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The Function of Digital Dentistry in the Production of Post and Core

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KEYWORDS

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ABSTRACT:

Introduction: Alongside the rise in demand for restorative dentistry in recent years has been the development of automated dental technology, which dental practices may readily access. The new era of dentistry is centred on computer-aided milling and additive manufacturing of restorative materials, which not only shorten work times but also have a low frequency of faults and repeats and are nearly flawless. This article focusses on the development of post and core fabrication for teeth that have undergone endodontic treatment.

Purpose: The development of digital dentistry aims to speed up production and improve workflow accuracy. By using extremely precise cast and post, which will be more accurate, less time-consuming, and easier for the operator, this paper aimed to evaluate the superiority of CAD-CAM and additive manufacturing.

Conclusion: Since digital dentistry expedites the creation of anatomical posts and core restorations, it offers clinicians opportunities.

Introduction

For teeth that have had endodontic treatment, post and core restorations are recommended when a restoration that uses the coronal remaining tissue to satisfy the tooth's masticatory and aesthetic tasks is not feasible. Endodontically treated teeth are known to be more prone to fracture. The main scientific evidence for this is that the loss of hard tissues is caused by a combination of the initial carious pathology, the endodontic access cavity, the instrumentation, and, to a lesser extent, the biochemical and structural alterations in non-vital dentin[1].

On the other hand, saliva is crucial for the management of oral microbial flora. A suitable restorative approach is required following endodontic treatment to guarantee the coronal seal and the preservation of any remaining tooth structure. Endodontic posts are required for the final restoration of teeth that have lost two or more walls. This not only improves stability and retention but also influences the treatment's success[2].

Numerous materials have been suggested for post fabrication; the I and II generations of posts are made of metal, while the III and IV generations are made of fiber, ceramic, and zirconium oxide. Because fiber posts' physical characteristics are more like those of natural dentin, they have better biomechanical

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behavior than rigid metal and/or ceramic posts. This is because they allow for a better distribution of occlusal forces and significantly lower the risk of vertical root fracture when compared to harder materials[3].

Additionally, there are two types of posts: prefabricated and customised, which are made using the CAD-CAM or lost wax techniques. Cast posts have been made from a variety of metal alloys, including cobalt-chromium [Co-Cr], nickel-chromium [Ni-Cr], and gold alloys, because of their tensile strength, hardness, and cost. Alternatives to metal posts include fibre posts, which are strong but far less rigid and powerful. By using specially made posts [or posts and cores], a very thin coating of cementing resin can be applied, which is a suitable method to significantly lower polymerisation stresses and the generation of gaps or voids in the adhesive interface[4].

By conserving the root dentin with little to no post-space preparation, the current concept of a customized post and core leads to thicker dentin walls, greater resistance to root fracture, and simpler core restoration. Over the past ten years, computer-assisted technologies, like computer-aided design (CAD) and computer-aided manufacturing (CAM), have gained a lot of popularity for creating both fixed and removable partial prostheses. Crowns, long-span fixed partial dentures, and detachable partial dentures are only a few of the prostheses that can be made in dentistry using these technologies[5].

Co-Cr products are fabricated using CAD/CAM milling and direct metal laser sintering [DMLS], which have reduced costs, eliminated manufacturing errors (time-consuming processing) and human error (distortion of wax patterns and irregularities in the cast metal), and enhanced fitting accuracy when using the conventional casting technique. A popular additive metal fabrication technology, DMLS uses a high-power ytterbium [Yb]-fiber optic laser to melt the metal powder, which is then built-up layer by layer to a thickness of 10 to 30 mm. In contrast, intraoral digital scanners with CAD/CAM and rapid prototyping have been used to fabricate post and core with accelerated techniques[6].

The DMLS technology provides extremely precise fixed partial denture production with sophisticated mechanical qualities and subtle marginal adaptability. While studies are directed at marginal and internal fit of metal ceramic restorations fabricated with CAD/CAM and DMLS, In the past years, several attempts to customize prefabricated posts have been done by subtractive or additive ways. this “hand-made” approach could be surpassed by CAD-CAM technology[7].

