

## Shear bond strength of orthodontic brackets bonded to zirconia ceramic restorations: An in-vitro study

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**Aim:** The present study aimed to evaluate the shear bond strength of metal bracket bonded to zirconia and feldspathic porcelain specimens, subjected to different surface treatment, sandblasting (SB) and hydrochloric acid (HF).

**Materials and Methods:** Sixty specimens were constructed for this study. The specimens were divided according to material of construction into two main groups, group (1): Zirconia (Ceramill Amann Girrbach) (30 specimens), group (2): Traditional feldspathic porcelain (Vita VM13) (30 specimens). The two main groups were subdivided according to surface treatment into six subgroups (10 specimens) each treated with (SB), (HF+silane) or combination of both methods. 60 metal brackets were bonded to the surface treated specimens. Prior to testing for shear bond strength (SBS), all of the bonded specimens underwent thermocycling. Following that, the bond failure mode was noted.

**Results:** There was a statistically significant difference in SBS values between the two ceramic materials with higher SBS in feldspathic porcelain specimens. The sandblasting treated specimens presented a statistically significant higher SBS values than the HF treated specimens. The adhesive remnant index (ARI) scores were 2 and 5 for most of the groups; There was a statistically significant difference in the proportions of ARI scores between the study groups with higher scores 1&2 in feldspathic porcelain sandblasting group.

**Conclusion:** Both ceramic material and surface treatment can affect the shear bond strength. Sandblasting influences the SBS in both zirconia and feldspathic porcelain specimens.

**Keywords:** Shear bond strength, Zirconia, Surface treatment, Orthodontic brackets Porcelain

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## Introduction

The growing need for aesthetically pleasing restorations has led to a sharp rise in the usage of ceramic crowns. Because gluing orthodontic brackets to various ceramic materials is different from bonding to the enamel surface, orthodontists and prosthodontists are faced with a difficulty as the number of people seeking orthodontic treatment rises.<sup>1</sup>

The type of ceramic, surface treatment, bracket material and retention mode, bonding adhesive composition, light curing source, and clinician expertise are some of the variables that determine the bond strength.<sup>2</sup>

A lot of surface treatment techniques have been applied to enhance the bond strength of orthodontic brackets on feldspathic porcelain surfaces since the ceramic structure is inert.<sup>2</sup> These techniques may be chemical, mechanical, or a mix of both.<sup>3</sup>

Sandblasting and the use of coarse diamond stone are examples of mechanical techniques.<sup>2</sup> Despite the fact that these techniques greatly strengthen the connection, they also increase surface roughness and the likelihood of ceramic fracture upon debonding.<sup>4</sup>

Chemical techniques include etching with hydrofluoric acid gel (HFA) or phosphoric acid gel (PA), or employing a silane coupling agent to change the feldspathic porcelain's affinity for adhering components. A 9.6% HFA gel is the most often used ceramic acid etchant. HFA is a potent acidic solution, though, therefore it must be applied very carefully to prevent soft tissue contact.<sup>5</sup>

The silane creates a bridge between the tested substrate and strengthens the binding to feldspathic porcelain surfaces by reacting with the silica in the feldspathic porcelain and the organic groups of the bonding resin. Several all-ceramic dental

restorations have rapidly advanced in technology in recent years.<sup>3</sup>

Compared to conventional feldspathic porcelain, zirconia is a very popular material in dentistry due to its unquestionable mechanical qualities, chemical inertness, and superior optical qualities.<sup>6</sup>

High-translucency zirconia HT, which is made from a single monolithic block of zirconia, is used to create monolithic crowns and bridges that have stunning translucencies.<sup>7</sup> Clinical success rates for these ceramics with high crystalline content (aluminum and/or zirconium oxides) have been demonstrated to be higher than or comparable to those of ceramics based on feldspar, leucite, and lithium disilicates.<sup>8</sup>

However, when the amount of crystalline phase in the ceramic increases, the amount of silica decreases, making this chemical reaction less effective.<sup>9</sup>

The best technique for preparing ceramic surfaces to produce the strongest possible binding between orthodontic attachments and different ceramic surfaces is still up for debate. This study will use innovative bonding approaches with a universal bonding system that contains 10-methacryloyloxydecyl dihydrogen phosphate (MDP) in combination with various surface treatments to address these issues.<sup>10</sup>

This work aims to calculate the shear bond strength of metal brackets bonded to zirconia and feldspathic porcelain specimens that have been exposed to various surface treatments, including hydrochloric acid (HF) and sandblasting (SB).

