCOLS IN FULL-ARCH IMPLANT
REHABILITATION: A CRITICAL REVIEW

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Abstract: *The fully digital workflow has emerged as a major development in full-arch implant rehabilitation because it links cone-beam computed tomography, digital scanning, virtual planning, guided surgery, and CAD/CAM manufacturing within a single restorative chain. Its main promise is not merely technological novelty, but better coordination between surgical and prosthetic stages, shorter treatment time, and improved patient comfort. This extended abstract critically synthesizes the evidence summarized in the source review and focuses on three clinically decisive questions: how accurate the digital chain is, whether that accuracy is sufficient for passive full-arch prosthetic fit, and what limitations still restrict broad routine use. The literature supports the clinical feasibility of fully digital full-arch treatment and shows favorable early outcomes in selected cohorts. However, the evidence also demonstrates a persistent problem of cumulative error, especially in edentulous arches and long-span implant restorations. Photogrammetry is currently the most promising digital method for implant position capture, while guided surgery improves reproducibility of implant placement. Neither*

approach eliminates the need for critical verification in complex cases. At present, the strongest conclusion is that the fully digital workflow is a selective, high-performance strategy rather than a universal standard for every full-arch patient.

Keywords: *full-arch implant rehabilitation; fully digital workflow; photogrammetry; digital impressions; guided surgery; passive fit; CAD/CAM.*

Introduction: Digital dentistry has changed the way full-arch implant rehabilitation is planned and delivered. In a conventional workflow, information passes through multiple analog transfers, including impression materials, casts, articulator procedures, and laboratory duplication steps. A fully digital protocol attempts to reduce these transfers by integrating radiographic imaging, surface scanning, digital planning, guided surgery, prosthetic design, and manufacturing into one coordinated workflow. In theory, this should improve efficiency and reduce errors introduced by repeated manual handling.

Yet full-arch treatment is unforgiving. Unlike short-span prosthodontics, it demands accurate transfer of implant positions across a large distance, controlled framework fit, and stable biomechanics under immediate or early function. A small deviation at one implant may become a clinically meaningful discrepancy when multiplied across the arch. Therefore, the real value of digitalization must be assessed not by novelty or convenience, but by its ability to maintain precision across every stage of treatment.

Materials and Methods: This text follows a critical structured review model based on the user-provided source manuscript and its reference framework. Priority was given to systematic reviews, meta-analyses, comparative studies, methodological reviews, and representative clinical

reports on full-arch digital rehabilitation. The interpretation was intentionally conservative: short-term success was not equated with long-term superiority, and laboratory accuracy was not assumed to translate automatically into clinical passivity. The goal was to identify where the evidence is strong, where it remains provisional, and where full digitality still requires caution.

Results and Discussion: The central limitation of a fully digital full-arch protocol is cumulative error. Deviations may arise during image acquisition, superimposition of datasets, virtual planning, guide fabrication, guide seating, drilling, implant insertion, scan-body recording, or prosthetic manufacturing. In edentulous arches, this problem is amplified by the lack of stable reference points and by the long restorative span. The literature consistently indicates that full-arch accuracy cannot be judged by one step in isolation; it depends on error control throughout the entire chain.

Digital impression methods have improved, but complete-arch implant cases remain challenging for conventional intraoral scanning because stitching distortion increases with span length. This is why photogrammetry has become especially relevant. Recent systematic reviews suggest that photogrammetric systems may provide more accurate implant position capture in complete arches than standard intraoral scanning. Even so, these findings should not be overextended. The clinical reliability of a purely digital impression still depends on scan-body geometry, implant angulation, tissue conditions, arch configuration, and the restorative material being delivered. In complex cases, digital acquisition may still need verification barriers before definitive prosthesis fabrication.

Passive fit remains the decisive prosthetic endpoint. A workflow may appear efficient and technically advanced, but it cannot be considered clinically sound if it compromises framework passivity. The literature suggests that

experienced teams frequently preserve some form of verification even within predominantly digital protocols, particularly when managing long spans, unstable mucosa, or immediate loading. This point is crucial: the best digital workflows are not the ones that remove every checkpoint, but the ones that reduce unnecessary steps without abandoning control of biologic and mechanical risk.

Guided surgery and stackable templates strengthen the link between virtual planning and surgical execution. They are especially useful in immediate full-arch concepts because they help coordinate implant trajectory, bone reduction, abutment emergence, and provisional prosthesis design. However, guided surgery is not synonymous with perfect transfer accuracy. Template support, fixation, access limitations, drilling tolerance, and system-specific factors still influence the final result. Published case series and retrospective studies demonstrate promising early performance, but they mainly confirm feasibility in experienced hands rather than universal predictability across all practice settings.

Reported clinical outcomes of fully digital full-arch rehabilitation are encouraging, particularly for short- and medium-term implant and prosthesis survival. Patient-reported outcomes also tend to favor digital methods because they reduce discomfort associated with conventional impressions and may shorten chair time. Nevertheless, survival alone is an incomplete endpoint. The literature still provides limited long-term information about framework maintenance, screw complications, component wear, occlusal corrections, hygiene-related challenges, and cost-effectiveness. For this reason, digital workflows should currently be interpreted as clinically promising but not yet conclusively superior to carefully executed hybrid or conventional approaches.

Conclusion: Fully digital full-arch implant rehabilitation is clinically feasible and increasingly relevant in contemporary implant dentistry. Its main strengths are workflow integration, prosthetically driven planning, improved patient comfort, and the possibility of highly coordinated immediate or early treatment. Its main weaknesses are cumulative error, persistent uncertainty regarding passive fit in difficult cases, and the limited amount of high-quality long-term comparative evidence. Photogrammetry and guided surgery have improved the performance of the digital chain, but neither technology removes the need for careful case selection and verification. The most defensible interpretation of the evidence is pragmatic: fully digital protocols should be adopted when the team can control the entire workflow and when case complexity remains within a safe precision margin; otherwise, hybrid control steps remain justified.

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