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Case report

The Role of Porcelain Veneers in The Aesthetic Restoration of Discolored Endodontically Treated Teeth

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Abstract: Discoloration of endodontically treated teeth poses a significant aesthetic concern for many individuals, impacting their confidence and self-image. Ceramic veneers have emerged as a popular solution for the aesthetic restoration of such teeth. This paper explores the role of ceramic veneers in addressing tooth discoloration, examining their efficacy, durability, and aesthetic outcomes, via a clinical case. Various factors influencing the selection of ceramic veneers as a treatment modality, including shade matching, preparation techniques, and adhesive bonding, are discussed. Additionally, advancements in materials and techniques have enhanced the versatility and aesthetic appeal of ceramic veneers, making them a valuable option for achieving natural-looking and durable aesthetic restorations in individuals with discolored endodontically treated teeth.

Keywords: ceramic veneer; aesthetic; discolored teeth; restoration; endodontically treated teeth

1. Introduction

Many different materials and treatment options are available in restorative aesthetic dentistry for the anterior aesthetic zone. One of the most common therapeutic approaches is the use of ceramic veneers. The high aesthetic performance, excellent biocompatibility of ceramic materials, advancements in bonding techniques with dental tissues, and the longevity of restorations have made ceramic veneers a reliable treatment solution for the anterior aesthetic zone, despite being a sensitive clinical and laboratory process [1–7]. The use of veneers is primarily indicated for restoring anterior teeth with abrasions, fractures, tooth decay, enamel defects, hypoplasia, or replacing old and extensive resin composite fillings that have been retreated or do not have satisfactory aesthetic results. Ceramic veneers can also be used to change the shape of teeth or close spaces, often in combination with orthodontic treatment. Additionally, they provide aesthetic solutions for cases of discolored teeth due to tetracycline use, fluorosis, or endodontic treatment. The use of ceramic veneers for the aesthetic restoration of discolored endodontically treated teeth in the anterior aesthetic zone, although not a very common technique, is gaining ground in aesthetic dentistry due to its conservative nature compared to placing a full crown [8–11].

This paper presents the use of ceramic veneers for the aesthetic restoration of endodontically treated teeth that have undergone discoloration, examining their efficacy, durability, and aesthetic outcomes, via a clinical case.

2. Clinical Case

A 43-year-old woman presented at the private dental clinic due to discoloration of tooth 11. (Figure 1) The patient reported that this tooth had undergone endodontic treatment five years ago. The patient's general medical history was clear, with no underlying diseases. The overall clinical condition of the patient's teeth was good, and the condition of the periodontal tissues was satisfactory. An X-ray examination was performed to assess the quality of the endodontic treatment of the specific tooth, which was found to be satisfactory. The patient was presented with all alternative treatment

options, and it was ultimately decided to restore the specific discolored tooth with a ceramic veneer, following internal bleaching to reduce the degree of discoloration.



Figure 1. Intraoral photograph at the first visit.

The tooth was opened on the palatal surface, and the pulp chamber was cleaned from the remnants of the endodontic treatment material. After sealing the root canal orifice with glass ionomer cement, the ready-to-use whitening gel (active ingredient: 35% H₂O₂) was applied directly into the pulp chamber using a special syringe, and the cavity was hermetically closed with temporary filling material. Four days later, the patient was recalled to assess the progress of the whitening. During the recall appointment, the temporary filling was removed, the cavity was cleaned from the whitening agent, and then the whitening agent was reapplied, followed by temporary filling for an additional 3 days. The final result of the internal whitening is depicted in Figure 2.



Figure 2. The final result after the internal bleaching of the tooth.

After the internal bleaching procedure, tooth preparation for the ceramic veneer followed. Before the preparation, a diagnostic wax-up was performed to serve as a reference point. The preparation was limited to the buccal surface, and the amount of tooth substance removal was kept to a minimum. Specifically, no more than 0.5-1 mm of tooth structure was removed to preserve enamel across almost the entire preparation, ensuring both mechanical retention and bonding capability with the ceramic veneer. Preparation was performed using the guided depth cutting technique with L.V.S. diamond burs (Laminate Veneer System, Komet Co). The cervical margin of the preparation was defined at the

gingival level in a chamfer shape. The preparation extended towards the adjacent surfaces but stopped short of the contact points with neighboring teeth to preserve them intact. Additionally, there was a reduction of the incisal edge by 1.5 mm through a reverse beveling of the enamel. This created a larger enamel surface, necessary for better bonding and resistance in an area subject to significant stress. Finally, all undercuts and sharp edges were smoothed out during the final stage of preparation.

