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Original Article

Laboratory evaluation of shear bond strength of porcelain repair methods

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Abstract

Introduction: Porcelain fracture is a relatively common problem in clinical dental practice. Various methods have been proposed for repairing porcelain fractures including direct composite resin repair or construction of a porcelain laminate veneer and its cementation with a resin cement. Evaluation of shear bond strength of porcelain repair methods was the purpose of this study.

Methods: Twenty feldspathic porcelain discs (10 mm in diameter) were fabricated. The samples underwent air-born abrasion with an aluminum oxide and etching with HF, and were then ultrasonically cleaned and randomized into two groups: 1- repair with porcelain disc (7 mm in diameter) with light cure cement (Choice 2); and 2- repair with resin composite (Clearfil AP-X). We measured the shear bond strength of the samples by Zwick Roll at 0.5 mm/min crosshead speed.

Results: The resin composite group had the highest shear bond strength (12.91 MPa). We found no significant differences between the choice and composite groups (p=0.970).

Conclusions: Our findings indicate that resin composite yields acceptable shear bond strength to be used in porcelain repair.

Keywords: Shear bond strength, Porcelain repair, Resin cement.

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Introduction

The increasing demands for cosmetic restorations have resulted in the development of novel ceramic systems; however, fractures remain the major cause of failure in these restorations (1). The majority of fractures (65%) occurs in anterior parts and (35%) posterior parts, and they are mostly found in maxilla (2, 3). Numerous factors influence porcelain fractures, including impact load, fatigue load, inappropriate design, micro deficiencies in porcelain structure and discrepancies between metal and porcelain physical properties (4). Based on the extensiveness of fracture and the site requiring repair, the management plan may vary from a small composite repair to fabricating a new prosthesis (5). Restoration replacement is not always the optimal solution to fractured ceramic restorations, as it compromises dental structure, exerts further trauma on restoration exchange, and imposes greater costs on the patient (2). Approaches to a fractured porcelain restoration may be categorized as direct repair with resin composite or indirect repair such as

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overcastting with porcelain or fabricating a porcelain facing over the fractured restoration, etc. (4-6).

If a small fragment of the porcelain is lost, it is reasonable to adopt an intraoral repair approach with light cure resin composites. Although a large porcelain fracture may be repaired by the same technique, the results will not be comparable to the main restoration in terms of cosmetics and strength (3).

Larger fractures may be treated with resin composite or fabricating a laminate veneer and porcelain facing over the previous porcelain. Bonding may be achieved with various resin cements such as light cure or dual cure cements.

The benefits of such a repair may appear temporary; nevertheless, it is preferable over replacement of a complicated FPD restoration (7, 8). Considering these facts, the aim of this study was to evaluate the shear bond strength of porcelain repair methods, dealing with composite and resin cement as repair methods.

Methods

Using putty type condensational silicon, we prepared 20 feldspathic porcelain discs (Ceramco III) with A2 color, 10 mm in diameter and 3 mm in thickness, as well as 10 porcelain discs, 7 mm in diameter and 2 mm in thickness.

In order to prepare the porcelain samples, we mixed the porcelain powder with distilled water and condensed it on a vibrator (Vibro 80) with generator. Once the water was sufficiently absorbed by tissue paper, the samples were transferred to porcelain furnace (P700 programat, ivoclar,vivadent) by porcelain mat (Noritake Kiazi Co). Subsequently, the samples were mounted with self cure acryl (Acropars) as to level the acryl surface with the porcelain disc (10 mm in diameter).

The surface of the mounted porcelain was then abraded with milling machine (Frasgarat F1, Degussa). The samples then underwent superficial treatment. For this purpose, the surface of the mounted porcelain was thoroughly cleaned and then subjected to air-abrasion for 10 seconds by aluminum oxide (30-50 micron in diameter and 60 psi in pressure) over a distance of 10 mm and 90^{o} angle.

The samples were then preserved in ultrasonic cleaner (Sonica, Soltec) for 10 minutes. Using a table of random numbers, the samples were randomly assigned to either of the two groups below, each containing 10 samples:

1- porcelain–silan–bonding agent–light cure ement–bonding agent– silan– porcelain

2- porcelain–silan–bonding agent–direct composite

For both groups, the surface of the porcelain was etched for 60 seconds by 9.5% hydrofluoric acid (Porcelain Etchant, Bisco, USA). Afterwards, the surface was cleaned and air-dried. In the first group, after etching with hydrofluoric acid (HF), the surface of the porcelain was smeared with silan (Bis-Silan TM, Bisco, USA) and thinned after 20 seconds with air pump. Subsequently, the surface of both porcelain discs were smeared with HEMA free porcelain bonding resin (Bisco, USA) and the second porcelain disc was cemented gently onto the mounted sample using translucent light cure (Choice 2) cement and polymerized for 40 seconds using light (Coltolux ,Coltene Co. Switzerland).

