Effect of Different Surface Pre-Treatments and Veneering Techniques on Shear Bond Strength of Peek Copings: In Vitro Study.

Waad Alomran[1], , Mohammed AlQahtani[1], Hibah AlJutayli [2]

[1] King Saud University, College of Dentistry, Department of Prosthodontics. [2] Dentist, Private sector practitioner.

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Introduction:

Polyetheretherketone (PEEK) is a high-temperature polymer of the family of polyaryletherketone. It is a semicrystalline thermoplastic consisting of an aromatic backbone molecular chain, interconnected by ketone and ether functional groups. The ease of its use, preparation and behavior as a physiologically inert material promotes its applications in various medical devices specially in orthopedics because of its excellent chemical, mechanical, and thermal properties. Its high strength in combination with adequate milling and grinding properties. (Stawarczyk et al., 2015, Toni et al., 2015) Applications of PEEK In dentistry, its used for interim abutments, implant-supported bars, clamp material, dental implants and obturators (Najeeb et al., 2016). PEEK is unsuitable for the fabrication of full counter monolithic esthetic dental restorations they have an opaque color. Thus, To meet a satisfactory esthetics; veneering is required. Essentially, through establishing a durable bonding to ensure an adequate functional outcome and long-term stability.

Objective

The purpose of this study is to evaluate the shear bond strength of PEEK copings that is surface treated and veneered with different materials and techniques in both artificial aging and non-aging conditions.

Materials and Methods:

90 PEEK copings were surface treated with five surface treatments; (A) No treatment (B) Sandblasting with alumina; mean particle size of 50 µm (C) Sandblasting with alumina; mean particle size of 110 µm (D) Acid-etching with sulfuric acid (98%) figure 1. (E) Acid-etching with sulfuric acid (98%) with silane coupling agent. Followed with ceramic veneering using the layering technique with low fusing temperature feldspathic porcelain, lithium disilicate ceramic ingot and leucite glass-ceramic ingot. Both PEEK and ceramic disks were bonded together using RelyX TM unicem self-adhesive resin cement (3M ESPE) figure 2. Half of each veneered PEEK group was artificially aged in a computer-controlled dual-axis artificial oral environment (Thermocyler). All aged and non-aged specimens were loaded compressively in a universal testing machine and the maximum load before debonding was measured, shear bond strength was then determined figure 3.

Figure 1 , Sandblasting the PEEK disks with alumina; mean particle size of 50 µm and 110 µm.

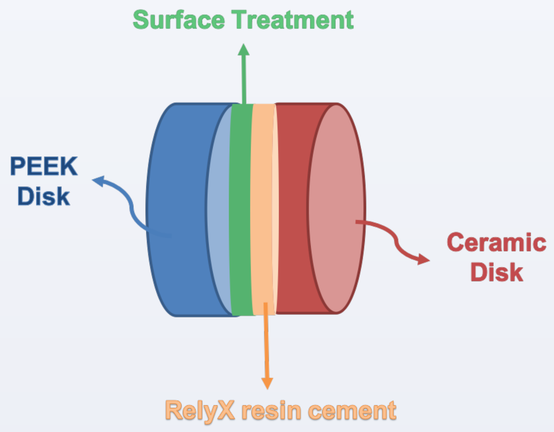


Figure 2 , The final apparatus of the sample ready for artificial aging and testing.

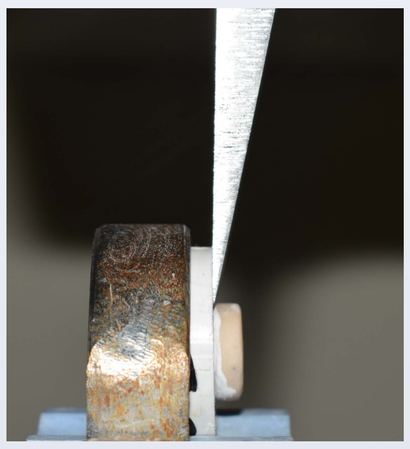


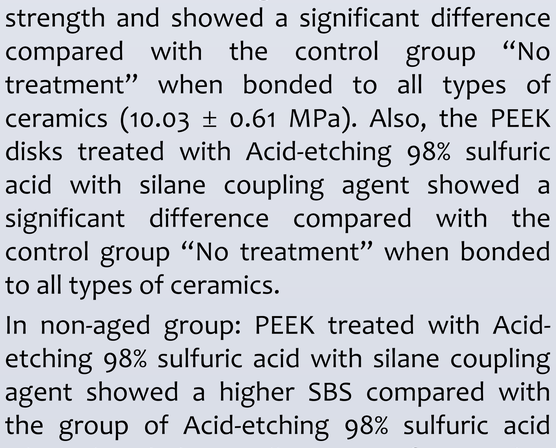
Figure 3 , Specimens were loaded compressively in a universal testing machine **(Instron).** The load was applied with a cross-head speed **of 2mm / min.**

