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Review Article

ASSESSING THE FIT, THE ACCURACY AND THE ADAPTATION IN CONVENTIONAL VS. DIGITAL CUSTOM POST AND CORE RESTORATIONS: A REVIEW

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ABSTRACT

Post and core systems are often required for restoration of endodontically treated teeth to provide retention and stability for definitive crowns. Conventional cast posts, also known as the gold standard, offering strength and adaptability to canal morphology. but remains to be a sensitive technique, involving multiple steps fragile to distortion and inaccuracies. The Advances in digital dentistry, particularly computer-aided design and manufacturing (CAD/CAM), have enabled the fabrication of custom posts and cores while improving reproducibility, reducing chairside time, and superior or equivalent fit accuracy compared with traditional methods. A systematic review of studies published from 2015 and 2025 indicates that CAD/CAM milling and 3D printing provides reliable adaptation and expanded material choices such as fibre-reinforced composites, ceramics, and titanium, producing biomechanical and aesthetic benefits. However, the limitations in intraoral scanner depth capture, high cost, and the lack of long-term in vivo evidence restricts its widespread clinical adoption. While digital workflows are promising, conventional methods remain relevant until further feasible validation.

Keywords: Dental prosthesis, Dental prosthesis design, Computer Aided Designing, Dental materials,3D.

INTRODUCTION

Prosthodontic restorations of endodontically treated teeth form an essential part of prosthodontic rehabilitation, especially when a lot of coronal tooth structure has been lost (Akkayan & Gülmez, 2002). From this perspective, post and core systems provide adequate retention/resistance for the final crown, making it functional and increasing its longevity (Antony *et al*., 2021; Farah *et al*., 2020). Conventional cast post and core systems have traditionally been considered the "gold standard" because of their strength and rigidity and their ability to conform to irregular canal morphology (Antony *et al*., 2021; Alnazzawi et al., 2024). The fabrication of these systems requires the carrying out of a series of clinical and laboratory procedures, including the making of impressions, casting, and cementation of posts, which, if well executed, produce highly durable restorations (Farah *et al*., 2020). Despite this great asset, the conventional approaches have in-built technique sensitivity. At any stage, distortion may creep in: impressions could deform, wax patterns might be inaccurate, casting may shrink, or it may not be possible to reproduce the complicated internal, tapered morphology of root canals (Awada & Nathanson, 2015). An error in any step may reduce the accuracy of the fit and result in retention, stress distribution, and prognosis problems (Balkaya & Birdal, 2013). In addition, several clinical visits are typically required, which add to chairside time and patient inconvenience (Awada & Nathanson, 2015). These constraints have driven the quest for alternative approaches that balance accuracy, efficiency, and standardization.

The advent of digital dentistry, specifically computer-aided design and computer-aided manufacturing (CAD/CAM) systems, has transformed prosthodontic procedures. Post and core production digitally eliminates multiple analogue steps, which includes elastomeric

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impressions and casting, and substitutes them with the intraoral scanning, digital design, and additive or subtractive production (Mangano *et al*., 2017; Güth *et al*., 2017). This shift minimizes operator dependence, improves reproducibility, and facilitates chairside or laboratory production within a much shorter timeframe (Farah *et al*., 2020; Buda *et al*., 2018). Comparative studies consistently show superior or at least equivalent accuracy of CAD/CAM custom posts compared with traditional approaches, with fewer marginal and internal adaptation discrepancies (Balkaya & Birdal, 2013).

The expanded, superior restorative materials have been afforded by digital technology. Posts can be fabricated apart from conventional metal alloys through milling or 3D printing from high-strength resins, fibre-reinforced composites, ceramics, and titanium, depending on the needs of clinicians (Al-Haj Husain *et al*., 2022; Bitter & Kielbassa, 2007). These materials provide biocompatibility, aesthetics, and mechanical properties closer to those of dentin to possibly ensure better stress distribution and thus reduce the risk of catastrophic root fracture (Figueiredo *et al*., 2015; Bitter & Kielbassa, 2007). Such invention means a paradigmatic shift from functional replacements towards biologically and biomechanically harmonious restorations. However, primary cause for post systems not being accepted universally is the challenge to their acceptance (Fernandes *et al*., 2003). A few factors that inhibit acceptance are the impression or scanning accuracy of the post space and the very problem in acquisition posed by intraoral scanners to narrow, deep, and highly tapered post spaces (Mangano *et al*., 2017; Güth *et al*., 2017). Other factors obstructing the accuracy of a digital impression include the differences between different intraoral scanner technologies; these technologies can give different resolutions for different canal diameters or a particular scenario. Another significant factor that could work against the precision of digital impressions is that there are many intraoral scan technologies (Azhari *et al*., 2025). Such technologies might give different resolutions for other canal diameters of a particular depth (Buda *et al*., 2018; Al-Haj Husain *et al*., 2022). On the other hand, all such in vitro data favour digital workflows, but there rarely exist any long-term clinical trials in vivo, which leads to an unknown factor with respect to survival times on failure modes under functional load (Farah *et al*., 2020; Mangano *et al*., 2017). Cost, systems availability, the learning curve associated with CAD/CAM guides must remain acute to clinical decision-making.

