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Conventional and digital approaches in post-endodontic restorations

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ABSTRACT

In endodontically treated teeth, the application of appropriate coronal restorations that restore functional and aesthetic integrity, prevent microbial ingress, and minimize the risk of fracture is essential for treatment success. The longevity of endodontically treated teeth in the oral cavity is influenced by multiple factors, including the amount of remaining tooth structure, the type of restorative material used, the restoration technique employed, and the interactions between the tooth, the restorative material, and the oral environment. Although various materials are available for the restoration of these teeth, composite resins and ceramics are among the most frequently preferred options in contemporary practice. Depending on the extent of coronal structure loss in posterior teeth, different therapeutic approaches can be employed, such as indirect composite resin restorations, indirect restorations (inlays, onlays, overlays), full crowns, and endocrowns.

Keywords: Endocrown, digital, 3D

INTRODUCTION

In the clinical success of endodontic treatment, the quality of the coronal restoration placed after therapy is of equal importance to the endodontic procedures performed during the treatment phase. Caries, trauma, previous restorations, and enlargement procedures conducted during endodontic preparation can result in substantial loss of coronal tooth structure in root canal–treated teeth. Following endodontic treatment, particularly in posterior teeth, it is essential to employ appropriate restorative treatments to minimize the risk of fracture, ensure coronal sealing to prevent bacterial contamination, and restore functional integrity. For this purpose, endodontically treated teeth can be restored through various methods, utilizing either direct or indirect restorative techniques.[1,2]

Among the conventional restorative approaches applicable after endodontic treatment are amalgam fillings, composite resin restorations, and fiber post applications. Advances in adhesive dentistry, the development of next-generation resin nanoceramic composite materials, the enhancement of strengthened ceramics, the capability to etch surfaces with acid, and the introduction of resin cements with high bonding strength have supported the concept that posterior teeth can be successfully restored without the use of post-core systems. Progress in adhesive systems has also enabled the pulp chamber to be utilized as a retention area, thereby allowing onlay and overlay restorations to be applied as alternatives to traditional treatment methods in the restoration of endodontically treated teeth with extensive coronal tissue loss.

In line with these developments, the fabrication of monoblock crown restorations-known as endocrowns-which utilize the pulp chamber for retention, has become increasingly common, particularly in teeth with severe coronal destruction.[3,4]

In parallel with technological advancements, the rapid adoption of digitalization has become increasingly evident in the field of dentistry.[5] Intraoral and extraoral scanners have begun to replace conventional impression techniques, and CAD/CAM technologies now enable the digital design and fabrication of restorations. Compared to traditional impression methods, the ability to record intraoral and mandibular movements with greater precision allows for the fabrication of restorations that demonstrate superior adaptation and are more favorably accepted from an esthetic perspective. These advancements have the potential to reduce the necessity for restoration replacement due to treatment failure or misfit. Currently, while intraoral scanners are rapidly supplanting conventional impression methods, three-dimensional (3D) dental printing has emerged as an alternative manufacturing technology to CAD/CAM systems. Collectively, these digital tools and techniques offer patients a more comfortable clinical experience and provide clinicians with a more efficient workflow, along with a high potential for restorative success.[5-8]

RESTORATION OF ENDODONTICALLY TREATED TEETH

When selecting a restorative material, priority should be given to options that maximize the preservation of tooth

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structure, cause minimal removal of sound tissue, possess morphological and mechanical properties compatible with natural tooth structure, and demonstrate biocompatibility with oral tissues.[9] Endodontically treated teeth exhibit lower resistance to masticatory forces compared to vital teeth. The primary reasons for this include loss of tooth structure during the creation of the endodontic access cavity, reduced elasticity, and changes in cavity morphology. Various coronal restorative treatment options are employed to reestablish the functional integrity of the tooth, protect filled root canals against microleakage, and maintain occlusal stability. However, even when all treatment steps are performed correctly, the literature indicates that fracture rates in endodontically treated teeth are higher than those in vital teeth. Therefore, in cases with significant loss of tooth structure, the selection and application of an appropriate coronal restoration are of critical importance. In treatment planning, there is a direct relationship between the extent of existing structural loss and the type of coronal restoration to be selected.[10]

