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Post and Core Restorations – CAD/CAM vs. Conventional Methods

Mariya Dimitrova[1]*; Rada Kazakova[1,2]

[1]Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University – Plovdiv, 4000 Plovdiv, Bulgaria.

[2]CAD/CAM Center of Dental Medicine, Research Institute, Medical University – Plovdiv, 4000 Plovdiv, Bulgaria.

Corresponding Author: Mariya Dimitrova

Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University-Plovdiv, 4000 Plovdiv, Bulgaria.

Email: dimitrovamarria@gmail.com

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Abstract

The aim of the current paper is to review the available literature reporting on studies of post and core restorations in terms of their composition, fabrication techniques, and clinical performance. The methodology included applying a search strategy, defining inclusion and exclusion criteria, and selecting studies to summarize the results. Searches of PubMed, Scopus, and Embase databases were performed independently by three reviewers to gather literature published between 2000 and 2023. A total of 124 titles were obtained from the electronic databases, and the application of exclusion criteria resulted in the identification of 26 articles pertaining to conventional and CAD/CAM technology for post and core restorations. Several ways for restoring endodontically treated teeth with CAD/CAM post and cores have been published, including direct and indirect procedures. The most often reported materials were zirconia, composite resin, and hybrid ceramic. There are few published studies on CAD/CAM post and core; however, more research is needed to study the long-term outcome of this treatment.

Keywords: Post and core; CAD/CAM; Prosthodontics; Digital dentistry.

Introduction

Customized cast post and core restoration are frequently applied to repair severely damaged teeth caused by caries or bruxism [1]. Because the custom-made design fits effectively in the prepared post area, it is recommended for elliptical or flared canals where prefabricated posts are unable to adapt well. The better adjustability of cus-tom-cast post and core benefits in torsional stress resistance [2]. These customized posts and cores function as corona-radicular stabilizers for single-rooted and premolar teeth that become weak because of the combined impact of tooth structure reduction during tooth and access preparation [3] similarly, these customized posts resist rotational stresses in multi-rooted teeth with significant tooth structure loss [4].

A post and core should improve crown retention, be biocompatible, nontoxic, and have high tensile strength and fatigue resistance to occlusal and shear loads. A post should equally distribute stresses to the surrounding root surface and extend apically to at least crown height or two-thirds the length of the root [5]. This helps to evenly distribute stress and provides resistance to occlusal load. Furthermore, the color of the post and core should be similar to the color of natural dentin, especially when restoring anterior teeth [6]. This paper provides a brief history of bespoke post and cores, as well as evidence on more recent CAD/CAM produced post and cores.

Customized post and cores can be produced via one of two methods: a direct procedure using a resin model or an indirect technique with elastomeric impressions of the prepared canal. The benefit of using tailored post and cores is that they fit the root canal area of the majority of teeth, including those with oval canals, and are simple to remove following retreatment [7]. Furthermore, both the post and the core function as a single unit, reducing the chance of core separation. Even when treating proclined teeth, the angulation of the core in cast post and cores can be adjusted to match the contour of the crown [8].

A study by Balkenhol et al. found that teeth restored with custom-cast post and cores had a favorable long-term prognosis, with a survival rate of 7.3 years [9]. Dietschi et al. demonstrated high fracture resistance of teeth repaired with custom-cast post and cores in similar experiments [10]. Cast metal

posts, on the other hand, necessitate additional chairside and laboratory time, making the treatment more expensive.

Materials and methods

Using a search strategy, defining inclusion and exclusion criteria, finding studies; selecting studies; and collecting pertinent data to summarize the results were all part of the methodology. To gather literature published between 2000 and 2023, PubMed, Scopus, and Embase databases were searched. The search criteria were "Post and core restorations" [Mesh] OR "Indirect restoration" OR ''CAD/CAM fabrication" OR "Digital dentistry" OR "Post and core" AND "CAD/CAM" [Mesh]. Articles written in English and published between 2008 and 2023 on post and core restoration techniques, clinical studies and in vitro studies, and articles reporting different fabrication techniques, clinical performance, or quality assessment with conventional and CAD/CAM post and core restorations were the inclusion criteria for selection. Articles that failed to incorporate items described in the inclusion criteria or described data that had previously been included, were excluded.

Results and discussion

The purpose of this research is to conduct a literature review on investigations of post and core restorations in terms of composition, fabrication procedures, and clinical performance.

Materials used to make posts and cores are classified as metallic or non-metallic [11]. Custom cast post and cores are built of gold alloys such as type III and IV, silver-palladium alloys, or base metal alloys. Cast gold post and cores are considered superior to other materials due to their high success rate, attractive mechanical qualities, and ease of manufacture, whereas base metal alloys are considered a lower-cost option. However, because base metals are stiffer than dentin, they cause high levels of stress within the tooth [12]. Furthermore, the breakdown of base metal alloys produces chemicals that may be toxic to patients. A retrospective analysis found that cast post and cores had a success rate of 89% to 98.5%.

