REVIEW

CUSTOMIZED (CAD/CAM) POSTS AND CORES – CONSIDERATIONS REGARDING FABRICATION

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Abstract: This systematic review presents an overall presentation of existing research materials on post-core restorations in terms of content, materials, fabrications, and performance. The research methodology for this work will follow the strategy by integrating a refined methodical search approach, setting the inclusion and exclusion criteria, and specifying certain requirements based on which the relevant literature will be selected for the synthesis of results. Three independent reviewers conducted database searches to obtain literature from the years 2013 to 2024, which was later summarized. A total of 185 titles were obtained through electronic database searches. Regarding, the post and core restoration, advancements have been made in both conventional and CAD/CAM technologies. To date, several methodologies have been published regarding the CAD/CAM post-core restoration of endodontically treated teeth using direct and indirect methods.

Keywords: CAD/CAM, post and core, restoration, endodontically treated teeth, Zirconia.

1. Introduction

Zirconia, composite resins, and hybrid ceramics are frequently cited as the materials typically documented in this context [1]. While the existing research on CAD/CAM posts and cores is scarce, additional investigations are necessary to assess the extended durability and effectiveness of this treatment approach [2].

They are usually more flexible in relation to the prepared post space and do not pose a problem in any other configuration. This is probably the right solution for elliptical or flared canal modifications when prefabricated posts cannot handle the situation optimally. The increased flexibility of the custom-cast post and core enhanced the resistance to torsional stress [3].

Thus, even in compromised teeth where teeth have lost structure during tooth preparation, and access cavity preparation, custom posts also provide resistance to rotation to multi-rooted teeth. The materials for post and core must exhibit excellent crown retention, be biocompatible and non-toxic, possess strong tensile properties, and demonstrate resistance to fatigue when subjected to occlusal and shear forces [4]. The dental post should evenly distribute pressure across the surrounding root surface and extend downward to at least the height of the crown or two-thirds of the root length. This design facilitates efficient stress dissipation and improves resistance to biting forces [5]. A major added achievement is the resemblance in colour between the post and core with natural dentin [6]. Tar-Gold-Platered CAD/CAM manufactured posts and cores exist today [7].

Most teeth are fitted with oval canals so that the post and core are customized, and canal obstruction is made easy in cases of retreatment. Therefore, the post and core act as one entity, thereby reducing the chance of core separation. In restorative procedures for teeth that are angled forward, even when using crown-angled techniques, it is possible to adjust the orientation of cast post and cores to align with the crown's shape, which is considered appropriate [8,9]. Research by Balkenhol et al. demonstrated a positive long-term outlook for teeth with custom cast post and cores, showing a 7.3-year survival rate [10]. Additional studies conducted by Dietschi et al. corroborated these findings, confirming the high resistance to fracture in teeth treated using custom-cast posts and cores [11].

Posts and cores can be constructed from either metallic or non-metallic substances [12]. The metallic posts and cores offer ease of fabrication and are considered cost-effective solutions [13]. In general, non-noble metals have the lowest relative costs [14]. The majority of the outcomes from the study meetings showed that most of the materials used did not provide fully accepted results as required for dental applications.

Because patient demand is conservative, there is a greater awareness of the benefits of adhesive dentistry; the standard cast post and core are among many options [15]. The fabrication process may involve direct techniques using resins or indirect methods that utilize elastomeric impressions of the prepared canal [8].

The adoption of castable glass ceramics and glass-infiltrated ceramics has grown in recent years. Zirconia posts were first applied

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to dental procedures in 1995, when substantial structures from the coronal plane began to serve as an alternative to traditional cast metal posts and cores [16].

2. Materials and method

"CAD/CAM", "post and core", "Zirconia" were searched over the last 9 years from 2013 to 2024. A total of 324 results were obtained, with 145 and 179 results retrieved from PubMed and Scopus, respectively. Initial de-duplication led to the removal of 98 records. Six articles had no English versions. Subsequently, the remaining 220 articles were screened through titles and abstracts to remove studies unrelated to dentistry.185 studies were further assessed to establish their eligibility for inclusion in the review.

Articles were purposely selected in accord with the research objective of existing research materials on post-core restorations in terms of content, materials, fabrications, and performance. The articles inclusion criteria were: CAD/CAM post and core restorations, direct restoration using CAD/CAM, CAD/CAM manufacturing, or digital dentistry techniques for post and core procedures and written in English or full text English version was available.

Articles were excluded if they used other qualitative research methods or the main subject of the study did not wholly concern dentistry.