RESTORATIVE OPTIONS FOLLOWING ENDODONTIC TREATMENT

Traditionally, endodontically treated teeth have been restored using full crown restorations placed over post-core systems. However, during conventional treatment, the removal of sound tooth structure alters the biomechanical properties of the remaining dental tissues and weakens the tooth. In addition, the risk of root perforation and fracture associated with post placement has led to the investigation of alternative restorative approaches.[11-13] In parallel with the development of adhesive cements, the ease of use of fiber-reinforced composites, and the advancements in digital dentistry, various restorative options have recently been introduced as alternatives to conventional treatment methods.

Post-Core Restorations

Posts are utilized in cases where there is substantial loss of coronal tooth structure to ensure adequate retention of the core to the tooth. The primary functions of post placement include dissipating stress in structurally compromised teeth, preventing root fractures, providing a stable anchorage within the root canal, ensuring sufficient retention of the restoration, and supporting the coronal structure.[14] Currently, prefabricated metal posts, fiber posts, and ceramic posts are commonly used as post materials, while amalgam, composite resin, glass ionomer cement, and cast metal cores remain in clinical use as core materials.

Posts manufactured from metal, fiber, or ceramic differ from one another in terms of mechanical properties such as strength and elasticity. Metal and ceramic posts generally exhibit greater stiffness and higher strength compared to fiber posts, whereas fiber posts demonstrate greater elasticity, thereby exhibiting mechanical characteristics closer to that of dentin. Metal and ceramic posts are capable of withstanding functional forces, particularly lateral forces, without structural flexion; however, this rigidity may lead to concentration of stresses in the dentin, resulting in root cracks or fractures. In contrast, fiber post systems distribute occlusal forces more evenly, mimicking dentin-like behavior and thus reducing the potential risk of root fracture.[15,16] Esthetics is one of the essential considerations in post-core restorations. In cases where the final restoration is not planned as a metal-ceramic crown, the choice of post material can directly influence the esthetic outcome. Particularly in situations where esthetics is prioritized, ceramic posts and certain types of fiber posts may be preferred to achieve an appearance more closely resembling natural tooth structure.[17]

In restorations utilizing posts, various types of failures such as post deformation, loss of retention, root fracture, corrosion, and esthetic complications may occur. The primary cause of these failures is considered to be the excessive loss of tooth structure during endodontic treatment and post space preparation. Particularly in cases with narrow roots, the amount of remaining tooth structure after preparation for post placement may be insufficient, leading to an increased risk of fracture. Although several recommendations regarding post length exist, these guidelines are often modified in clinical practice according to the specific case. In the literature, post length has been described in various ways, which can be summarized in six approaches:

- The post length should be equal to the inciso-cervical or occluso-cervical height of the crown.
- The post should be longer than the crown height.
- The post length should be three-fourths (4/3) of the crown height.
- The post should be one-half, two-thirds (2/3), or four-fifths (4/5) of the root length.
- The post should terminate at the midpoint between the crestal bone level and the apex.
- The post should be of sufficient length to maintain apical seal integrity without compromising it.[18]

Fiber-Reinforced Direct Composite Restorations

Composite resin-based materials have been significantly improved in parallel with technological advancements. Due to their superior esthetic properties, strong bonding capability to dentin and enamel via adhesive systems, and ease of application under clinical conditions, they are widely preferred in modern dentistry. Although the most notable disadvantage of the material-polymerization shrinkage-has been considerably reduced in new-generation composites, its adverse effects on clinical success have not been completely eliminated.[19-21] Fiber meshes are employed to reduce polymerization shrinkage in composite resins, enhance the mechanical resistance of both the composite material and the remaining tooth structure, and improve fracture resistance. Owing to their high elastic modulus and low flexural modulus, they help to reduce stresses at the adhesive interface between the tooth and restorative material, thereby supporting the long-term success of the restoration. Following endodontic treatment, teeth that have lost their mesial and distal walls exhibit reduced resistance to occlusal forces. Over time, this may lead to fractures of the buccal or lingual walls, resulting in severe crown destruction that is often irreparable. To prevent such complications, the reinforcement of restorations in extensively damaged endodontically treated teeth with woven fibers has been proposed, and successful clinical outcomes using this technique have been reported in the literature.[22-24]

