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To evaluate the bond strength of Lithium Dislicate to Peek and Zirconia following surface treatment.

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Abstract

Background: Zirconia is a ceramic material that has been used in dentistry for crowns, bridges, implants crowns and abutments lately. Lithium disilicate is glass ceramic that has better aesthetic and optical properties than zirconia. Polye there ther ketone (PEEK) is a high-performance polymer that is increasingly used in dentistry for implant framework, implant abutment and crowns. Various surface treatment can be used to increase the bond strength between the materials. The most commonly used surface treatment is air abrasion. So this study uses a different method to increase the surface roughness.

Aim: To evaluate the efficacy of piranha solution on the bond strength between peek, zirconia and lithium disilicate material.

Materials and methods: Lithium disilicate specimen were sectioned from a block. Each specimen measuring 10mm in diameter and thickness of 2mm. Cylindrical Zirconia specimen were milled from a block with each specimen having a diameter of 10mm and thickness of 2mm.Cylindrical Peek specimens will be sectioned from a block with each specimen having a diameter of 10mm and thickness of 2mm.Group 1(12 in #)- air abraded & piranha solution treated zirconia bonded to lithium disilicate. Group 2(12 in #)- air abraded & piranha solution treated peek bonded to lithium disilicate.Peek material was surface treated with combination of air abrasion and piranha solution. Zirconia material was surface treated with combination of air abrasion and piranha solution. Peek and zirconia surface was cleaned with isopropyl alcohol after surface treatment. Lithium disilicate was treated with hydrofluoric acid and cleaned with distilled water and then bonded to peek and zirconia following manufacturers instruction using resin cement. During bonding constant pressure was applied to all specimens. After bonding the samples was placed in distilled water for 24 hours. Bond strength was tested using a universal testing machine.

Result: Shear Bond strength of Group 1 was higher- 5.978 ± 0.393 as compared to Group 2- 2.573 ± 0.274. Independent sample t test was applied to compare the shear bond strength between the groups. Independent sample t test showed statistically significant difference between the groups (p=0.001) with mean difference of 3.40.

Conclusion: The shear bond strength of Lithium Disilicate to zirconia was three times stronger than that of Lithium Disilicate to Peek.

Clinical implication: The surface treatment of abutment material with piranha solution and sandblasting can be used chairside to improve the bonding between abutment and lithium disilicate crowns.

Keywords: PEEK, UTM, EMAX, Implant, Abutment, Piranha

Introduction

Aesthetics is of main concern in anterior teeth Reha bilitation. Conventional fixed partial prosthesis uses the adjacent natural teeth for support. So implants are minimally invasive than the fixed partial prosthesis. the main material used in implants are titanium that has proven to proven to be an exceptional biomaterial, except that the grey colour of the metal can compromise appearance, especially when an implant is placed in the maxillary anterior area. The conventional implant abut Ment material is titanium, but the disadvantage is the metallic hue that will be shown through the restoration. The titanium abutment of conventional implant systems imparts a greyish shade to the peri-implant tissue. Also, metal ceramic restorations may not match the colour of natural teeth because of the metal substructure. An implant with a titanium abutment may produce dis coloration near the gingival margin, decreasing in the apical direction. So newer ceramic material are being used as abutment materials[1-3].

Zirconia is a ceramic material that has been used in dentistry for crowns, bridges, implants crowns and abutments. The successful use of zirconia as a material for dental implants is mainly contributed by its excellent osseointegration behaviour. According to the in vivo studies, zirconia has shown predictable osseointegration, cell metabolism and positive tissue response when used as a implant material. One of the advantages of zirconia is that the phase transformation inside the material increases its crack propagation resistance. So zirconia abutments are available as prefabricated form or can be custom milled according to individual needs. Zirconia can be used as a implant alone or as abutment that can be CAD CAM fabricated[1,4,5,6].

