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Review Article

Differences between ceramic and porcelain laminate veneers

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ABSTRACT

In dental care, treating anterior dentition esthetically has always been difficult. Numerous restorative solutions, including resin composites, all-ceramic crowns, and ceramic veneers, become accessible with the advancement of dental materials. In such situations, practitioners and patients should pick the most appropriate option to enhance oral health and aesthetic outcomes. Any substance made of non-metallic inorganic matter and fired at an elevated temperature is referred to as ceramics (pyrochemical process). Ceramics called glass ceramics are those that commence in a glassy phase and later devitrify to a partly or wholly crystalline form. Dental ceramics that most closely optically resemble the characteristics of real teeth are primarily glassy materials, which are derived primarily from triaxial porcelain compositions of feldspar, quartz, and kaolin. Glass-ceramics possess much more toughness and strength than porcelain but are also less translucent. Tougher and more durable ceramics, primarily yttrium stabilized tetragonal zirconia polycrystals, have been developed recently (Y-TZP). Due to its limited translucency, Y-TZP presents a major drawback. A significant amount of current tooth structure must be removed in order to allow for a porcelain veneer that is wide enough to overlay an opaque zirconia base and replicate the optical characteristics of the surrounding natural teeth. Ceramic restoration effectiveness, in the end, relies on the material choice, production process, and restoration strategy.

Keywords: Ceramic, Porcelain, Laminate, Veneer

INTRODUCTION

In dental care, treating anterior dentition esthetically has always been difficult. Numerous restorative solutions, including resin composites, all-ceramic crowns, and ceramic veneers, become accessible with the advancement of dental materials. In such situations, practitioners and patients should pick the most appropriate option to enhance oral health and aesthetic outcomes. When there is sufficient healthy dental structure along with anterior teeth wear, ceramic laminate veneers may be recommended. Owing to their color stability, non-toxicity, structural capabilities, and aesthetic results, this restorative therapy has been widely adopted.[1] Any substance made of non-metallic inorganic matter and fired at an elevated temperature is referred to as ‘ceramics’ (pyrochemical process). Ceramics called glass ceramics are those that commence in a glassy phase and later devitrify to a partly or wholly crystalline form. The more specific name ‘porcelain’ designates ceramics made of kaolin, quartz, and feldspar.

Effective restorations require the concept of minimally invasive restorative treatment.[2,3] Ceramic laminate veneers with a nominal width have, therefore, been recommended more frequently. However, these aesthetic procedures must not be carried out without adequate restorative plan. The load to failure of ceramic veneers is significantly influenced by the prepared design and the extent of residual tooth structure.[4] A planned approach could help with the cosmetic procedure and create aesthetically pleasing smiles. To increase therapeutic effectiveness, the clinic and laboratory personnel need to adhere to a correct methodology. In order to determine the proper bonding technique that will promote longevity of the restorations, the physician must have a strong grasp of the ceramic variety.[5]

METHODOLOGY

This study is based on a comprehensive literature search conducted on 27 November 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the differences between ceramic and porcelain laminate veneers. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Dental ceramics that most closely optically resemble the characteristics of real teeth are primarily glassy materials, which are derived primarily from triaxial porcelain compositions of feldspar, quartz, and kaolin.[6,7] The advancement of vacuum firing techniques in 1949, the production of the high-speed handpiece, the recognition of elastomeric impression materials, the introduction of pressing and CAD/CAM methods in the 1980s, and many other technological advancements have all helped to contribute to the usage of porcelain in fixed prosthodontics.[8] From a materialistic perspective, porcelain compositions have changed from the original hard-paste Meissen porcelain, that had more clay and needed to be fired at an elevated temperature, to the contemporary soft-paste porcelains, which are primarily made of feldspar and lack kaolin or quartz and possess superior translucency. The therapeutic applications of dental porcelains with the most appealing aesthetics are, even though, severely constrained by their poor strength and high susceptibility to crack progression.[9-11] A significant development was the creation of a leucite-containing porcelain that could be burned directly onto ordinary dental metals in 1962.[7] Potassium alumino-silicate is the main component of the rock-forming mineral known as leucite. Leucite has a tetragonal form when it is at room temperature. But around 625°C, the crystalline form changes from a tetragonal to a cubic phase. This leads to a volumetric expansion by 1.2% during this phase change, producing a high coefficient of thermal expansion (20-25×10-6/°C).[12] Contrarily, the coefficient of thermal expansion of feldspar glass is rather modest (~8×10-6/°C). Consequently, porcelain frits with mean coefficients of thermal expansion approaching those of dental alloys (12-14×10-6/°C) can be created by adjusting the ratios of leucite and feldspar glass. When porcelain veneer and metallic alloy coping cool from firing temperatures, harmful thermal stress is prevented by harmonizing coefficients of thermal expansion amongst them. In reality, dental manufacturers have found that giving the porcelain a little lesser coefficient of thermal expansion than the metal (usually a difference of less than 1×10-6/°C) can somewhat compact the porcelain, enhancing the restoration's fracture-resistant properties.

