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# THE ANALYSIS OF EFFECT OF DIFFERENT SURFACE-TREATMENT METHODS ON RESIN BONDING ON LONG TERM SUCCESS OF HIGH-STRENGTH CERAMICS

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**Abstract:**
***Introduction:*** *Ceramics are still the most aesthetically pleasing materials available for restorative dentistry. However, due to the metal infrastructure of metal-supported ceramic systems, which were developed to increase the physical properties, esthetic and biological adaptations cannot be fully obtained.* ***Objective of the study:*** *The main objective of the study is to find the evidence on resin bonding related to long-term clinical outcomes of tooth- and implant-supported high-strength ceramic restorations.* ***Methodology of the study:*** *Four different surface processes were used as surface-treatment procedures. The first three procedures were applied to samples of IPS Empress and IPS Empress 2 ceramic discs. Sandblasting with $Al_2O_3$, blasting with soda and glass beads, and the Bateman etch retention system were applied to samples of In-Ceram ceramic discs. The discs were cemented to composite bars. Two types of cement were used; Rely X adhesive resin cement and Rely X modified glass ionomer cement and, all the samples were subjected to a shear test to evaluate their bond strengths.* ***Results:*** *With the IPS Empress and the IPS Empress 2 ceramic discs, the best bonding was obtained in the group etched with $Al_2O_3$ sandblasting and hydrofluoric acid after cementation using the Rely X adhesive resin cement.* ***Conclusion:*** *The* in vitro *findings from this study indicate that surface-treatment procedures applied to the IPS Empress and the IPS Empress 2 full-ceramic systems are important when cement types are considered. In contrast, cement types and surface-treatment methods had no effect on changing the bond strength of the In-Ceram ceramic system.*

**Key words:** *Ceramics, cement, treatment, bonding.*

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## INTRODUCTION:

Ceramics are still the most aesthetically pleasing materials available for restorative dentistry. Be that as it may, because of the metal infrastructure of metal-supported ceramic systems, which were created to build the physical properties, esthetic and biological adjustments can't be completely obtained [1,2]. Full-ceramic systems were produced to accomplish satisfactory esthetic and biological adaptations. An expanding number of every single ceramic material and systems are by and by accessible for clinical use [3,4]. At show, every ceramic material speak to special visual properties for profoundly stylish rebuilding efforts. Because of the assortment of materials and increment in the quantity of laboratories, which have these systems, full ceramics are currently one of the essential selections of specialists and patients and full-ceramic reclamations have bit by bit turned into the favored alternative. Because of the upgrades in their mechanical properties, these materials are utilized to reestablish single tooth absconds as well as multiunit abandons now [1-5]. Furthermore various clinical examinations have recorded the incredible long haul achievement of gum reinforced rebuilding efforts, for example, porcelain cover facade, ceramic trims and onlays, tar fortified settled halfway dentures, and all-ceramic crowns [6-13]. Improvements in full ceramics likewise prompted changes in the bonds used to stick these reclamations to the teeth. The common fragility of some ceramic materials, particular treatment conditions, and certain clinical conditions require compelling gum holding of the finished ceramic rebuilding to the supporting tooth structures for long haul clinical achievement. A solid and sturdy sap bond gives high maintenance, enhances peripheral adjustment, anticipates miniaturized scale spillage, and expands the crack protection of the reestablished tooth and the restoration [6, 8, 10]. Adhesive holding strategies and present day every single ceramic system offer an extensive variety of very tasteful treatment alternatives. Attaching to customary silica-based ceramics is an anticipated technique yielding tough outcomes when certain rules are followed [12].

Today, it is perceived that bond of the full-ceramic reclamations with the traditional concretes decreases the clinical achievement; moreover, small-scale spillage, which can show up with the regular bonds, can likewise cause shading of the crown [11]. Resin concretes have turned into the predominant cementation materials as of late since they increment the mechanical protection of the rebuilding and counteract microleakage [14-16].

**Objectives**

The main objective of the study is to find the evidence on resin bonding related to long-term clinical outcomes of tooth- and implant-supported high-strength ceramic restorations.

## METHODOLOGY OF THE STUDY:

In this study, 100 full-ceramic samples were prepared in accordance with the instructions of the manufacturers. At that point, samples were partitioned into three gatherings for every ceramic system and distinctive surface-treatment strategies were connected to every one of the 20 test samples of each gathering. These strategies were observed to be lacking to accomplish a surface contrast in the In-Ceram (a glass-penetrated aluminum-oxide ceramic) samples in light of their mechanical and compound protections. In this manner the methods connected to the In-Ceram samples were sandblasting, impacting (Perlablast 50 µm) + glass beads, and Bateman draw maintenance system (BERS).