Polye there the ketone (PEEK) is a high-performance, semi crystalline thermos plastic polymer that is in creasingly used in dentistry for implant framework, implant abutment and crowns. PEEK has been increasingly used in dentistry, in part because of its bio mechanical pro parties, including acceptable strength, low solubility and water absorption, good wear characteristics, low biofilm formation, high bio compatibility and chemical inertness, no allergenicity, adequate polish ability, a modulus of elasticity similar to that of bone, and tensile properties similar to those of bone, enamel, and dentin. Various bonding protocols have been tested, but no consensus has yet been reached. However, airborne-particle abrasion of the PEEK surface with aluminium oxide followed by application of an adhesive (Visio. link; bredent medical GmbH & Co KG) has been reported to be most effective for bonding to lithium disilicate[4,7,16.]

Lithium disilicate is glass ceramic that has better aesthetic and optical properties than zirconia.LS2 is used as material for implant restoration with properties revealing a flexural strength of more than 350 MPa. CAD/CAM-technology can be ideally used for the fabrication of full-contour monolithic LS2 restorations[9.]

Various surface treatment can be used to increase the surface area intern increase the bond strength between the materials. The most commonly used surface treat Ment is air abrasion in combination with other treatments like acid etching or plasma Modifications. With newer materials like zirconia and peek abutments in the market, the aesthetics is superior compared to titanium but the bonding of these materials to lithium disilicate is still a researched topic with scant literature. Studies have shown that surface modification of the peek and zirconia with air abrasion with alumina oxide particles increase the bond strength. However, no studies have been done to check for bond strength after surface treating Peek and zirconia with air abrasion and acid etching with piranha solution and compare the bond strength of peek to LS2 and zirconia to LS2 after surface treatment bonded using a dual cure resin cement[15,16].

Materials and methods

A total of 48 samples 12 zirconia and 12 peek and 24 lithium disilicate were used. Lithium disilicate specimen was sectioned from a block. Each specimen measuring 10mm in diameter and thickness of 2mm.Cylindrical Zirconia specimen was milled from a block with each specimen having a diameter of 10mm and thickness of 2mm.Cylindrical Peek specimens will be sectioned from a block with each specimen having a diameter of 10mm and thickness of 2mm.

Group 1(12 in #): Air abraded & piranha solution treated zirconia. [figure 1]

Group 2(12 in #): Air abraded & piranha solution treated peek. [figure 2]

These specimens were mounted onto acrylic blocks and lithium disilicate was bonded to the specimens using resin cement.