Leucite composition can range from few weight percent when combined with ceramic frameworks to 17 g% to 25 g% when combined with typical metallic alloys to customize the coefficient of thermal expansion of porcelain. Because a substantial amount of leucite (upto 35 g% to 50 g% can be added to feldspar glass without considerably affecting its translucency, leucite is also a useful material for improving the dispersal of feldspar glass. This is so since the reflecting index of feldspar glass (n= 1.52-1.53) and leucite (n= 1.51) are practically identical. Additionally, the leucite-comprising feldspar glasses can be acid-etched to produce micromechanical properties for resin bonding, increasing the restorations' fracture toughness. This is possible due to the preferred etching of crystalline leucite compared to the glass matrix. Leucite feldspathic porcelain products continue to rank among the most popular and aesthetically pleasing dental ceramics. Inlay, onlay, partial crown, crown, and veneer for ceramics and metals are among their clinical indications. According to clinical research, when bound to and maintained predominantly by enamel components, feldspathic porcelain restorations offer good long-term effectiveness. This class of materials is best suited for situations when there is still a sizable portion of sound tooth structure as well as enamel.[9]

Glass-ceramics possess much more toughness and strength than porcelain but are also less translucent. Through a technique known as ‘ceraming’, crystals precipitate from homogeneous glass via the nucleation and growth mechanisms under regulated thermal treatments to strengthen and toughen glass-ceramics.

The first glass-ceramic material utilized to create dental restorations was called dicor. It was made up of crystalline fluormica that were implanted in a glass matrix as separate sheets or plates. Microstructurally, it is akin to a house of cards, and offers an interlocking process to strengthen. Dicor was, though, withdrawn from the marketplace because of its generally subpar mechanical behavior when applied clinically. The present ‘ceraming’ procedure is also used to create certain leucite reinforced glasses. But, by reinforcing lithium disilicate, dental glass-ceramics of the highest grade of strength and toughness have been introduced to the marketplace. A basic glass structure of SiO_2-Li_2O-Al_2O_3-K_2O-P_2O_5-ZnO-La_2O_3 had been utilized to create the primary dental lithium disilicate ceramic, along with certain additions for coloration and fluorescence. The process involved heating a homogenous foundation glass ingot with a slight volume of lithium meta-silicate until it became viscous, then pressing it into a mold. A glass-ceramic with around 70% vol% of lengthened crystalline lithium disilicate could undergo precipitation from the parent glass through skillfully regulated heating, resulting in microstructural interlocking.

The final product had flexural strength of 350 MPa and fracture toughness of 2.9 MPam1/2, that were more than twofold as strong as glass-ceramics made of leucite. Under the label IPS Empress 2, the product was sold to be utilized in dental frameworks. Nonetheless, this product had a greater likelihood for fraying the framework in the connector region of short-span posterior fixed partial dentures and had poorer therapeutic failure rates of 9 to 50% beyond 24 to 60 months.[13-15] These results point to the product's inadequate flexural strength for multi-unit partial dentures. Later, a novel and superior lithium disilicate glass-ceramic (IPS e.max) was created with a vastly greater flexural strength (440-480 MPa). Both the performance of the first glass-ingot and the core glass composition were improved to achieve the advancements (with fewer flaws and reduced porosity). The new glass formulation (SiO_2- Li_2O-Al_2O_3-K_2O-P_2O_5-ZrO_2) featured up to 4 wt% ZrO2 additions, but the ZnO and La_2O_3 contents (0.1 wt%) decreased in comparison to the core glass for IPS Empress 2. The Press and CAD versions of the IPS e.max glass-ceramics were available, each corresponding to a different processing environment.[16,17] The IPS e.max Press ingots are heated for 20 minutes at 920°C.

The intermediary lithium meta-silicate glass-ceramics, that are simpler to process into shape, are first formed by heat treating the IPS e.max CAD ingots. The lithium meta-silicate glass-ceramic is then fired to 840°C for 7 min, during which time it changes into a lithium disilicate glass ceramic that has both, higher chemical stability and aesthetic superiority. In the glass matrix of lithium disilicate Press and CAD, there are roughly 70% lengthened, needle-like crystals. The crystallites in the Press grade are around 4 m long, 0.6 m wide, and relatively aligned perpendicular to the surfaces externally, whereas the crystallites in the CAD grade have approximately 1 m length, 0.4 m width, and more random orientation. Since the coarser grains present a stronger barrier to crack propagation, the Press grade demonstrates somewhat better toughness. Yet, as these same grains generate greater initial faults structurally, they also lead to marginally lesser strength. Lithium disilicate glass-ceramics are recommended for laminates, anterior crowns, as well as posterior inlays and onlays. Furthermore, they are also appropriate for solitary, full coverage crowns for posterior dentition when fashioned to monolithic restorations and cemented with resins. Lithium disilicate Press' sizeable, elongated particles are also believed to increase fracture resistance by crack bridging and deflecting. In particular, lengthened crystals are selectively orientated along to the tensile surface in the connector regions of a fixed partial denture. Such a ‘logs on the river’ configuration can significantly increase the unit's fracture toughness. Lithium disilicates can be used as individual units across the oral cavity and as short-span fixed partial dentures in the anterior portion.[18]