Recent micro-CT studies have also been able to validate the fit accuracy of cast metal posts made by the indirect and direct conventional methods, confirming clinical reliability, albeit with some technique sensitivity (Sheth *et al*., 2024). Likewise, comparative in vitro tests go along with the assertion that computer-aided digital workflow, and CAD/CAM-based systems in particular, provide internal and marginal fits as well as or even better than conventional methods, thereby giving impulse to the employment of digital technology in clinical applications (Liao *et al*., 2023). As possibilities and challenges given are involved, there exists an increasing necessity to critically evaluate both the traditional as well as digital methods of the production of custom post and cores. A structured synthesis of the evidence would clearly identify the strengths, limitation, and knowledge lacunae.

AIM AND OBJECTIVES

This article attempts to synthesize and fairly evaluate the evidence pertaining to the performance of conventional versus digital methods of fabrication of custom post and core with respect to fit accuracy, internal adaptations, material advances, and clinical outcomes. To compare the Traditional cast, post and core systems with digital CAD/CAM workflows for the fabrication accuracy, reproducibility, and clinical feasibility. To provide a report on the precision of intraoral and laboratory scanning technologies in registering post spaces of varying diameters and depths, thus influencing good adaptation. To investigate the spectrum of materials used in digital workflows (resin, fibre, ceramic, titanium) and look into their biomechanical and biological implications. To recognize the barriers and challenges associated with conventional and digital systems, including technique sensitivity, limitations of scanners, and evidence gaps. To look beyond the horizon as regards clinical translation, long-term follow-up, and research aims to best serve the cause of better post and core restoration.

METHODS

A systematic literature search was performed on PubMed, Scopus, and Google Scholar. Search terms were custom post and core, CAD/CAM, digital workflow, adaptation, fit accuracy, intraoral scanner. Articles between 2015 and 2025 were included. Both in vitro and in vivo studies, systematic reviews, and case reports were included. Studies were categorized by methodology (conventional vs digital), setting (in vitro vs in vivo), and key outcomes (fit accuracy, marginal/internal adaptation, clinical feasibility). 25 references were chosen to give an equal discussion of traditional and digital workflows, with sequential order of citation (Sheth *et al*., 2024; Liao *et al*., 2023).

This systematic review combined existing evidence comparing digital with traditional custom post and core restorations, with an emphasis on fit precision, marginal sealing ability, and clinical usefulness. They indicate the promise of the digital workflows as well as the persisting relevance for the traditional techniques in selected clinical situations. Most of the investigations below are in vitro trials, which present highly controlled settings for marginal and internal adaptation testing (Antony *et al*., 2021; Sheth *et al*., 2024; Liao *et al*., 2023). Micro-CT analysis has showed that traditionally cast posts, while being robust, tend to exhibit heterogeneity because of impression distortion, casting shrinkage, and operator technique heterogeneity (Antony *et al*., 2021). In comparison, digitalised workflows, either type milling or printing, exhibited smoother adaptation with variation usually