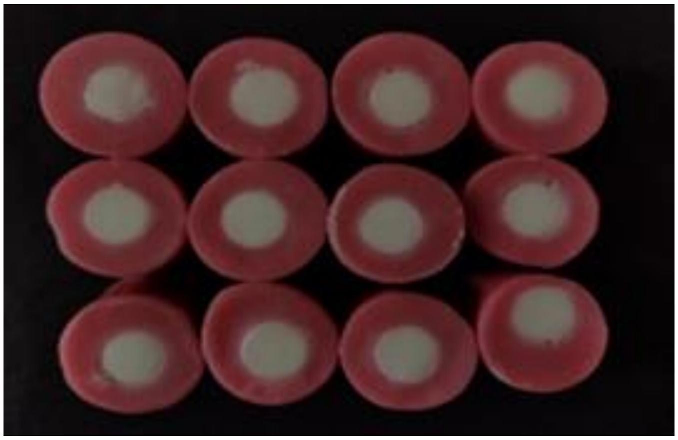


Figure 1: [group1] air abraded and piranha solution treated zirconia

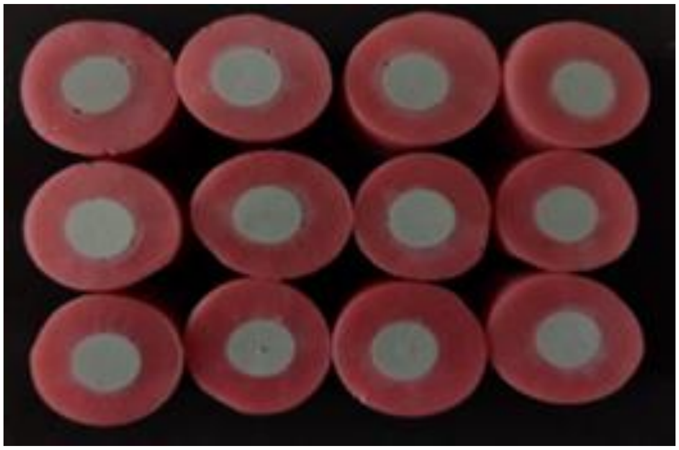


Figure 2: [group 2] air abraded and piranha solution treated peek.

Surface treatment

Zirconia and peek samples were air abraded using a pen blaster with alumina particles of 60 microns at an angulation of 45^0 on all sides followed by cleaning the samples using distilled water. Each sand blasted samples were acid etched with piranha solution [khariwal laboratory] {H_2So_4: H_2O_2 3:1} for 60 seconds followed by mounting onto acrylic blocks using cold cure resin [DPI] [figure 3,4]

The mounted sample surface was cleaned using isopropyl alcohol 70% [romsons] before the bonding procedure was started to clean off any residues that was left on the surfaces following treatment.

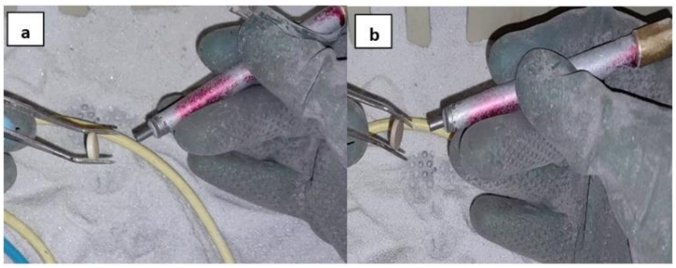


Figure 3a: air abrasion of zirconia disc using pen blaster followed by acid etching using piranha solution.

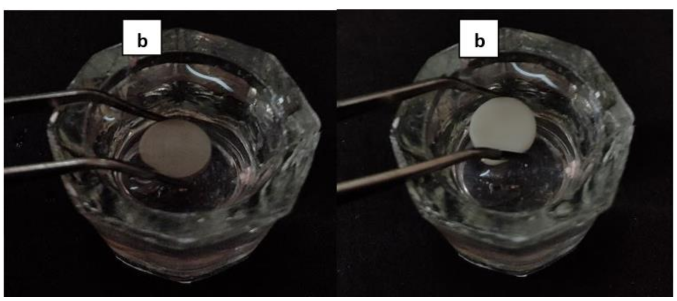


Figure 3b: air abrasion of peek disc using pen blaster followed by acid etching using piranha solution.

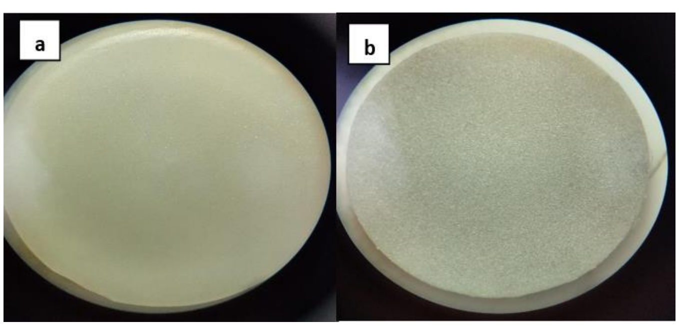


Figure 4 A: surface treated zirconia under Stereo micro scope

B: surface treated peek under Stereo microscope

Lithium disilicate was treated with hydrofluoric acid [ultra-dent] for 60 seconds and cleaned with n distilled water [figure 5] and then bonded to peek and zirconia using a resin cement [GC G-CEM ONE].