The first 20 samples of all the groups that were prepared for each ceramic system were blasted in a media-blasting device at a pressure of 2.5 bar using 50-µm $Al_2O_3$ for 14 seconds. The second 20 samples of the considerable number of gatherings were subjected to affecting with pop and glass beads. For this reason, the Perlablast impacting technique was connected at a weight of 2.5 bar utilizing 50-µm pop and glass beads for 14 seconds. At that point 9.6% HF corrosive gel was connected to the last 20 samples of the IPS Empress and the IPS Empress 2 ceramic systems for 90 seconds. The corrosive was then washed off the samples to clean them.

The surfacing method, which is clarified in this segment, was just connected to the last 20 In-Ceram samples. The suspension utilized as a part of the examination was set up from an answer of 2 g Aerosil 380, 0.09 g Beigostat phosphate diester hostile to flocculant, and in excess of 0.1 g of silicon gum in 40 g ethanol. The molecule size of Aerosil 380 was 7 nm. The readied suspension was connected to the samples, which were then kept at 960°C out of a heater for 30 minutes following vanishing of the ethanol [15,22].

Next, the greater parts of the samples were ultra sonographically cleaned in refined water and air-dried. A disinfection strategy was connected utilizing a weight steam motor at a weight of 3 bar and 133°C for 10 seconds.

After the surface techniques were directed on the IPS Empress, the IPS Empress 2, and the In-Ceram samples, composite bars of A1 shading were set up for the cementation method utilizing 3-mm-breadth straightforward pipettes. These bars were settled to the ceramic samples utilizing two kinds of concrete. Thus, test samples arranged for each gathering were isolated two gatherings. Ten samples were luted with the composite sap Rely X glue tar concrete, and the other ten samples were luted with the tar adjusted glass ionomer bond Rely X changed glass ionomer concrete (3M Dental). After cementation, every one of the samples were kept at room temperature in water for 24 hours. A thermocycle technique was connected utilizing 5°C and 55°C shower arrangements. The cycle length was 10 minutes in each shower arrangement. Each example experienced a sum of 500 warm cycles. The prepared samples were placed into the test device using special acrylic molds. The knife-edge-shaped apparatus used in our study was placed between the joint of the ceramic disc and the composite material. After the system was turned on with a force of 0.5 mm/min, the value at which the ceramic disc and the composite material ruptured was recorded.

**Statistical analysis**

Student's t-test was performed to evaluate the differences in roughness between group P and S. Two-way ANOVA was performed to study the contributions. A chi-square test was used to examine the difference in the distribution of the fracture modes (SPSS 19.0 for Windows, SPSS Inc., USA).

## RESULT AND ANALYSIS:

Provided that the cement type was the same, when the same surface procedures applied to the ceramics were compared with each other using the Rely X ARC composite resin cement, the tests indicated that the IPS Empress and the IPS Empress 2 samples showed statistically significant differences among all the three groups of ceramic systems (sandblasted with 50-µm $Al_2O_3$, blasted with Perlablast + glass beads, and sandblasted with 50-µm $Al_2O_3$ + acid etched with 9.6% HF acid). There was no statistical difference between the In-Ceram groups (Table 1).

**Table 1: Shear bond test results applied to all the test samples after cementation using the Rely X ARC.**

| | Surface treatment | n | $\bar{x}$ | SD | Mean rank |
|---|---|---|---|---|---|
| IPS Empress | Sandblasting (50-µm $Al_2O_3$) | 10 | 24.1948 | 6.3259 | 17.40* |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 21.0234 | 4.5559 | 9.90* |
| | Sand blasting (50-µm $Al_2O_3$) + acid etch | 10 | 28.9786 | 4.9729 | 19.20* |
| IPS Empress 2 | Sandblasting (50-µm $Al_2O_3$) | 10 | 28.1307 | 3.7986 | 15.60** |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 23.9273 | 4.8867 | 9.80** |
| | Sandblasting (50-µm $Al_2O_3$) + acid etch (HF) | 10 | 31.8899 | 4.2475 | 22.10** |
| In-Ceram | Sandblasting (50-µm $Al_2O_3$) | 10 | 18.6846 | 3.2054 | 19.70 |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 15.9997 | 1.3845 | 10.30 |
| | BERS | 10 | 17.7850 | 2.9919 | 16.50 |

**P < 0.01. *A P value <0.05

ARC = adhesive resin cement; BERS = Bateman etch retention system; HF = hydrofluoric; SD = standard deviation.

Because of the $Al_2O_3$ and the glass beads + pop impacting methods, the Rely X ARC composite tar concrete accomplished higher holding esteems with the IPS Empress and the IPS Empress 2 samples than with the In-Ceram samples, yet the outcomes were not measurably critical. Since the drawing strategy with 9.6% HF corrosive and the sandblasting with 50-µm $Al_2O_3$ were not connected to the In-Ceram samples, an examination was made just between the samples of IPS Empress and IPS Empress 2, and no distinction was found. In any case, because the BERS technique was connected just to the In-Ceram samples, those outcomes were excluded in the assessment at this stage. No distinction was found in the test aftereffects of the three ceramic systems in which the Rely X adjusted glass ionomer concrete was utilized (Table 2).