An initial total of 185 articles was identified through the electronic database searching, with the rest sourced from bibliography hand searches. After duplicate elimination, 92 articles remained for screening and eventual application of the inclusion criteria. Generally, a total of 26 articles met the required criteria and had relevance to the practice of dentistry. All full articles were studied. Meta-analysis was not conducted as part of this narrative review.

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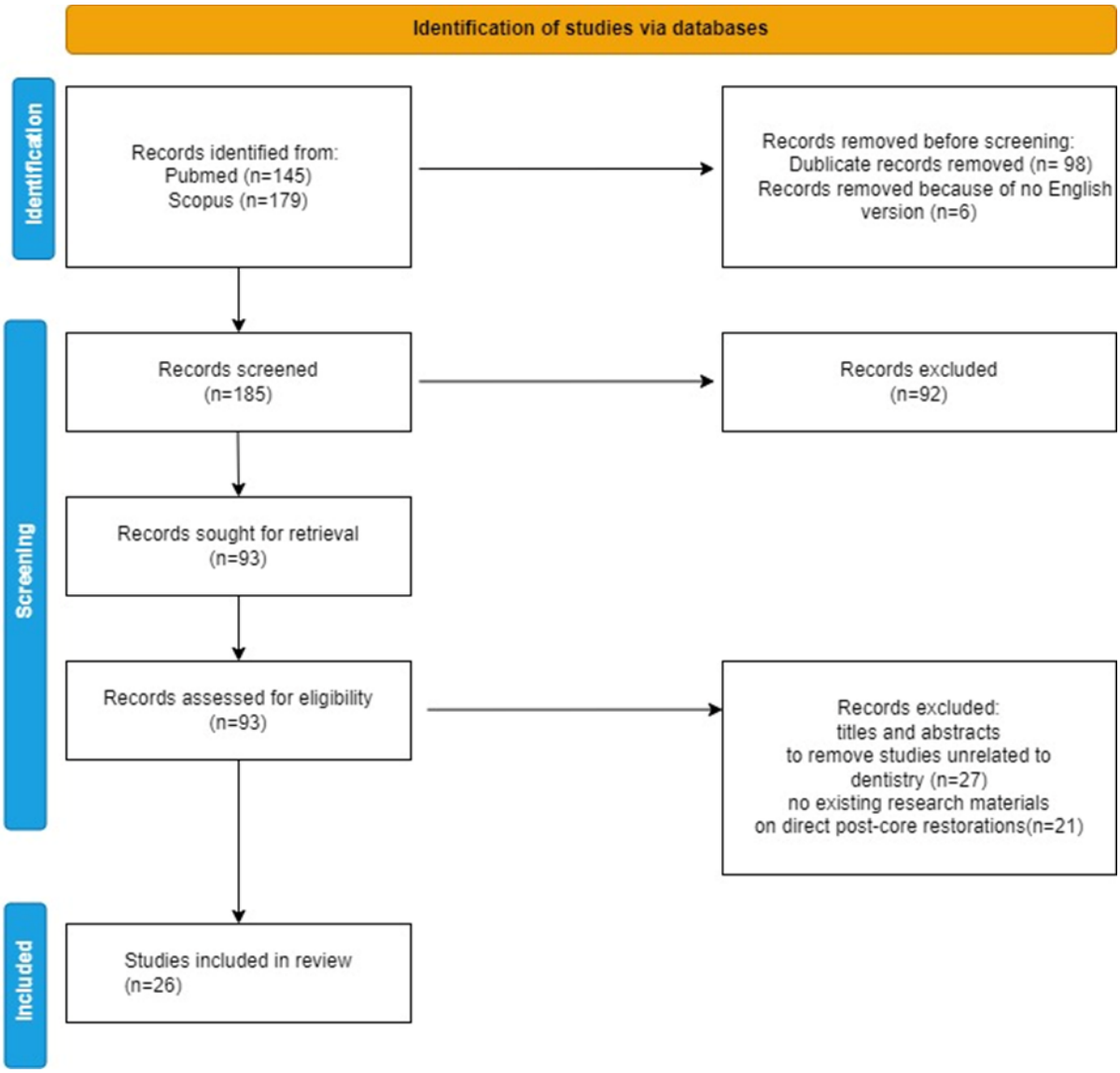

Figure 1. Identification of studies.

3. Results

This investigation aimed to examine the existing literature on post and core restorations, focusing on their composition, manufacturing methods, and effectiveness in clinical settings. After applying the exclusion criteria we got the results included in Table 1.

Table 1. Studies included in this review.