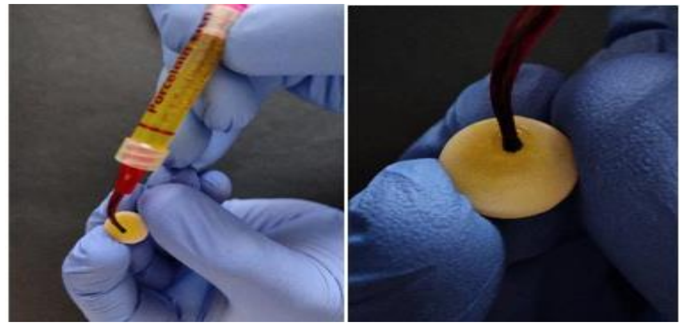


Figure 5: lithium disilicate treated with hydrofluoric acid.

Bonding procedure

G CEM ONE[GC] dual cure resin cement was used to cement the lithium disilicate discs to the zirconia and peek discs. According to manufactures instruction the surface of zirconia and peek were cleaned using iso propyl alcohol and dried. A primer that was provided with the resin cement was applied to the zirconia and peek surface and air dried. The resin cement was dispensed onto mixing pad and mixed for 30 seconds and placed onto the peek and zirconia surface and a lithium disilicate disc was placed onto it and constant finger pressure was applied by a single clinician and initial cure using led [wood pecker] for 2 seconds and excess cement was removed using a probe and again cured for 60 seconds [figure 6]. The same procedure was followed for all the samples.

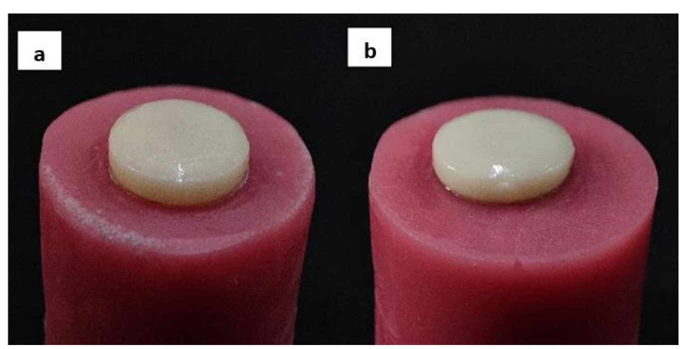


Figure 6 A: lithium disilicate bonded to zirconia

B: lithium disilicate bonded to peek

All the samples were stored in distilled water for 24 hours and the bond strength was tested using universal testing machine [Mecmesin Multi Test 10-i] at a cross head speed of 1mm/sec until debonding. [figure 7]

To perform the statistical analysis SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM corp. released 2011] was used to perform the statistical analysis. Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables. Independent sample t test was applied to compare the shear bond strength between the groups. The level of significance is set at 5%

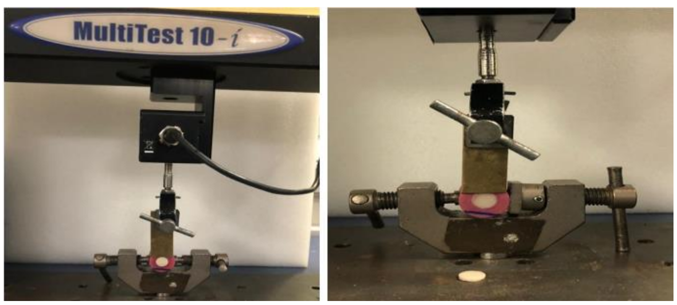


Figure 7: samples tested using UTM until debonding.