CAD/CAM cast post

Traditionally, endodontically treated teeth have been successfully restored using custom-fabricated post-and-cores, which are one of the oldest post systems composed of casting metal. With the development and widespread use of computer-aided design/computer-assisted manufacturing [CAD/CAM] systems in dental clinics and laboratories, custom post-and-cores can now be fabricated not only from cast alloys but also from many temporary [CAD/CAM] dental materials, such as zirconia, nano ceramic resin composite, fiber-reinforced composite, and high-density polymers. These custom post-and-cores are still seen as the gold standard for restoring structurally compromised endodontically treated teeth, and they are still a necessary treatment modality in modern dentistry[8].

A digital scan and scan posts that work with certain drills that form the canals are used in the fully digital process. Digital design utilising specialised design software modules and milling come next. Research focusses on fracture resistance, internal and marginal fit, and post-cores made using CAD/CAM, among other things. Endodontically treated teeth have been effectively re-stored using customised metal post-cores because of their superior physical characteristics. Root fracture results from a high concentration of stress in the surrounding radicular dentin, which is caused by the high elastic modulus. A metal post-core also has certain drawbacks, including corrosion, microleakage, and an aesthetic compromise due to the reflection of metal colour on all-ceramic restorations[9].

For the restoration of anterior endodontically treated teeth, a zirconia post and core made with computer-aided design/computer-aided manufacturing [CAD/CAM] technology has been utilized. Nevertheless, the high modulus of elasticity [200 MPa] of zirconia posts allows stress to be transferred to the less stiff dentin, which

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results in root fracture. Using CAD/CAM technology, the polymer-infiltrated ceramic network [PICN] Vita Enamic [Vident, Brea, CA, USA] may now be machined as a post and core. To combat ceramic's brittleness, which wears down opposing natural teeth, this material possesses high flexural strength, elasticity, and physical characteristics similar to those of natural teeth. The benefit of fabricating the post and core using CAD/CAM technology is that it allows for better adaptation with less compromise of tooth structure and can overcome the mistakes of traditional fabrication techniques[10].

The increased push-out bond strength of the CAD/CAM posts in comparison to the prefabricated ones makes it clear that the retentive strength of the post and cores of anatomically adapted posts is significantly higher than that of prefabricated ones. Growing aesthetic standards and possible problems with corrosion of posts made of non-noble alloys led to the development of tooth-coloured post systems. Better contact between the dentin and the cement/post assembly may result from custom-fit posts and cores, which ensure a better fit in the canal and higher-pressure during cementation. The strong binding observed in the apical third of the prefabricated groups may be explained by the fact that a thinner cement layer produces a stronger link and less polymerisation shrinkage[11].

The lower binding strength of the CAD/CAM groups in the apical region of the roots could be attributed to a higher C-factor caused by the unfavourable cavity structure of the post space and a lower depth of polymerisation. the effect of post-relining on push-out bond strength and the consequent drop in bond strength values in the apical region of the root canal due to the lesser polymerisation of the composite. By converting the concave surface of the root canal into the convex surface of the post using digital technology, we may produce an anatomical post and core that improves the biomechanics of the endodontically treated tooth and reduces the likelihood of root fractures[12].

According to one study, direct pattern scanning should yield better CAD/CAM post-and-core results than impression scanning. However, this method's drawbacks include the initial learning curve, extra processes, the need for several software programs, and the method's sensitivity when scanning small objects like a post-and-core pattern. Three distinct computer-aided design/computer-aided manufacturing [CAD/CAM]-fabricated post and core assemblies were used in another investigation to test the fracture resistance and failure modes of root-filled teeth repaired. The study's findings indicate that while few PICN samples shown a favourable fracture, metal and zirconia samples displayed an unfavourable one. Post and core assemblies made with PICN material can be fabricated with CAD/CAM[13].