No	Authors	Year	Article type	Technology
1	Li M, Ma B, Zhou Z, Liu W	2024	Research article	CAD/CAM nanoceramic resin restorations
2	Fathey IT, Azer AS, Abdelraheem IM	2024	Research article	CAD-CAM post and core restorations

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3	Terry Douglas, Swift Edward	2010	Clinical trial	Prefabricated Metal Posts/ Prefabricated Nonmetallic Posts(zirconia)
4	Morgano SM, Milot P	1993	Clinical trial	Cast metal posts and cores
5	Dimitrova M, Vlahova A, Kazakova R.	2024	A narrative review	CAD/CAM-based construction of post and cores
6	Marinescu AG, Abuabboud O, Zimbru ȘD, Cîrligeriu LE, Pițˌ BA, Borcean IA, Paven M, Nica LM, Stoia DI	2023	Research article	Fiberglass posts
7	Baba NZ, Golden G, Goodacre CJ	2009	Review	Nonmetallic prefabricated dowels
8	Leven R, Schmidt A, Binder R, Kampschulte M, Vogler J, Wöstmann B, Schlenz MA.	2022	Clinical trial	CAD/CAM Posts and Cores in a Fully Digital Workflow
9	Al-Qarni FD. Customized Post and Cores Fabricated with CAD/CAM Technology: A Literature Review	2022	Review	Customized Post and Cores Fabricated with CAD/CAM Technology
10	Balkenhol M, Wöstmann B, Rein C, et al.	2007	Clinical trial	Custom-fabricated, cast post and cores using a standardised technique
11	Dietschi D, Duc O, Krejci I, et al	2007	Review	Post and core materials
12	Elsubeihi, Emad & Aljafarawi, Tareq & Elsubeihi, Heba	2020	Review	Prefabricated fiber-reinforced posts
13	Lee, Ju-Hyoung & Sohn, Dong-Seok & Lee, Cheong-Hee	2014	Short communication	Fabricating a fiber-reinforced post and zirconia core with CAD/CAM
14	Perlea, Paula & Stefanescu, Cosmin & Al-Aloul, Omar-Andrei & Ionita, Cezar & Alexandru, Petre	2023	Short communication	Hybrid posts and cores
15	Kongkiatkamon, S.; Peampring, C	2022	Clinical trial	Translucent Zirconia Crowns
16	Awad MA, Marghalani TY	2007	Research article	Custom-made ceramic post and core using CAD-CAM technology
17	Bibi, Asma & Azam, Saima & Waseem, Rida	2024	Case report	Custom Made Cast Post and Core
18	MS, Nivedhitha	2020	Research article	Fiber reinforced composite
19	Mehra, Varun & Khera, Amit & Raghav, Pradeep & Yadav, Mohit.	2020	Case report	Custom-made ceramic post and core using CAD-CAM technology
20	Tortopidis D, Lyons MF, Baxendale RH, Gilmour WH	1998	Case report	CAD/CAM technologies with zirconia ceramics
21	Streacker AB, Geissberger M.	2007	Full length article	ceramic post and core
22	Ansarifard E, Farzin M, Zohour Parlack A, Taghva M, Zare R.	2022	Original article	Ni-Cr, NPG and Co-Cr alloys

23	Ying, S., Chen, S., Wang, S. et al.	2022	Research article	CAD/CAM zirconium dioxide post-cores
24	Chazine, Michelle & Casucci, Alessio & Mazzoni, Annalisa & Grandini, Simone & Goracci, Cecilia & Breschi, Lorenzo & Ferrari, Marco.	2012	Research article	Zirconia
25	Al Yahya RS, Al Attas MH, Javed MQ, Khan KI, Atique S, Abulhamael AM, Bahammam HA	2023	Research article	CAD-CAM technology
26	Ali Bagheri Behboud, Md Kawsar Ahmed, Arda Kurucu, Göksenin Kurt Çömlekçi, Mustafa Ordu	2023	Review	Zirconia Nanoparticles

A total of 26 articles were included in this narrative review. They have mainly been categorized fundamentally based on different fabrication methodologies, clinical evaluations, and quality of conventional post and core restorations and CAD/CAM post and core restorations, their applications in different aspects of dentistry, focusing largely on the implications of the main results in the study.

The current investigation was conducted to implement CAD/CAM technology in custom post and core fabrication to address clinical requirements with optimal efficiency. Multiple studies have evaluated CAD/CAM-fabricated posts and cores in comparison to both conventional and prefabricated posts.