After the preparation was completed, retraction cord was placed and the final impression was taken (Figure 3). The double-mix impression technique was employed using addition silicone materials. Following disinfection, the final impression was digitized using a tabletop scanner (extraoral), and the laboratory process for fabricating the ceramic veneer proceeded using digital methods (Cad-Cam). The prosthetic design initiates by delineating the finish line and determining the insertion axis. Subsequently, a virtual wax-up is created utilizing a database of dental morphologies, considering specific criteria like the cervical margin, material thickness, antagonist teeth, etc. This is succeeded by the computer-aided manufacturing process (CAM), facilitating the fabrication of the complete prosthetic veneer in full translucent zirconia 5Y TZP.



Figure 3. The tooth before the final impression.

After the fabrication of the ceramic veneer, it was clinically evaluated to assess its marginal fit and aesthetic outcome, followed by its bonding in the patient's mouth. Zirconia veneer was prepared for bonding with 50- μ m Al₂O₃ airborne-particle abrasion at 0.1 MPa air pressure for 10 seconds. Ceramic primer containing silane and MDP monomer (Monobond Plus, Ivoclar Vivadent AG) was applied to the veneer and then dried with oil-free air. The enamel tooth surfaces were treated with 37% phosphoric acid (Total Etch Gel, Ivoclar Vivadent AG) for 15 seconds, rinsed with water, and airdried. Bonding agent (Adhese Universal, Ivoclar Vivadent AG) was applied and light-polymerized for 10 seconds. Light-polymerized resin cement (Variolink Esthetic LC, Ivoclar Vivadent AG) was applied with the applicator tip to the intaglio of the veneers and evenly spread with a microbrush. The restoration was placed on the tooth and seated under firm finger pressure to achieve the desired cement thickness. An oxygen inhibiting gel (Liquid Strip, Ivoclar Vivadent AG) was applied after excess cement was removed. The natural and aesthetic appearance of the prostheses was very satisfactory for the patient. (Figure 4)



Figure 4. The final result.

3. Discussion

Treating aesthetic and functional issues of the aesthetic zone with ceramic veneers is one of the most prevalent therapeutic approaches. Ceramic veneers offer a predictable solution for conservative restorations of the facial surface of anterior teeth, serving as an alternative to full crowns and direct composite resin restorations. Their main advantages include excellent biocompatibility, high aesthetic performance, and the conservative nature of tooth preparation.

One indication for ceramic veneers is the aesthetic restoration of discolored teeth. The presence of discolorations in the anterior aesthetic region of the dental arches constitutes one of the most significant aesthetic problems and concerns an increasing percentage of patients nowadays. They have a negative impact on self-esteem, external appearance, interpersonal relationships, and the projection of one's image to the social environment [12,13]. Endodontically treated teeth often exhibit changes in color, particularly in the challenging area of the clinical cervical region, leading dentists to opt for the restoration of these teeth with full-coverage crowns [14,15]. Ceramic veneers provide a reliable and conservative alternative in these cases, as there is no need for preparation of the palatal or lingual surfaces of the teeth, while the preparation of the facial surface is limited to 0.5-1 mm.

For better aesthetic results, in cases of intrinsic discoloration, an internal tooth whitening procedure may precede, as was done in this specific case. Applying whitening techniques to discolored endodontically treated teeth achieves their decolorization, thus facilitating the dentist in their aesthetic restoration. Whitening endodontically treated teeth is a minimally invasive solution for improving their color [14–16]. The materials causing discoloration typically consist of organic residues with extensive carbon chain monomers or dimers, often containing complexes of atoms from other chemical elements, phenylic and carbonylic rings, generally referred to as chromophore groups. Whitening agents act as oxidative agents on these chromophore groups, modifying the polarity and shape of the discolored molecules [17]. Clinical examination should be accompanied by radiographic evaluation of endodontic treatment. Root canal obturation should be adequate in height and width to prevent bacterial microleakage and the spread of whitening agents to periapical tissues [18,19]. Endodontically treated teeth should be asymptomatic, with the absence of clinical and radiographic findings indicative of periapical lesion development [19]. The application of hydrogen peroxide (H_2O_2) for whitening endodontically treated teeth was first reported by Harlan [20]. The mechanism of action of hydrogen peroxide is quite complex. Its target molecules are the chromophoric organic compounds responsible for discoloration. Its strong oxidizing action leads to the formation of active oxygen radicals and peroxide anion compounds. The oxidation products act on the chromogenic compounds, breaking them down into smaller, colorless, and more soluble molecules [19–22].