To enhance the mechanical resistance of coronal restorations, the placement position of woven fibers within the cavity can directly influence the success of the procedure. Oskoee et al.[25]

reported that positioning the woven fiber in the occlusal third to cover the buccal and palatal cusps resulted in a statistically significant increase in fracture resistance compared to placement in the middle third or gingival third. However, some studies have also reported that positioning the woven fiber solely in the gingival third can lead to an improvement in fracture resistance.[25,26]

Şengün et al.[27] investigated the effect of fiber mesh reinforcement on the fracture resistance of endodontically treated mandibular premolars with MOD cavity preparations. In the study, appropriate recesses were prepared in the buccal and lingual cusps to accommodate the placement of the fiber mesh, and these cusps were connected using the mesh. The findings revealed no statistically significant difference in fracture resistance between the specimens restored solely with composite resin and those reinforced with fiber mesh. However, when fracture patterns were evaluated, the group with fiber mesh reinforcement exhibited a higher incidence of restorable fractures compared to the non-reinforced group.

Recent advances in composite resin technology, including the development of novel monomers, improvements in translucency, initiator systems, and filler technology, have led to the introduction of bulk-fill composites. High-viscosity composite resins designed for bulk placement contain additional fillers aimed at enhancing the strength of the restored tooth. For example, alert (Jeneric/Pentron, Wallingford, Conn.) and everX Posterior (GC Corporation, Tokyo, Japan) composites incorporate glass fiber particles that provide specific mechanical advantages. These fiber-reinforced composites, designed for use as dentin replacement materials, have been reported to prevent the initiation of fractures and cracks in restorations and to inhibit the propagation of existing cracks. Therefore, in composite restorations with large cavity dimensions-particularly in endodontically treated teeth-the use of fiber-reinforced composites as a reinforcing base material, placed using the bulk-fill technique, is recommended.[28-30]

Indirect Composite Restorations

Currently, for teeth that have undergone significant structural loss following endodontic treatment, restoration with composite resin using an indirect technique is recommended. Indirect composite resin restorations are fabricated on a model obtained from an impression of the patient, either in a clinical or laboratory setting, and are polymerized under heat, light, and pressure in special furnaces. The fabricated restoration is then adapted intraorally and cemented with resin-based luting agents. The primary advantages of indirect composite resins over direct composite restorations include a reduction in polymerization stress within the material and an improvement in its physical properties. These enhancements in mechanical performance have been reported to increase the longevity of the restoration and reduce both occlusal and proximal wear. Compared to direct composite resin restorations, indirect composite restorations exhibit a more homogeneous and uniform microstructure.[4,31,32]

Inlay, Onlay, Overlay, and Full-Crown Restorations

Intracoronal restorations are classified as inlays, onlays, or overlays depending on the cavity design. Inlay restorations are indirect restorations applied to the occlusal, gingival, and proximal regions, and are considered more conservative compared to other restorative options. Although they do not mechanically reinforce the tooth, they aim to replace the lost tooth structure in a functional and esthetic manner. Inlays are generally preferred in premolar and molar teeth with limited carious involvement or pre-existing restorations. Onlay restorations, on the other hand, extend to cover the remaining portion of the occlusal surface, thereby distributing occlusal forces over a broader area and contributing to the protection of the tooth. Overlay restorations encompass not only the occlusal surface but also the buccal or lingual surfaces, providing a more comprehensive restorative solution. Common materials used for these restorations include metal, resin composite, all-ceramic materials, and polyetheretherketone (PEEK).[33]

