



COMPARISON OF SHEAR BOND STRENGTH VALUES TO DENTIN USING DIFFERENT SURFACE TREATMENT OF PEEK BY SANDBLASTING AND ACID ETCHING TECHNIQUES

Dental Science

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ABSTRACT

Aim: To compare the shear bond strength values to dentin using different surface treatment of PEEK by sandblasting and acid etching techniques.

Methodology: In this study, sixty extracted human molar teeth (maxillary/mandibular) were collected. To remove the surface debris, extracted teeth were cleaned using ultrasonic scaler (EMS, Switzerland) and stored in 10% formalin solution. An acrylic resin block of dimensions 10mm x 10mm x 10mm was fabricated using autopolymerising acrylic resin (DPI-RR Cold Cure, India) and the teeth were embedded in the center of block up to complete submergence of the root. Two groups were made (group A and group B), each comprising of 30 blocks and colour coding was done to distinguish the groups. Group A comprised of clear acrylic resin blocks in which the PEEK surfaces were modified by acid etching and group B comprised of pink acrylic resin blocks in which PEEK surface was modified by sandblasting.

Results: Mean±SD of shear bond strength recorded for group A and B was 1.97±0.79 and 2.44±0.80 Mpa respectively with statistically significant difference as p<0.05.

Conclusion: It can therefore be concluded that surface modification with sandblasting is favored over acid etching to achieve good bonding between PEEK and dentin.

KEYWORDS

PEEK, Dentin, Acid etching, Sandblasting

INTRODUCTION:

Polyetheretherketone (PEEK) is semi crystalline high-performance polymer synthesized from aromatic dihalides and biphenolate salts via nucleophilic substitution (1). PEEK material can be sterilized by radiation and heat without structural damage thus making it an attractive biomaterial for medical use (2).

PEEK, in spite of having beneficial mechanical properties for dental prostheses, doesn't reach the standard of the esthetic demands. The material's opacity and color therefore involve a veneering layer using light-cured composite resins to improve the esthetics. To gain adequate bond strength between the veneering resins composite and the PEEK, due to low surface energy of PEEK material it requires surface treatment by sandblasting and acid etching. A recent study observed that pre-treatment of PEEK surface either with sulfuric acid or by mechanical abrasion with aluminum oxide increased the bond strength significantly (3).

Previous studies have also compared the adhesion of resin cements to PEEK with and without surface treatment to lute the restoration to dentin. These studies tested surface treatments, such as sandblasting with alumina and silica coating (Rocatec) (4). Other trials evaluated more experimental surface treatments for dental PEEK such as chemical assault with 98% sulfuric acid at distinct moments of exposure and inert plasma therapy with cold active gas. Also studied was the connection between surface treatments and the use of silane agents or adhesives. These studies found that PEEK surface therapy is appropriate for adherence to resin cement to further lute the dentin restoration (3).

Due to limited data availability, this study was undertaken to compare shear bond strength values to dentin using different surface treatment of PEEK by sandblasting and acid etching techniques.

MATERIAL AND METHOD:

This in-vitro study was taken up to evaluate the bond strength of surface modified PEEK (Polyether-Ether-Ketone) to dentin using two different techniques. In this study, sixty extracted human molar teeth (maxillary/mandibular) were collected. To remove the surface debris, extracted teeth were cleaned using ultrasonic scaler (EMS, Switzerland) and stored in 10% formalin solution. An acrylic resin block of dimensions 10mm x 10mm x 10mm was fabricated using autopolymerising acrylic resin (DPI-RR Cold Cure, India) and the

teeth were embedded in the center of block up to complete submergence of the root. Two groups were made (group A and group B), each comprising of 30 blocks and colour coding was done to distinguish the groups. Group A comprised of clear acrylic resin blocks in which the PEEK surfaces were modified by acid etching and group B comprised of pink acrylic resin blocks in which PEEK surface was modified by sandblasting.

INCLUSION CRITERIA:

Intact maxillary/mandibular molar teeth.

EXCLUSION CRITERIA:

Decayed/mutilated teeth, Restored teeth, Root canal treated tooth, Teeth with wasting disease such as attrition, abrasion, erosion and tooth with periapical pathology.

The teeth were embedded up to their roots in the center of autopolymerising acrylic resin block measuring 10mm x 10mm x 10mm. These acrylic blocks were color coded and randomly divided into two groups (30 blocks per group), according to surface treatment. The selected teeth were embedded along their long axis with the cemento-enamel junction positioned 1 mm above the top of the custom-made mounting base. The mounting base was fabricated using autopolymerising acrylic resin using a custom-made mounting template which had a slot measuring 10mm x 10mm x 10mm, into which the acrylic resin was poured in the center and selected tooth was placed into the base before the complete curing of acrylic resin, the acrylic block with mounted tooth was removed from custom made mounting base after complete setting of acrylic resin. Vertical alignment of the teeth was verified using a milling surveyor. The teeth with mounting block were kept in artificial saliva at room temperature after each procedure performed on the blocks.