PEEK and nano-ceramic composites with modified post-and-cores demonstrated strong mechanical performance. They had a fracture resistance that was lower than that of cast metal posts but on par with fibreglass custom-made posts. For PEEK post-and-cores specifically. A wax template is created, the post space and neighbouring teeth are imprinted, and type IV high-strength die stone is cast using the computer-aided design/computer-aided manufacturing [CAD/CAM] techniques for post and core construction that are detailed in the literature. Using auto-polymerized acrylic resin on a plastic post, another technique scans the canal's anatomy[14].

In one study, various scanning techniques were used to assess the internal fit and marginal adaption of milled fibre posts and cores. There were three distinct scanning techniques employed. A lab scanner to indirectly digitalise the silicone impression [Group S] and the resin pattern [Group RP] of the post space, and an intraoral scanner [IOS] [Trios 3; 3Shape] to directly digitalise the post space [Group T]. The vertical marginal discrepancy was measured on all specimens under an optical microscope, and the internal fit at the corner, post apex, and four horizontal cross-sections [CS1-4] within the canal was evaluated by scanning five of each group using microcomputed tomography[15].

Better adaptation was achieved with a complete digital workflow. Scanning the resin pattern or the silicone impression introduced more variables in the digital process or milling of a one-piece fiber post and core. A pattern must be scanned, and a digital design must then be created, in order to customise post-and-cores utilising computer-aided design and computer-aided manufacturing [CAD-CAM]. The process of creating a CAD-CAM-customized post-and-core that is milled from a resin block loaded with nanoparticles or nanoclusters and developed from a scanned polyvinyl siloxane impression is described in this technology. The

CAD-CAM post-and-core may be customised more quickly and effectively with the polyvinyl siloxane imprint than with a traditional acrylic resin template. The resin block loaded with nanoparticles or nanoclusters has features that make it appropriate for chairside CAD-CAM post-and-core fabrication[16].

Without a stone cast or wax pattern, a custom post and core were built utilising the CEREC system of CAD/CAM technology. Using vinyl polysiloxane, a two-stage simultaneous imprint procedure was carried out for the post space and neighbouring teeth. A 3D CEREC Bluecam camera was utilised for scanning. With the help of Inlab SW 4.2 software, which processed the data, a three-dimensional digital model of the impression was created by adjusting certain parameters. Without a stone cast or wax template, the CEREC technology demonstrated itself to be a dependable way to generate the design of a custom-made post and core[17].

The impact of applying CAD/CAM technology to manufacture custom-fit anatomical supports and cores from fibre-reinforced composite and high-density polymer blocks was examined in another study. The effect of heat cycling on the investigated materials' push-out bond strength was assessed, as was the bond strength to root canal dentin in comparison to prefabricated fibre posts. The push-out bond strength was substantially higher [$p < 0.001$] in the CAD/CAM post groups than in the prefabricated post groups, irrespective of the post material. However, the push-out strength was not significantly impacted by tooth ageing [$p = 0.536$]. All groups experienced adhesive failures between the cement and dentin, except for AMC, where adhesive failures between the cement and the post were also noted[18].

In an investigation of the fracture resistance of Co-Cr post cores made using three distinct methods—direct metal laser sintering, computer-aided design-manufacturing, and traditional casting—the differences between the three methods were examined. The study found no difference between Co-Cr posts made using direct metal laser sintering and traditional casting in terms of their fracture resistance. Conversely, posts made using CAD and CAM methods demonstrated greater fracture resistance ratings. Co-Cr metal posts made using direct metal laser sintering and CAD/CAM technology may be used in everyday clinical applications as an alternative to traditional casting processes[19].

CONCLUSION

Due to their advantageous mechanical, chemical, and physical qualities, post and core made using subtractive and additive manufacturing techniques are thought to be superior to those made using conventional methods, according to several research and clinical reports. According to the constraints of this evaluation of the literature, metal posts made using CAD/CAM and Direct Metal Laminating systems had fracture resistance strengths that were comparable to or greater than those of traditional casting, within a reasonable range. Although there is not many research, it was feasible to confirm that the CAD-CAM endodontic posts have produced satisfactory outcomes. However, more laboratory and clinical studies utilising these technologies are required, including those that examine the three points bending test, clinical longevity, and shear bond quality.

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