Although cast posts and cores were once thought to be the gold standard, increased patient demand for greater aesthetics led to the creation of ceramic posts and cores. As a result, the use of castable glass ceramics and glass-penetrated ceramics has increased [13]. Zirconia posts were first used on teeth with substantial loss of coronal structures in 1995, as an alternative to cast metal posts and cores. These posts were cosmetically superior and resulted in restorations that resembled genuine teeth due to their great translucency and ability to match the tooth color [14].

Endodontically treated teeth with customized zirconia posts had superior fracture resistance than cast metal posts and cores and glass fiber posts with composite resin cores. The high modulus of elasticity of zirconia, on the other hand, transfers significant loads to root dentin, increasing the likelihood of root fractures [15]. Furthermore, establishing a firm attachment to acid-resistant zirconia can be difficult, and in the event of treatment failure, retrieving zirconia posts from root canals may be extremely difficult.

Computer technology has aided in the fabrication of single crowns, fixed partial dentures, detachable partial dentures, and complete dentures. This technique provides various benefits, including enhanced precision, a uniform production approach, a simpler and faster method of creating restorations in a bigger capacity, and an efficient means of quality control [16] CAD/CAM technology employs either "additive" or "subtractive" production processes. Additive manufacturing creates different restorations by printing structures layer by layer. Many printing technologies, including as stereolithography (SLA), selective laser melting (SLM), and others, have been described [17]. The subtractive process, on the other hand, entails removing material to manufacture the desired output, which can be accomplished by machining and milling or laser ablation technologies [3].

When compared to additive manufacturing, the subtractive approach of manufacturing has been shown to generate mechanically superior restorations. However, approximately 90% of the prefabricated block material is squandered during the restoration process [18]. The additive technique approach has grown popular because it builds complex structures with excellent precision and little material waste. Given the benefits, CAD/CAM technology has been studied for custom-cast post and core fabrication. Awad and Marghalani pioneered the use of CAD/CAM technology in post and core manufacturing in 2007, and Strecker and Geissberger followed suit [19]. This was followed by a number of in vitro experiments and case reports utilizing a variety of methodologies and materials, which are commented on further in the following sections.

The application of CAD/CAM technology to construct custom post and cores has been reported to successfully fulfill clinical requirements in an efficient and practical manner. Several studies have compared customized, CAD/CAM-fabricated post and cores to traditionally produced and prefabricated ones [20]. According to a recent study, CAD/CAM composite resin post and cores provided adequate adaptation to the post space and were less time demanding to build, however, cast post and cores gave somewhat better adaption. Similarly, an in vitro study found that normally cast Co-Cr alloy was more precise in terms of apical gap when compared to milled from the same alloy [21].

According to several reports, the CEREC system's intraoral camera can scan post-space lengths of up to 10 mm [22,23]. As a result, studies have often used a 9 mm post-space preparation length prior to scanning. When the post gap is greater than 10 mm, it is recommended to utilize an indirect technique to build CAD/CAM post and cores. For CAD/CAM post and core made by direct scanning of the post space, scanning of a polyether impression, or scanning of a plaster model, post retention, cement layer thickness, and nano leakage were measured. Post retention was highest for direct scanning posts and cores, whereas cement thickness and nano leakage were generally identical [24].

The majority of reported investigations employed indirect manufacture of CAD/CAM post and cores. Although directly scanning the root canal area is a rapid and uncomplicated process, it may be necessary to use indirect approaches when recovering teeth with long or small root canal spaces [25]. In vitro experiments comparing milled, and 3D-printed Co-Cr alloys to cast post and cores have recently been described. Despite the fact that many of the other materials utilized have been reported in case reports, there has been no report on the clinical usage of CAD/CAM-manufactured Co-Cr alloy, probably due to the inherent aesthetic disadvantage of metal alloys, especially considering the multiple alternatives that offer greater aesthetic qualities [26].

The limitations of the study are related to the difficulties in distinguishing one material from another because most published data are clinical reports, with milled zirconia and glass-fiber-reinforced composites being the most often reported. Therefore, a comparison of the various materials and their mechanical properties warrants further investigation.

Conclusion

The application of CAD/CAM technology in dentistry is no longer confined only to crowns, inlays, onlays, and dentures. With the growing success of using CAD/CAM fabricated post and cores, this method can be viewed as an alternative to traditional procedures. Despite the fact that these post and core restorations have excellent fracture resistance, bond strength, adaptability, and aesthetics, there have been few in vivo investigations reported so far. As a result, multiple long-term investigations are required to validate the findings of clinical reports.

Declarations

Conflict of interest: The authors declare no conflict of interest.

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