In cases involving group guidance occlusion, pronounced occlusal anatomy, parafunctional habits such as bruxism or clenching, and advanced loss of tooth structure, restorative designs that encompass all cusps-such as onlays, overlays, endocrowns, or full crowns-should be considered. Additionally, in situations where the cavity size is extensive, the configuration factor of direct resin composites should be taken into account, and such indirect restorative options may be preferred. The selection of the indirect restoration type should be determined based on the amount and pattern of the remaining tooth structure. When the buccal and lingual walls are preserved at a height of 3-4 mm and a thickness of 1.5-2 mm from the floor of the pulp chamber, restorations covering all cusps can be performed without the need for post placement. In these restorations, stability is achieved through the macromechanical retention provided by the design and the micromechanical retention ensured by adhesive systems.[34]

Introduced into the dental literature in the 1980s, CAD/CAM technology has become increasingly prevalent in recent years in both dental clinics and laboratory settings. These systems enable faster, more reliable, and highly successful applications across various fields of dentistry. The primary advantages of CAD/CAM technology include the use of high-quality materials, reduced production costs, and the capability for patient-specific customization.[35]

In the application of indirect restorations, the carious tissues are first removed and the tooth is prepared. Impressions of the prepared tooth can be obtained using two different methods. The first method is the conventional impression technique performed with silicone-based impression materials. The second method involves taking digital impressions using CAD/CAM scanning systems. Based on the obtained impression, the restoration is fabricated either in a dental laboratory or in the milling unit of the digital scanning system. Once fabrication is complete, the restoration is adhesively cemented to the tooth using a specialized and precise resin-based luting cement.[36]

In cases where the coronal tooth structure has been significantly lost due to caries, restorative procedures, or endodontic treatment, full crowns can be applied as a restorative option. In certain cases, full crown restorations can be performed directly over the existing coronal structure. However, when adequate coronal support is not present, a post placed within the root canal must provide sufficient retention for both the core material and the crown restoration. Currently, metal-ceramic restorations and all-ceramic systems are among the preferred crown materials in clinical practice. Materials processable with CAD/CAM technology range from feldspathic ceramics and leucite-reinforced glass ceramics, which have relatively low mechanical strength, to high-strength options such as lithium disilicate and zirconia. Furthermore, resin nanoceramics, zirconia-reinforced glass ceramics, and polymer-infiltrated ceramics have been increasingly utilized in recent years, offering alternative solutions in terms of both esthetics and mechanical performance.[33]

Endocrown Restorations

Endocrown restorations are monoblock (single-piece) restorations indicated for teeth with extensive loss of tooth structure, utilizing support from both the pulp chamber and the cavity margins. Macroretention is achieved through the pulpal walls, while microretention is provided by adhesive cementation. When evaluating the bonding surface, devital teeth present a larger surface area compared to vital teeth, raising the question of whether this could enhance the strength of the adhesive bond. Advances in adhesive technology, along with the reinforcement of contemporary ceramics, their ability to be etched, and their effective bonding to dental tissues with high-strength resin cements, have increased the applicability of endocrown restorations in the posterior region. However, in cases where the pulp chamber depth is less than 3 mm or the cervical margin width is less than 2 mm, endocrown restorations are contraindicated due to the inability to achieve sufficient bonding surface.[33,37]

The following parameters are recommended when performing endocrown preparations:

- The endodontic access cavity and the coronal pulp chamber should be prepared as a single continuous entity.
- Occlusal reduction should be achieved in the range of 2-3 mm.
- The preparation design should incorporate supragingival enamel margins whenever possible.
- Enamel should be preserved as much as possible to ensure strong adhesive bonding.
- A finish line with a width of 1-1.2 mm should be established at the restoration margin.
- The pulp chamber floor should be flattened using a suitable cavity base material.
- Internal cavity walls should be prepared with 90° butt joint margins.
- Axial walls should be prepared with a 6-10° taper to provide an appropriate path of insertion for the restoration.