Tougher and more durable ceramics, primarily yttrium stabilized tetragonal zirconia polycrystals, have been developed recently (Y-TZP). However, due to its limited translucency, Y-TZP has serious therapeutic shortcomings. Zirconia's opacity causes issues, particularly when anterior crowns or short-span fixed partial dentures are used in the midst of healthy teeth. The reflectivity and light dispersion in the situation do not seem normal. A significant amount of current tooth structure must be removed in order to allow for a porcelain veneer that is wide enough to overlay an opaque zirconia base and replicate the optical characteristics of the surrounding natural teeth. Additionally, academic trials and usage have shown that although zirconia frameworks are relatively immune to fracture, porcelain veneers often get chipped and delaminated.[19,22-24]

In 25 clinical trials, chipping and delaminating were generally observed at 6% to10% in three to five years for individual crowns and 20% to 32% in five to ten years for fixed partial dentures made of various brands and types of zirconia.[25-27] Contrarily, fracture rates for crowns and fixed partial dentures with metallic frameworks ranged from 2.7% to 6% during a 15-year period, showing noticeably decreased rates of fracture.[28,29] The lower heat conductivity of the zirconia center comparative to the metallic coping is one of the main causes of the porcelain-veneered zirconia bilayer prostheses' subpar therapeutic effectiveness. This could lead to a significant temperature difference in the porcelain veneer upon cooling, and as a consequence, residual thermal stresses might be trapped into the material structure.[30] Although it is clear that these remnant stresses are the primary cause of the greater chipping/fracture incidences, a thorough understanding of the regulating material (elastic modulus and coefficient of thermal expansion), design (veneer/core thickness ratio), and processing (cooling rate) characteristics is still widely lacking.[30-33] Therefore, studies in this field are still ongoing. In complete arch restorations, posterior crowns, and fixed partial dentures, monolithic zirconia is frequently utilized to prevent delaminating and development of chips.[34-36] Even though the whitish, opaque monolithic Y-TZP restorations may be appropriate for whitened teeth, the opacity of Y-TZP zirconia continues to be a severe problem in all of these situations.[37]

Nevertheless, closer inspections have shown that commercially. Available translucent Y-TZP restorative materials are mostly opaque unless they are fine (i. e.; 0.5 mm).[38] Pores and impure constituents must be removed in addition to one another in order to considerably increase Y-TZP's translucency. Since the refraction index in tetragonal zirconia is birefringent, it exhibits anisotropy in several crystallographic planes.[37,39] As a result, light transmittance is decreased near grain boundaries due to reflecting and refracting. Theoretically, a sub-100 nm grain size is required for a Y-TZP ceramic to be adequately translucent while maintaining strength, allowing light to pass through without significant dispersion.[37,39] Technology-wise, it is difficult to densify without significant grain development above the crucial 100 nm size. The present solution to this issue is mixing a normally tetragonal material with a cubic zirconia phase with optical isotropy. In contrast to its tetragonal sibling, biphasic tetragonal/cubic zirconia is poorer and more fragile. For example, Zpex Smile's flexural strength and fracture toughness (609 MPa and 2.4 MPa m1/2) are only slightly higher than Y-TZP's. In actuality, they exhibit low-temperature deterioration and resemble Procera alumina from Nobel Biocare more closely.[12,40]

Increasing the number of yttria generally results in more cubic phase and hence more translucency. As the cubic content rises, it becomes weaker in exchange. As a result, a number of translucent dental zirconia materials with different proportions of cubic phase have been developed. For instance, the flexural strength of the Katana ultra-translucent zirconia material is 557 MPa, while that of their super-translucent and high-translucent zirconia is 748 MPa and 1125 MPA, correspondingly. These translucent zirconia pucks also have multi-layered color, with two fairly thin transition layers interspersing a lighter shade in the occlusal third of width and a darker tint in the gingival third. These multilayer constructions' mechanical integrity has not yet been tested though.

CONCLUSION

Ceramic and porcelain laminates and veneers are made to be aesthetically pleasing, biocompatible, and chemically durable. The clinical indications of distinct classes of dental ceramics are determined by the composition, microstructure, and characteristics of ceramics. The restorative layer's width, remaining stresses, contact settings, tooth size and shape, modulus of elasticity of the adhesives and substrate (enamel or dentin), and surface condition are additional aspects that affect material choice. Ceramic restoration effectiveness, in the end, relies on the material choice, production process, and restoration strategy.

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