Teeth treated with root canal procedures and restored using custom-made zirconia posts exhibited notably higher resistance to fracture compared to those with cast metal posts and cores or glass fibre posts combined with composite resin cores[17]. However, the high elasticity modulus characteristic of zirconia results in increased stress on the root dentin, thereby elevating the risk of root fracture [18]. Furthermore, it is difficult to bond to acid-resistant zirconia, and retrieving it in case of failure to remove it from the root canals would be very challenging for crowns, bridges, removable partial dentures, and complete dentures. There are some of the advantages of this approach: greater accuracy and homogeneity in the production methodology, a more efficient and expeditious approach to creating restorations on a larger scale, and an effective means of quality assurance [19].

Tortopidis et al., used CAD/CAM technologies with zirconia ceramics on restorations. They found that the additive manufacturing process produces dental restorations with much-improved mechanical properties compared to the traditional subtractive method[20].

In 2007, Awad and Marghalani pioneered the application of CAD/CAM technology for post and core fabrication, with Strecker and Geissberger following suit shortly thereafter[21]. The subsequent years have witnessed the implementation of diverse techniques and materials in in vitro studies and case reports, which are thoroughly examined in the ensuing sections.

Recent research has shown that the wear behaviour of CAD/CAM composite resin

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posts and cores is lower than that of conventionally fabricated devices. Posts and copings made by CAD/CAM technology exhibited superior fit in the post-space and necessitated reduced fabrication time, although cast posts and copings demonstrated marginally superior fit. A comparable in vitro study revealed that cast Co-Cr alloy exhibited superior accuracy of apical gap compared to machined Co-Cr alloy [22].

CEREC intraoral camera post lengths up to 9 mm have been reported in several other studies. Therefore, in previous studies, 8 mm was adopted as the length of the post-space preparation before scanning. If the post-space exceeds 10 mm, an indirect procedure is recommended to create CAD/CAM posts and cores. For CAD/CAM posts and corenot achieved by post-retention, cement thickness was measured by direct scanning of the post-space, polyether impression scanning, or plaster model scanning[23]. The post retentions of directly scanned posts and cores were found to be better than those of indirectly scanned posts and cores. The cement thickness and nano leakage were similar between the two groups[24].

The majority of studies reported in the literature have employed an indirect approach to CAD/CAM post and core fabrication. Direct scanning of the root canal region is expedient and immediate; however, indirect approaches may be recommended when rehabilitating teeth with elongated or diminutive root canal spaces [25].

An additional limitation is the challenge in differentiating between materials, as the majority of the published literature consists of case reports, with milled zirconia and glass-fibre-reinforced composites being the most frequently reported materials. Consequently, this study can only provide a basis for further research in which an exhaustive study on the interrelations between different materials and their mechanical characteristics is defined.

Post, retention, and cement thicknesses were assessed indirectly by scanning with post spaces, either polyether impression scanning or plaster model scanning. Post-retention was the highest in directly scanned posts and cores, where the two groups were generally comparable in terms of cement thickness and nano leakage.

CAD CAM technology offers the possibility of creating a hybrid post in the dental office that contains a zirconia core and a fiber-reinforced resin part that can be fitted in the patient mouth on the same day [26].

While its application has been recorded for several other materials, there are few reports for the the clinical application of a CAD/CAM-produced Co-Cr alloy. This inherent aesthetic limitation which is common to metal alloys is a special shortcoming related to most of the time numerous other alternatives superior in aesthetic qualities. However, a 2024 study shows that for metal post and core, no statistically significant difference was identified between digital and conventional impressions, while for zirconia, a significantly higher acceptance rate is evident in conventional impressions, compared to those produced by digital impressions.[27]

A limitation of the present study is in drawing material distinctions, which could be justified by most available literature taking the form of clinical anecdotes, where zirconia and glass-fibre-reinforced composites appear

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to be the most popular among the materials. Thus, this study serves only as a stepping stone for future investigations, which may involve a more detailed study of various materials[28].

4. Conclusions

Such increased availability of CAD/CAM fabricated posts and cores may warrant consideration of this technique as an alternative approach to traditional methods. The fracture resistance, bond strength, adaptability, and aesthetic excellence of post and core restorations are considered impressive features. Nevertheless, limited in vivo research has been conducted to corroborate this evidence. Therefore, it is crucial to perform extended studies to validate the results obtained from these brief clinical trials.

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Author contributions

S.B and A.R contributed to the study design, the data acquisition, analysis, and interpretation, and wrote the manuscript draft. M.T contributed to the study design, and the interpretation of the results, and revised the manuscript. D.A and A.B contributed to the study design, revised the manuscript, and supervised the work. All authors have read and approved the final manuscript.

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Data availability statement

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