All internal line angles should be rounded to reduce internal stress concentrations and enhance the adaptation of the restorative material.[38,39]

One of the primary advantages of endocrown restorations is that, when sufficient bonding surface is available, they do not require macroretentive preparation. Another significant benefit is the elimination of the need to prepare a post space within the root canal and construct a core structure. This approach not only reduces chair time but also minimizes the risk of root fractures that may occur as a consequence of post placement. Various modifications to the preparation can be made based on esthetic, biomechanical, and material-related requirements. These modifications may include reducing cuspal axial height to a lesser extent-particularly when using composite resin, applying the immediate dentin sealing technique to enhance bond strength, and incorporating either uniform or non-uniform ferrule designs into the preparation to maximize fracture resistance.[1,40,41]

Endocrown restorations can be fabricated either by pressing ceramic materials under pressure or by milling prefabricated ceramic blocks using CAD/CAM systems. In recent years, parallel to technological advancements, CAD/CAM systems have become increasingly favored for the fabrication of endocrowns. These systems eliminate multiple laboratory steps, thereby reducing potential errors during production, and allow the restoration to be delivered in a single clinical appointment. Additionally, they enable precise control over parameters such as layer thickness and cement space. Other notable advantages of CAD/CAM technology include the ability to achieve restorations with high marginal adaptation and the possibility of digital archiving. For these systems, endocrown restorations can be produced from a variety of specially developed block materials with distinct mechanical and esthetic properties.[4,42,43]

Composite resin blocks developed for CAD/CAM technology have been introduced as an alternative to ceramic blocks. Compared to ceramics, their relatively softer structure allows for faster milling and shaping processes. In addition, their repairability provides a significant clinical advantage. Hybrid ceramic materials such as Vita Enamic, which has a polymer-infiltrated ceramic network, and Cerasmart and Lava Ultimate, which possess a nanohybrid structure, have been introduced and incorporated into endocrown applications. One study reported that resin nanoceramic blocks exhibit higher fracture resistance compared to other CAD/CAM ceramics, such as feldspathic and lithium disilicate ceramics; however, due to their resin-based composition, they demonstrate higher microleakage values.[33,39,44]

Restorations Produced by Three-Dimensional (3D) Printers

Three-dimensional (3D) printing technology was first utilized in dentistry in 1999, when it was employed to fabricate an obturator to replace lost maxillary bone tissue. Over time, advancements in additive manufacturing techniques have enabled a wide range of treatment options within the field of dentistry. The primary advantages of 3D printers include reduced production time and costs, the ability to produce clean, safe, and rapid outputs, digital archiving capability, and the potential to fabricate restorations with minimal error, even in complex cases. Today, 3D printers used in dentistry can process a variety of materials, including polymers such as resin, polylactic acid (PLA), and thermoplastic elastomer (TPA), as well as glass, ceramics, zirconia, and metals such as titanium.[45]

The first-generation 3D printers predominantly employed the Fused Deposition Modeling (FDM) technique. However, due to its limitations such as insufficient resolution for fine details, porosity issues, and the inability of the fabricated materials to provide adequate mechanical strength for intraoral use this method is no longer preferred in current dental applications. Subsequently, selective laser sintering (SLS) technology, based on the principle of fusing metal powders using laser energy, was developed. This technique enables the fabrication of implants, crown–bridge frameworks, and metallic bases for removable partial dentures.[5,46]

Since aesthetics, function, and hygiene are equally important in restorative dentistry, Digital Light Processing (DLP) and Stereolithography (SLA) printers capable of processing epoxy resin-based composite/ceramic hybrid materials have become more widely adopted than SLS systems in this field. In both techniques, the restoration is constructed layer by layer from a photopolymer resin; these layers are fused using an ultraviolet laser, and polymerization is achieved with ultraviolet light. The main advantage of SLA technology is its ability to produce large-volume restorations or models rapidly and at a low cost. DLP, on the other hand, stands out for its higher resolution and the optimization of materials to be more suitable for intraoral conditions. Today, the applications of 3D printing in restorative dentistry are diverse: FDM printers are generally used to fabricate whitening trays, dental retractors, and isolation devices, while DLP technology is employed for the production of inlay, onlay, veneer restorations, as well as temporary and permanent single crowns.[47,48]