**Table 2: Shear bond test results applied to all the test samples after cementation using the Rely X RMGIC.**

| | Surface treatment | n | $\bar{x}$ | SD | Mean rank |
|---|---|---|---|---|---|
| IPS Empress | Sandblasting (50-µm $Al_2O_3$) | 10 | 11.5761 | 3.3028 | 17.80 |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 10.6911 | 2.0520 | 12.90 |
| | Sand blasting (50-µm $Al_2O_3$) + acid etch | 10 | 11.5656 | 3.1561 | 15.80 |
| IPS Empress 2 | Sandblasting (50-µm $Al_2O_3$) | 10 | 11.9441 | 2.9474 | 13.30 |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 10.9681 | 2.0059 | 15.90 |
| | Sandblasting (50-µm $Al_2O_3$) + acid etch (HF) | 10 | 12.2202 | 2.5551 | 17.30 |
| In-Ceram | Sandblasting (50-µm $Al_2O_3$) | 10 | 10.2785 | 1.9391 | 16.70 |
| | Blasting (Perlablast 50 µm) + glass beads | 10 | 10.1580 | 2.1844 | 15.60 |
| | BERS | 10 | 9.8917 | 1.6157 | 14.40 |

**P < 0.01. *A P value <0.05

BERS = Bateman Etch Retention System; HF = hydrofluoric; RMGIC = modified glass ionomer cement; SD = standard deviation.

## DISCUSSION:

A requirement for the clinical success of ceramic restorations over time is appropriate adhesion between the ceramic and the tooth substances [11,12]. Holding of a ceramic to the tooth substance depends on attachment of the luting concrete and its holding pitch to the ceramic substrate together with the bond of the luting concrete to the veneer and the dentin. Bond qualities are impacted by a few elements, one of which is the sort of luting cement [1-15].

A strong resin bond relies on micromechanical interlocking and chemical bonding to the ceramic surface, which requires roughening and cleaning for an adequate surface activation [11]. Common treatment choices are granulating, scraped area with precious stone rotational instruments, airborne molecule scraped spot with aluminum oxide, corrosive carving, and mixes of any of these techniques. Corrosive scratching with the arrangements of HF corrosive or ammonium bifluoride can accomplish appropriate surface and roughness [11-14].

Since the idea of scratching porcelain surfaces was presented and glue cementation of full-ceramic rebuilding efforts was accounted for, a few creators exhibited that the focuses and carving periods must be changed in accordance with every particular sort of ceramic to advance the bond strength [11,14,23].

The HF acid selectively dissolves glassy or crystalline components of the ceramic and produces an irregular porous surface that increases the surface area and facilitates the penetration of resin into micro-retentions on the etched ceramic surface [11]. In this investigation, corrosive carving showed better outcomes with glass ceramics (IPS Empress and IPS Empress 2), despite the fact that it was not used to enhance the bond quality of luting concretes to high-alumina ceramics (In-Ceram). The BERS that depends on consolidation of plastic chips on the surface of an example was utilized for those samples.

Changes occur in the surface topography after sandblasting procedures [4,5,7]. This technique was included in the present study as it is a commonly employed procedure in prosthodontic laboratories, and dental offices have miniaturized devices, which facilitate its use.. The molecule estimate, strategy length, and weight and separation utilized as a part of the method are imperative factors in the execution of the concrete bond [18-21]. It was accounted for that a sandblasting methodology with high weight or with substantial particles does not build the security quality; all things considered, it causes contradiction in the reclamation because of wear [16,19-21].

The present study did not find an ideal surface-treatment method that could be applied to all types of ceramics, because many factors affect the bond strengths of the resin luting cements applied to the ceramics.

## CONCLUSION:

The present study demonstrated that shear bond strengths of the resin composite luting cements tested on the dental ceramics after the surface-conditioning techniques varied in accordance with the type of ceramic. The in vitro findings from this study indicated that the surface-treatment procedures applied to the IPS Empress and the IPS Empress 2 full-ceramic systems are important when considering the cement types, although the cement types and surface-treatment methods were ineffective in changing the bonding strength of the In-Ceram ceramic system.

The findings confirmed that the use of HF acid with sandblasting is one of the available methods that can be chosen for bonding the resin-based luting cement to the ceramics with a glassy matrix in their structures. Further studies are necessary so that the clinicians can understand the characteristics of the ceramics and the surface-treatment methods in accordance with which the cements should be chosen.

**Contribution of authors**

All the authors contributed equally. Dr. Shahzada Faiz Ahmad conceived of the presented idea and do all the lab work and carried out the experiment with other co-authors. Dr. Zeeshan Arshad developed the theory and performed the computations. Dr. Ahmad Naeem Orakzai supervised the findings of this work and Dr. Furqan Jamal and Dr. Shahzada Faiz Ahmad developed the theoretical formalism, performed the analytic calculations and performed the numerical simulations. All the authors contributed to the final version of the manuscript

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