Various types of ceramic materials are recommended for making veneers, including lithium disilicate, feldspathic ceramic, feldspathic ceramic reinforced with leucite, and lithium silicate reinforced with zirconia [23–26]. These ceramics are prized for their high translucency, owing to their

abundant glass matrix content, which ensures pleasing aesthetics. Moreover, they exhibit strong adhesion to adhesive agents following conditioning with hydrofluoric acid (4-10%) and subsequent silanization [27]. Consequently, these ceramics are preferred for veneer production [23,24]. Nonetheless, they come with certain limitations, particularly their inability to effectively conceal significant dental discolorations and their increased fragility when reduced in thickness [25].

Alternatively, ceramics with a high crystalline content, such as yttria-stabilized tetragonal zirconia polycrystals (Y-TZP), were initially primarily utilized for framework fabrication, given their notable fracture resistance and capacity to conceal substrate discolorations [27]. However, computer-aided design and computer-aided manufacturing (CAD-CAM) technology and the improved translucency of recently developed high strength monolithic zirconia have made them clinically acceptable for bonded restorations [27,28]. The higher translucency is achieved by altering the grain size and sintering temperature and by adding more yttria to reduce the residual pores and reduce the impurities [27,28]. Also, in recent years, several manufacturers have enhanced the composition of Zr to create a polychromatic multilayer, aiming to mimic the shade gradient observed in natural teeth. This design involves the incisal portion of the veneer being the most translucent, with chroma and opacity increasing gradually towards the gingival portion [29,30]. Initially, pre-shade layers of the same Zr composition were created to form a polychromatic multilayer, presenting as uniform Zr. It has been indicated that the only difference among the various layers of this uniform multilayer zirconia material is the pigment composition, leading to distinct shades while maintaining similar translucency [29,30]. Following that, ultra-translucent Zirconia (Zr) materials were introduced, featuring distinct microstructures among the layers. These included Tetragonal Zirconia Polycrystals (TZP) and Partially Stabilized Zirconia (PSZ) layers with diverse compositions and properties, resulting in the development of a polychromatic multilayer hybrid composition of Zirconia [30,31]. The varying Yttrium content and chemical composition of the layers result in diverse formulations, leading to differences in the physical properties within the material. Consequently, several manufacturers suggest that advancements in different grades of ultra-translucent Zirconia have made monolithic translucent Zirconia a feasible choice for restoring anterior teeth with indirect veneer restorations [32,33].

In contrast to lithium disilicate veneers, achieving strong bonding to zirconia has presented greater challenges. Polycrystalline zirconia is chemically inert and not susceptible to attack by hydrofluoric acid, resulting in less effective adhesion compared with silica-based ceramics [34]. So, studies indicate that a combination of micromechanical and chemical pretreatment is essential for establishing durable resin bonds with zirconia restorations over the long term. Airborne-particle abrasion using Al_2O_3 is effective in creating mechanical bonds, while an adhesive resin cement or a ceramic primer containing monomers like 10-methacryloyloxydecyl dihydrogen phosphate (MDP) is advised for achieving chemical bonding to zirconia [35–38]. According to research by Blatz et al., the APC Zr Bonding Concept is a useful technique for creating strong, durable resin bindings to Zr [39]. The three primary processes of zirconia cementation are referred to as the APC Zirconia Bonding Concept [39]:

Step A: The process entails air-abrading the entire surface of the zirconia intended for bonding. This is achieved using either plain alumina particles or alumina particles coated with silica.

Step B: MDP or phosphate-monomer-based primer is applied to the air-abraded zirconia surfaces.

Step C: Utilizes a dual-cure adhesive composite to guarantee thorough polymerization of the composite beneath the zirconia restoration.

A case series with a follow-up period of up to five years has shown a 100% survival rate for ultra-translucent Zirconia veneers bonded with adhesive resin cement after airborne particle abrasion and silica coating. No noticeable failures such as debonding, veneer fracture, or secondary caries were observed [40–42]. Additionally, when bonded with a resin-based adhesive system, the fracture resistance of monolithic all-ceramic restorations is increased compared to conventional cementation methods [42,43].

4. Conclusions

Based on all the aforementioned, we can draw the following conclusions:

- Ceramic veneers provide a reliable and conservative alternative for the aesthetic restoration of endodontically treated teeth that have undergone discoloration.
- For better aesthetic results, in cases of intrinsic discoloration, an internal tooth whitening procedure may precede.
- Considering bonding and cementation, adhesively cemented high translucency monolithic zirconia seems to be a suitable option for veneers.

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