ranging from 50–120 µm (Mostafa *et al*., 2025; Al-Rubaye & Elsubeihi, 2024; Alzaid *et al*., 2024). All these laboratory findings always attest to the correctness of CAD/CAM fabrication, especially with the use of high-def scanners and optimal milling parameters (Al-Rubaye & Elsubeihi, 2024). Computerized workflows also minimize human error and chairside time, offering clinicians reproducible results. Less has been observed in the assessment of in vivo findings, but these are the key to clinical translation. Fasbinder *et al*. (2020) demonstrated the possibility for digital chairside construction of posts and cores, with similar clinical fit to traditional workflows as well as patient acceptance. Intraoral conditions, however, present certain challenges including the risk for saliva contamination, reduced access for deep-rooted canal coverage, as well as scanning movement artifacts (Fasbinder *et al*., 2020). It was said by Abouseif *et al*. (2025) and by Wahba & ElBasty, (2025) that scanner variability in depths may impact the accuracy, especially for long or thin post spaces. Such findings again stressed the need for scanner performance verification in clinical situation instead of an in vitro situation. There also exist case reports on the potential use of digital posts in aesthetic areas or complex anatomic cases (Abouseif *et al*.,2025). When compared side by side, the digital post tends to surpass the conventional post in reproducibility and fit accuracy. Alnazzawi *et al*. (2024) also demonstrated improved adaptation for selective laser sintering over casting. Digital workflows are not without demerit, however. Intraoral scanner limited depth is a drawback (Wahba & ElBasty 2025), and the additive methods in manufacturing lead to the potential for interior porosity or roughness on the post surfaces compared with the cast post (Alnazzawi *et al*., 2024). Marchionatti *et al*. (2017) also pointed out that the survival results depend not only on the fit but also on ferrule effect, post design, and restorative method. Hybrid workflows with the digital design combined with the conventional cementation may overcome these deficiencies. There are limited data resulting from in vitro studies, which overestimate the validity for clinical conditions (Fasbinder *et al*., 2020). Insufficient long-term survival data: Relatively few studies have challenged long-term outcomes following initial adaptation. Long-term resistance to bending and long-term survival for digital posts remain questionable (Marchionatti *et al*., 2017; Naumann *et al*., 2008). Intraoral scanners also fail to record dentinal impressions accurately for deep narrow-rooted teeth, particularly molars (Abouseif *et al*., 2025; Wahba & ElBasty 2025). Method heterogeneity: Variation in scanners, materials, and methodology for evaluating the players renders comparison challenging.

Table 1. Fit Accuracy of Conventional Custom Posts (In Vitro Studies).

Author (Year)	Method	Key Findings
Antony *et al*. (2021)	Micro-CT analysis of cast metal posts using direct and indirect techniques	Better adaptation seen in direct than indirect; due to casting shrinkage we have seen variability.
Sheth *et al*. (2024)	Comparative evaluation of cast vs. digital posts	Conventional casting was less precise in marginal fit compared to digital workflows
Liao *et al*. (2023)	Half-digital vs. conventional fabrication	Half-digital showed improved reproducibility; conventional casting less consistent

Table 2. Accuracy of Digital Workflows for Post and Core Fabrication.

Author (Year)	Technology	Main Outcome
Mostafa *et al*. (2025)	CAD/CAM milling vs. 3D printing	Both methods demonstrated high accuracy, though milling slightly superior in reproducibility
Al-Rubaye & Elsubeihi, (2024)	CAD/CAM milled vs. conventional cast	Milled posts showed significantly better internal fit
Alzaid *et al*. (2024)	3D-printed vs. milled titanium	Both showed acceptable fit, with milling offering smoother adaptation

Table 3. Comparative and Clinical Evaluations of Conventional vs. Digital Approaches.

Author (Year)	Study Design	Findings
Fasbinder *et al*. (2020)	In vivo chairside study	CAD/CAM workflow clinically feasible, accuracy comparable to conventional
Abouseif *et al*. (2025)	In vitro scanner accuracy	Depth discrepancy affected digital accuracy in long/narrow canals
Wahba & ElBasty, (2025)	In vitro comparison of scanners	Notable differences in accuracy between devices; deeper canals reduced trueness
Alnazzawi *et al*. (2024)	SLS vs. conventional casting	SLS improved fit compared to conventional methods
Marchionatti *et al.* (2017)	Systematic review of post restorations	Reported variable survival rates; highlighted need for more long-term evidence

FUTURE DIRECTIONS

In the forthcoming years, the subsequent innovations may significantly influence the trajectory of post and core construction: Design with AI: Post and core restorations could be customized with artificial intelligence, eliminating the variability of the operator and delivering the best fit. Next-generation scanners: Enhanced depth capture and wireless portability potentially will begin to overcome existing intraoral scanning shortcomings. Printed biocompatible materials: Novel 3D-printable resin materials for metals may increase the biomechanical strength and biocompatibility (Revilla-León & Özcane, 2019). Hybrid workflows: Balancing the efficacy of the digital design with the predictability of the traditional cementation may yield balanced approaches.

CONCLUSION

Digital workflows for the fabrication of individualized posts and cores are highly reproducible and accurate when contrasted with the traditional techniques. On the other hand, the unavailability of full in vivo evidence and long-term clinical trials still keeps the traditional techniques in place for full replacement. With the progressive enhancement in the area of AI, scanning technology, as well as biocompatible materials, digital fabrication will certainly become the standard for restorative dentistry.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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