CONCLUSION

In the restoration of endodontically treated teeth, the choice of restorative material, preparation technique, and applied technology directly influence the long-term clinical success. Current literature indicates that, when sufficient tooth structure remains, endocrown restorations offer an effective alternative to post–core systems and reduce the risk of root fracture. CAD/CAM-based fabrication techniques provide significant advantages in terms of precision fit and patient comfort. Nevertheless, the restorative approach in each clinical case should be individually planned, taking into account the amount of remaining tooth structure, occlusal loading conditions, and esthetic requirements.

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The authors have no conflicts of interest to declare.

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Koç S. Endodontik tedavili molar dişlerin, endokron ile protetik rehabilitasyonu: olgu serisi. *Selcuk Dent J.* 2020;7:500-506. doi:10.15311/selcukdentj.574189
2. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *Int Endod J.* 1995;28(1):12-18. doi:10.1111/j.1365-2591.1995.tb00150.x
3. Kanat Ertürk B. Aşırı kron harabiyeti olan kanal tedavili dişlerde Cad/Cam ile endokron uygulamaları: olgu serisi. *J Dent Fac Atatürk Uni.* 2016;14:56-65.
4. Sezgin E, Kantacı Y, Üstün B. Endokron restorasyonlar ve endokron restorasyonlarda kullanilan materyaller. *HRU Int J Dent Oral Res.* 2022;2(1):59-65.
5. Peşkersoy C. Restoratif diş hekimliğinde dijitalleşme digitalization in restorative dentistry. *EÜ Dişhek Fak Derg.* 2022;43:95-104.
6. Coachman C, Sesma N, Blatz MB. The complete digital workflow in interdisciplinary dentistry. *Int J Esthet Dent.* 2021;16(1):34-49.
7. Peng M, Li C, Huang C, Liang S. Digital technologies to facilitate minimally invasive rehabilitation of a severely worn dentition. *J Prosthet Dent.* 2021;126(2):167-172. doi:10.1016/j.prosdent.2020.05.012
8. Kaleli N, Ural C. What does complete digital workflow mean for dentistry? *J Exp Clin Med.* 2021;138(3s):175-179. doi:10.52142/omujecm.38.si.dent.16
9. Avcılar İH, Bakır Ş. Use of fiber-containing materials in restorative dentistry. *J Dent Sci Educ.* 2023;1(2):49-54. doi:10.51271/JDSE-0010
10. Sterzenbach G, Franke A, Naumann M. Rigid versus exible dentine-like endodontic posts-clinical testing of a biomechanical concept: seven-year results of a randomized controlled clini-cal pilot trial on endodontically treated abutment teeth with severe hard tissue loss. *J Endod.* 2012;38(12):1557-1563. doi:10.1016/j.joen.2012.08.015
11. Assif D, Gorfil C. Biomechanical considerations in restoring endodontically treated teeth. *J Prosthet Dent.* 1994;71(6):565-567. doi:10.1016/0022-3913(94)90438-3
12. Ross IF. Fracture susceptibility of endodontically treated teeth. *J Endod.* 1980;6(5):560-565. doi:10.1016/S0099-2399(80)80151-8
13. Bindl A, Mörmann WH. Clinical evaluation of adhesively placed Cerec endo-crowns after 2 years-preliminary results. *J Adhes Dent.* 1999;1(3):255-265.
14. Huang TJ, Schilder H, Nathanson D. Effects of moisture content and endodontic treatment on some mechanical properties of human dentin. *J Endod.* 1992;18(5):209-215. doi:10.1016/S0099-2399(06)81262-8