In the second group, silane (porcelain bond activator, Kuraray, Japan) and bonding agent (Clearfil SE bond, Kuraray, Japan) were mixed, microbrushed on the porcelain disc and thinned gently by air pump. Finally, it was repaired with color A2 direct composite (Clearfil AP-X, Kuraray, Japan) using a silicone mold with internal diameter of 7 mm and thickness of 2 mm. Similar to the first group, the second group was polymerized with light cure unit for 40 seconds.

The samples were preserved in distilled water and eventually tested for shear bonding strength by Zwick Roll Z050 at crosshead speed of 0.5 mm/min until fractured. Force was applied to the second fragment via a chisel-shaped stylus which moved tangentially to the acryl surface and the first porcelain fragment. The values were recorded in MPa. Statistical analysis was accomplished with one-way ANOVA using SPSS software version 16.

Results

In this interventional study, we used an experimental in vitro approach to repair 20 porcelain discs, randomly assigned to either of two groups. In the first group, porcelain discs bonded with choice 2 light cure cement, the mean shear bond strength was 12.54±3.6 MPa. The minimum and maximum values of shear bond strength were 8.05 MPa and 17.6 MPa, respectively. In the second group, porcelain samples bonded with clearfill APX resin composite, the mean shear bond strength was 12.9±4.1 MPa, with the minimum and maximum values being 8.05 MPa and 19.31 MPa, respectively. The highest shear bond strength pertained to the composite group, with a strength value of 12.9±4.1 MPa. The difference in shear bond strength was not significant between the choice 2 and resin composite groups (p=0.970).

Discussion

In this study, we evaluated the shear bond strength between the two methods of porcelain repair. Shear test is particularly appropriate for investigating the bond strength between the two substances. On the other hand, given the fact that most forces exerted on the an ferior restorations eccentric, especially in centric movements, were of shear type, we used shear bond strength test to evaluate the bond strength of porcelain repair methods.

Numerous studies had dealt with surface treatment of porcelain and its surface modification prior to repair, yielding a wide range of surface treatment methods based on the type of substance used including air-abrasion, hydrofluoric acid (HF) acidulated phosphate fluoride (APF), ammonium bifluoride, phosphoric acid, salinization of porcelain surface, grit blasting etc (9-11).

In the present study, we used sandblasting with aluminum oxide acid etching with HF, and silan**e** for surface treatment. The findings of many studies, including Brentel et al. (11) in 2007, Nagai et al in 2005, Mutlu Ozcan et al. (12) in 2003, Saygili et al. (10) in 2003, Madani et al. (13) in 2000, Aida et al. (14) in 1995, Kamada et al. (15) in 2004, and Amini and Sheibani (16) in 2003 indicate that using, air-abrasion HF and silan improve porcelain bonding to adhesive substances significantly.

The shear bonding strength of porcelain repair systems varies greatly in different studies. The shear bond strength ranges from 3 MPa to 37.4 MPa depending on many factors such as type of surface treatment and type of repair material. This wide range may reflect the difference in variables such as bond strength, materials used for testing porcelain repair and lack of a standardized protocol used by the different studies (4).

The mean shear bond strength of composite to porcelain is relatively diverse in the different studies, ranging from 6 MPa to 29.9 MPa based on the type of composite, type of ceramic and type of surface treatment (17-19). Although we found the highest mean shear bond strength in the resin composite Clearfil AP-X group (12.9±4.1 MPa), it was lower compared to the findings of similar studies, such as Santo et al. in 2006, Kelsey et al. (18) in 2000, Shahverdi et al. (5) in 1998 in 2001.

The greater shear bond strength in the composite group might be accounted for greater compatibility between porcelain bonding surface**,** and porcelain repaired with intermediate cement as various factors such as cement film thickness or properties of the repair porcelain fragment in terms of structural deficiencies (e.g. crevices or flaws) or type of surface treatment affected bonding strength when using intermediate cement. Different studies have dealt with bond strength of dual cure cements (includingPanavia F) to various porcelains (13, 17, 20, 21). Studies by Brentel et al. (11) in 2007, Quass et al. (22), and Yoshida et al. (23) in 2006 reported acceptable bonding between Panavia F resin cement and different porcelain types.

However, few studies have addressed the bond strength of light cure cements. Williamson et al. (24). In 1993 used a light cure resin cement to bond with alumina porcelain and reported a mean shear bond strength of 17.7 MPa.

In the present study, we found mean shear bond strength of 12.54±3.6 MPa for choice2 light cure cement. The shear bond strength of choice 2 cement may be due to the high mineral filler content in this type of cement, as mentioned by Lee et al. (19) in 2008. Choice 2 cement uses two bottle silan. Some studies, including that of Berry et al. (25) in 1999, stated that the shear bond strength of porcelain repair systems with two mix silan**e** was greater compared to those with one mix silane; this might be due to the presence of acidic components in two mix silane which acted as a facilitator and improve reaction speed, especially in the primary steps of bonding.

Considering the limitations of this study as well as its findings, it may be concluded that composite repair as a porcelain repair method yields acceptable bonding in fracture repair.

Regarding porcelain repair by porcelain discs, it may be stated that light cure cement yields acceptable strength.

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Conflict of interest: There was no conflict of interest.

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