Results

Shear Bond strength of Group 1 was higher- 5.978 ± 0.393 as compared to Group 2- 2.573 ± 0.274. Independent sample t test was applied to compare the shear bond strength between the groups. Independent sample t test showed statistically significant difference between the groups (p=0.001) with mean difference of 3.40.[table 1]

Groups	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Group 1	12	5.45	6.76	5.978	0.393	3.40	0.001*
Group 2	12	2.04	3.07	2.573	0.274		

*significant

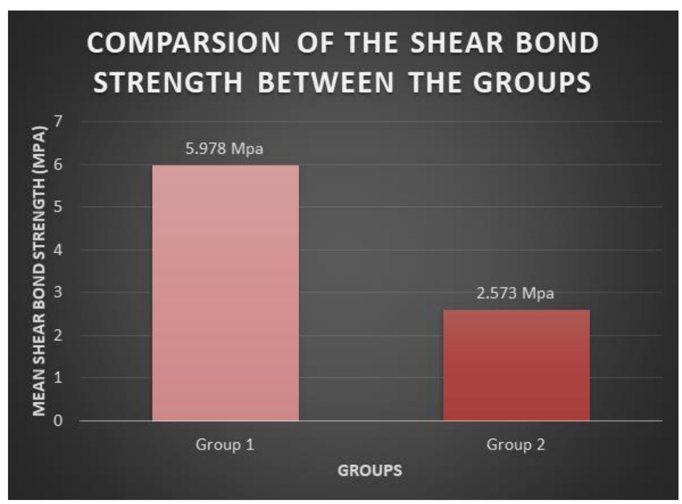
Table 1: Comparison of the shear bond(mpa) strength between the groups using independent sample t test.

Discussion

Various bonding methods and techniques have been developed for zirconia and peek that have significantly increased the bond strength of the materials in oral environment such as acid etching, sandblasting, plasma treatment, laser ablation. Abrasion of the abutment materials with acid etching or sandblasting have claimed to improve the surface area that inturn increases the wettability and bonding are and strength. The null hypothesis in the study is that there will be no significance difference between the bond strength of zirconia to LS2 and Peek to LS2 following surface treatment.

The test results showed that zirconia bonded to LS2 had 3 times higher bond strength than peek bonded to LS2. [graph 1].

Both the zirconia and peek in this study was treated with sandblasting with aluminium oxide 60 microns as it produces same adhesive strength as higher grain particles but is less abrasive.



Graph 1: comparison of the shear bond (mpa) strength between the groups.

A study by Hiroki Tsuka et al used various cements to check for bond strength of peek and resin luting cement. They used 4 different resin cements and peek with no treatment was control group while other group had sand blasting as a surface treatment. The Superbond C&B showed the highest bond strength both in the control as well as the surface treated group. Therefore, in this study a combination of sandblasting with acid etching was used as a study by Patrick r et al showed that peek had best wettability when treated with piranha solution[16].

Ryan sloan et al in his study checked for bond strength of lithium disilicate to peek and zirconia after air abrasion using 50 microns alumina oxide followed by a bonding protocol using primer and monoband and for peek surface and for lithium disilicate surface hydro fluoric acid and primer was used before bonding. And the results showed that bond strength of peek to lithium disilicate was significantly weaker zirconia and lithium disilicate. So in this study a combination of surface treatment was considered instead of just air abrasion [15].

Since peek is polymer the bond between peek and lithium disilicate will be weaker compared to zirconia and lithium disilicate. So studies are required to assess the various surface treatment and their effect on the bond strength of peek to lithium disilicate using various resin cements.

Clinical implication

The surface treatment of implant abutment can be done chair side using piranha solution, sand blasting prior to cementation to increase the bond strength therefore decrease the incidence of debonding. Lithium disilicate does not bond as readily to PEEK as to zirconia. If using a PEEK framework for an implant - supported fixed prosthesis, adequate retention in the height and taper of the axial walls of the framework seems to be preferable to reliance on adhesion. Additionally, PEEK is significantly more flexible than zirconia and, if used as a framework, may present mechanical challenges. Various resin cements show various strengths so proper selection is of utmost importance.

Conclusion

Within the limitations of the study, it was concluded that:

The shear bond strength of Lithium Disilicate to zirconia was three times stronger than that of Lithium Disilicate to Peek treated with a combination of air abrasion and acid etching.

However, further studies are required to know the effect of combination of various surface treatment to improve the strength Lithium Disilicate to Peek.

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