15. Ahmetoğlu F, Şimşek N, Yıldırım G, Polat MT. Endodontik tedavili dişlerin restorasyonunda post materyallerin. *Atatürk Üniv Diş Hek Fak Derg.* 2014;24(1):153-157. doi:10.17567/dfd.59440
16. Bateman G, Ricketts DN, Saunders WP. Fibre- based post systems: a review. *Br Dent J.* 2003;195(1):43-37. doi:10.1038/sj.bdj.4810278
17. Uzun G, Keyf F. Geleneksel post-core sistemlerine bir alternatif: polietilen fiber post. *Hacettepe Diş Hek Fak Derg.* 2007;31(2):43-48.
18. Cheung W. A review of the management of endodontically treated teeth. Post, core and the final restoration. *J Am Dent Assoc.* 2005;136(5):611-619. doi:10.14219/jada.archive.2005.0232
19. Schirrmeister JF, Huber K, Hahn P. Four-year evaluation of a resin composite including nanofillers in posterior cavities. *J Adhes Dent.* 2009;11(5):399-404. doi:10.3290/j.jad.a17633
20. Chang M, Dennison J, Yaman P. Physical property evaluation of four composite materials. *Oper Dent.* 2013;38(5):E144-E153. doi:10.2341/12-203-L
21. Avcılar İH, Bakır Ş. Diş hekimliğinde adeziv sistemler. *Dicle Dent J.* 2023;24(1):28-36.
22. Kaval ME, Pişkin B, Yapar GD, Sarıkanat M. Endodontik tedavili dişlerde koronal restorasyonun örgü fiber ile güçlendirilmesinin kırılma dayanımına etkisi. *EÜ Dişhek Fak Derg.* 2014;35:37-40. doi:10.5505/eudfd.2014.56338
23. Versluis A, Tantbirojn D, Pintado MR, DeLong R, Douglas WH. Residual shrinkage stress distributions in molars after composite restoration. *Dent Mater.* 2004;20(6):554-564. doi:10.1016/j.dental.2003.05.007
24. Karbhari VM, Wang Q. Influence of triaxial braid denier on ribbond-based fiber reinforced dental composites *Dent Mater.* 2007;23(8):969-976. doi:10.1016/j.dental.2006.08.004
25. Oskoee PA, Ajami AA, Navimipour EJ, Oskoee SS, Sadjadi J. The effect of three composite fiber insertion techniques on fracture resistance of root-filled teeth. *J Endod.* 2009;35(3):413-416. doi:10.1016/j.joen.2008.11.027
26. Eronat N, Candan U, Türkün M. Effects of glass fiber layering on the flexural strength of microfill and hybrid composites. *J Esthet Restor Dent.* 2009;21(3):171-181. doi:10.1111/j.1708-8240.2009.00259.x
27. Sengun A, Cobankara FK, Orucoglu H. Effect of a new restoration technique on fracture resistance of endodontically treated teeth. *Dent Traumatol.* 2008;24(2):214-219. doi:10.1111/j.1600-9657.2007.00538.x
28. Garoushi S, Mangoush E, Vallittu M, Lassila L. Short fiber reinforced composite: a new alternative for direct onlay restorations. *Open Dent J.* 2013;7:181-185. doi:10.2174/1874210601307010181
29. Opdam NJM, Van De Sande FH, Bronkhorst E, et al. Longevity of posterior composite restorations: a systematic review and meta-analysis. *J Dent Res.* 2014;93(10):943-949. doi:10.1177/0022034514544217
30. Çakır NN, Demirbuğa S. Restoratif diş hekimliğinde bulk fill kompozit rezinler. *Sagl Bil Derg.* 2019;28(3):188-193. doi:10.34108/eujhs.368759
31. Dourado Loguercio A, Roberto de Oliveira Bauer J, Reis A, Miranda Grande RH. In vitro microleakage of packable composites in class II restorations. *Quintessence Int.* 2004;35(1):29-34.