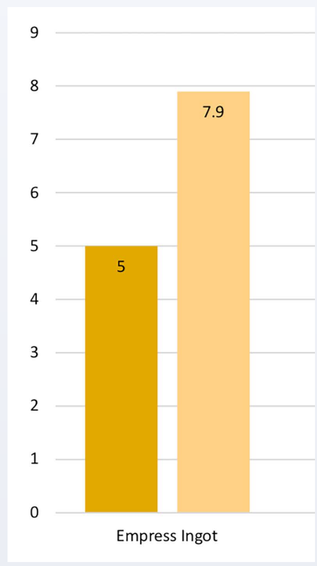
Results

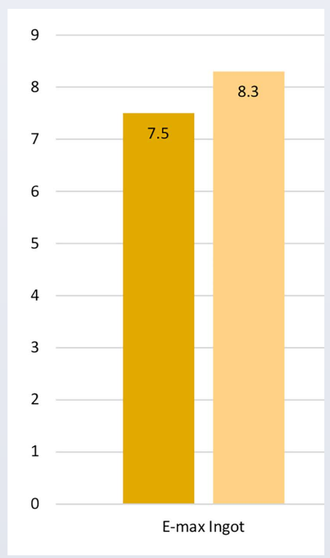
PEEK group treated with acid-etching (98% sulfuric acid and Monobond) and bonded with lithium disilicate ceramic ingot in non-aged condition had the highest mean shear bond strength and showed a significant difference compared with the control group "No treatment" when bonded to all types of ceramics (10.03 ± 0.61 MPa). Also, the PEEK disks treated with Acid-etching 98% sulfuric acid with silane coupling agent showed a significant difference compared with the control group "No treatment" when bonded to all types of ceramics.

In non-aged group: PEEK treated with Acid-etching 98% sulfuric acid with silane coupling agent showed a higher SBS compared with the group of Acid-etching 98% sulfuric acid when bonded to all types of ceramics. However, E-max ingot was the **only ceramic type** that had no significant difference in aged group.

Difference in SBS between the acid-etched groups with 98% sulfuric acid ***with and without*** the addition of monobond veneered with different ceramic materials after artificial aging.







Discussion

The effective bonding to PEEK is a prerequisite for its use in dentistry as a prosthetic material. After the shear test in the present study, veneering ceramic were separated from the PEEK surface for every specimen group. Thus, it could be observed that the bond strength between PEEK and the veneering ceramic was weaker than the cohesive strength of the veneering ceramic. As PEEK being an inert material with high chemical resistance and low surface energy, bonding can't be achieved on its polished untreated surface (Schmidlin et al., 2010). Surface roughness was shown to enhance the adhesive techniques and therefore different surface treatments were applied to increase the surface roughness and bonding area (Rosentritt et al., 2015, Schmidlin et al., 2010). Schmidlin et al. found that the highest bond strength value out different surface treatments when the PEEK was chemically pre-treated with 98% sulfuric acid. A SBS value of 19.0 ± 3.4 MPa for RelyX Unicem was measured. Current study elicits similar results, as the highest bond strength value was found in PEEK specimens that were treated with 98% sulfuric acid with monobond. Previous study on SBS between PEEK and resin cement reported that the bond strengths of untreated specimens were not tested, because it was not possible to obtain adequate bond strength between PEEK and resin cement with an untreated surface. (Zhou et al., 2014, Hallmann L et al., 2012, Sproesser et al., 2014) However, in this study the untreated specimens were tested with the highest SBS value was 5.11±0.38 MPa when veneered with empress ceramic and the lowest value was 2.09±0.17 MPa when veneered with E-max ceramic, a significant difference was found between in SBS of different ceramics.

Conclusion:

Within the limitations of this study, it can be concluded that 98% sulfuric acid with Monobond saline coupling treatments improved the bond strength of PEEK with resin cement RelyXTM Unicem. Therefore, the null hypothesis was rejected. Comparing the pooled data of the three different veneering ceramics, IPS E-Max Press Ingot seemed suitable to bond to PEEK material. However, the use of 98% sulfuric acid is not clinically viable for the corrosive performance and considered toxic for dental office use. Thus, Bonding of Porcelain to PEEK is not applicable and more effective surface treatments of PEEK and favorable adhesives may be explored in future experimental studies.

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