Sixty PEEK disks with dimensions of 3mm diameter and 3mm thickness were prepared from breCAM. BioHPP blank (Bredent group) using CAD/CAM technology. A file for PEEK disk was designed with 3D printing software and this file was transferred to CAD software and after nesting of disk in PEEK blank, the disk was milled using milling machine (Yenadent D 43 Turkey). The PEEK disk surfaces of group A and group B were then subjected to treatment with acid etching and sandblasting respectively as under:

(A) 30 samples of group A were treated with acid-etching using

sulfuric acid (98%) for 1 min followed by careful rinsing with de-ionized water for 1 min.

(B) 30 samples of group B were treated using sandblasting with alumina for 15 s at a pressure of 2.8 bar. A distance of 1 cm was maintained between the nozzle and the surface.

Shear Bond Strength Test (SBS): After luting, samples were tested to evaluate if there were differences in SBS between PEEK and dentin depending on the use of surface treatment. Shear bond strength of specimens was tested by Universal Testing Machine (Model H 25 KS, Birmingham, United Kingdom). The device for applying shear force was mounted in the upper jaw and the prepared specimens were mounted in the lower jaw of the Universal Testing Machine. Specimens were tested in the parallel shear test, under a constant load of 5000N with a crosshead speed of 0.5 mm/min. The force was applied at the interface of the tooth surface and the bonded disc. The machine recorded the amount of force required for debonding of the disks in Newton (N). The shear bond strength was recorded by dividing the load by the bonding surface area (7.07 sqmm) and the result of SBS was measured in Mpa.

STATISTICAL ANALYSIS:

The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 24.00 for windows; SPSS inc, Chicago, USA). For each assessment point, data were statistically analysed using t test and the level of significance was set at $p < 0.05$.

RESULTS:

In the current study, mean±SD of shear bond strength recorded for group A and B was 1.97 ± 0.79 and 2.44 ± 0.80 Mpa respectively with statistically significant difference as $p < 0.05$ (table 1).

Table 1: Shear bond strength (Mpa) of Group A (Acid etching) and Group B (Sandblasting)

Shear bond strength	Mean	SD	Minimum	Maximum	Median	
Group A	1.97	0.79	0.43	3.49	1.62	
Group B	2.44	0.80	1.24	4.36	2.21	
Group	Mean	95% CI (Lower to Upper)	Df	Standard error of difference	t test	p value
A	1.97	-0.88 to -	58	0.205	2.29	0.03*
B	2.44	0.06				

*: statistically significant

DISCUSSION:

In the current study, mean±SD and median of shear bond strength recorded for group A was 1.97 ± 0.79 Mpa and 1.62 Mpa respectively. Past studies (5) have found an extremely poreful and sticky permeable surface area for PEEK, modified by 98% concentrated sulphuric acid. This led to an increase in bond power. Nevertheless, PEEK surface structure cannot be modified because of the concentration of hydrochloric acid and nitric acid. Schimidlin et al (6) noted a lack of PEEK sulfuric acid tag formation. The increase in sulfuric acid exposure time leads to increased pores. The longer the time of exposure, the worse the PEEK layer, the more coherent it may result. A higher percentage of the PEEK cohesive failures when exposed to 90, 120 or 300s is correlated in Sproesser et al (7).

In the present research, mean±SD and median of shear bond strength recorded for group B was 2.44 ± 0.80 Mpa and 2.21 Mpa respectively. Sandstorms can alter the morphology of PEEK layer, thereby enhancing the micro-mechanical interlocking and eventually the bond strength of the strutting cement to penetrate the composite material. It can be well appreciated that shear bond strength of group B (2.44 Mpa) was greater as compared to group A (1.97 Mpa) with statistically significant difference as $p < 0.05$. The findings were similar to the study done by Stawarczyk et al (8). Rocha RFV et al (3) also found similar outcomes in their study, but study did not reveal statistically significant differences.

The null hypothesis assumed for the present study was that there is no difference in shear bond strength between dentin and PEEK after surface modification of PEEK using sandblasting and acid etching techniques. It was seen in the analysis that significant difference in shear bond strength between dentin and PEEK after surface

modification of PEEK using sandblasting and acid etching. Hence, the null hypothesis is rejected.

It must be borne in mind that sulfuric acid at such a high concentration (98%) is dangerous as it can cause serious damage on contact making it very impractical to use on the chair or in the laboratory. An acceptable method could be the industrial milling and pretreatment of PEEK with 98 percent sulfuric acid. Nonetheless, pretreated surface contamination in the dental laboratory and dental office must be stopped or eliminated before bonding.

CONCLUSION:

It can therefore be concluded that surface modification with sandblasting is favored over acid etching to achieve good bonding between PEEK and dentin. Only the effect of various surface modification techniques on bond strength can be calculated on the basis of this invitro analysis, which can give an indication of the clinical phase. For human patients, for vivo trials are advised to compare the results obtained with in vitro studies in order to investigate the long-term success of PEEK under actual conditions.

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