32. Egilmez F, Ergun G, Cekic-Nagas I, Vallittu PK, Lassila LV. Short- and long-term effects of additional post curing and polishing systems on the color change of dental nano-composites. *Dent Mater J.* 2013;32(1):107-114. doi:10.4012/dmj.2012-251
33. Azeez GM, Çekiç Nagaş I. Aşırı harabiyet gösteren endodontik tedavili dişlerin protetik restorasyonları. *7tepe Klin Derg.* 2019;15(2):231-241. doi:10.5505/yeditepe.2019.36449
34. Güven MÇ, Yıldırım G. Endokron restorasyonlar. *Selcuk Dent J.* 2019; 6(2):201-205. doi:10.15311/selcukdentj.339075
35. Davidowitz G, Kotick PG. The use of CAD/CAM in dentistry. *Dent Clin North Am.* 2011;55(3):559-ix. doi:10.1016/j.cden.2011.02.011
36. El-Mowafy OM, Rubo MH, El-Badrawy WA. Hardening of new resin cements cured through a ceramic inlay. *Oper Dent.* 1999;24(1):38-44.
37. Veselinović V, Todorović A, Lisjak D, Lazić V. Restoring endodontically treated teeth with all-ceramic endo-crowns: case report. *Stomatol Glas Srbije.* 2008;55(1):54-64. doi:10.2298/SGS0801054V
38. Tzimas K, Tsiafitsa M, Gerasimou P, Tsitrou E. Endocrown restorations for extensively damaged posterior teeth: clinical performance of three cases. *Dent Endod.* 2018;43(4):e38. doi:10.5395/rde.2018.43.e38
39. El-Damanhoury HM, Haj-Ali RN, Platt JA. Fracture resistance and microleakage of endocrowns utilizing three CAD-CAM blocks. *Oper Dent.* 2015;40(2):201-210. doi:10.2341/13-143-L
40. Belleflamme MM, Geerts SO, Louwette MM, Grenade CF, Vanheusden AJ, Mainjot AK. No post- no core approach to restore severely damaged posterior teeth: an up to 10-year retrospective study of documented endocrown cases. *J Dent.* 2017;63:1-7. doi:10.1016/j.jdent.2017.04.009
41. Rocca GT, Krejci I. Crown and post-free adhesive restorations for endodontically treated posterior teeth: from direct composite to endocrowns. *Eur J Esthet Dent.* 2013;8(2):156-179.
42. Zoidis P, Bakiri E, Polyzois G. Using modified polyetheretherketone (PEEK) as an alternative material for endocrown restorations: a short-term clinical report. *J Prosthet Dent.* 2017;117(3):335-339. doi:10.1016/j.prosdent.2016.08.009
43. Fages M, Bennasar B. The endocrown: a different type of all-ceramic reconstruction for molars. *J Can Dent Assoc.* 2013;79:d140.
44. Cekic-Nagas I, Ergun G, Egilmez F, Vallittu PK, Lassila LVJ. Micro-shear bond strength of different resin cements to ceramic/glass-polymer CAD-CAM block materials. *J Prosthodont Res.* 2016;60(4):265-273. doi:10.1016/j.jpor.2016.02.003
45. Fasbinder DJ. Digital dentistry: Innovation for restorative treatment. *Compend Contin Educ Dent.* 2010;31:2-11.
46. Cakmak G, Donmez MB, Cuellar AR, Kahveci C, Schimmel M, Yilmaz B. Additive or subtractive manufacturing of crown patterns used for pressing or casting: a trueness analysis. *J Dent.* 2022;104221. doi:10.1016/j.jdent.2022.104221
47. Anadioti E, Kane B, Zhang Y, Bergler M, Mante F, Blatz MB. Accuracy of dental and industrial 3D printers. *J Prosthodont.* 2022;31(S1):30-37. doi:10.1111/jopr.13470
48. Jockusch J, Özcan M. Additive manufacturing of dental polymers: an overview on processes, materials and applications. *Dent Mater J.* 2020; 39(3):345-354. doi:10.4012/dmj.2019-123