The hypothesis assumed that both material types regarding etchable feldspathic porcelain and non-etchable zirconia. And all surface treatment will affect the future SBS.

## Material and methods

The material used in the study illustrated in table (1).

**Table 1: showing the materials used in this study.**

| Material                                               | Company                                     | Composition                                                                                                                                                                                                        | Lot#                                                               |
|--------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| zirconium oxide                                        | Ceramill Amann Girschbach zirconia          | ZrO <sub>2</sub> + HfO <sub>2</sub> + Y <sub>2</sub> O <sub>3</sub> : > 99,0<br>Y <sub>2</sub> O <sub>3</sub> : 4,5 - 5,6<br>HfO <sub>2</sub> : ≤ 5<br>Al <sub>2</sub> O <sub>3</sub> : ≤ 0,5<br>Other oxides: ≤ 1 | 1608000-16<br>1608000-66<br>1608000-88<br>1608000-10<br>1608000-63 |
| 50 µm Aluminum Oxide powder                            | Zest Dental solutions, Carlsbad, California | 50 µm Aluminum Oxide Powder AL <sub>2</sub> O <sub>3</sub>                                                                                                                                                         | L12YD                                                              |
| Universal adhesive                                     | Bisco, Inc, Schaumburg, IL, USA.            | Organophosphate and carboxylic acid, biphenyl dimethacrylate and hydroxyethyl methacrylate                                                                                                                         | 2100008511                                                         |
| Metal brackets                                         | Ortho ognisers inc, USA.                    | Metal brackets                                                                                                                                                                                                     | 716-392HK                                                          |
| feldspathic porcelain etch                             | Bisco, Inc, Schaumburg, IL, USA             | Hydrofluoric acid 9.5%                                                                                                                                                                                             | 2100008544                                                         |
| Feldspathic porcelain powder and modeling fluid (VM13) | VITA Zahnfabrik, Germany                    | SiO <sub>2</sub> (58 – 63%), Al <sub>2</sub> O <sub>3</sub> (20 – 23%), Na <sub>2</sub> O (9-11%), K <sub>2</sub> O (4-6%), B <sub>2</sub> O <sub>3</sub> (0.5-2%), K <sub>2</sub> O (<1%).                        | 76820<br>66720                                                     |
| orthodontic luting composite                           | Ormeo corporation LA ,USA                   | Resin composite                                                                                                                                                                                                    | 8776093                                                            |
| Silane coupling agent                                  | Bisco, Inc, Schaumburg, IL, USA             | (3- <u>Aminopropyl</u> ) triethoxysilane<br>Feldspathic porcelain primer                                                                                                                                           | 2100008544                                                         |

## Study design

Sixty specimens were constructed for this study. The specimens were divided according to material of construction into two main groups, group (1): Zirconia (Ceramill Amann Girschbach) (30 specimens), group (2): Traditional feldspathic porcelain (Vita VM13)(30 specimens). The two main groups were subdivided according to surface treatment into six subgroup (10 specimens) group (G1&G4) sandblasting using particles of 50 µm aluminum oxide In groups G2 and G5, 50 µm aluminum oxide particles were

sandblasted, and hydrofluoric acid and silane coupling agent were used for acid etching. In groups G3 and G6, the same process was used.

## Zirconia Specimens

Thirty zirconia specimens (10x12 mm, 2 mm thick) were fabricated using Ceramill zirconia blanks. After confirming the design using Ceramill Mind software, the blanks were milled using the Amann Girschbach Ceramill Motion 2 CAD/CAM machine

## Milling & Sintering

The specimens were milled to the required dimensions and sintered in a specially programmed sintering furnace at temperatures between 1350-1550°C with shrinkage reaching approximately 25%.

## Feldspathic porcelain Specimens

Mold Creation, zirconia specimen was used to create a gypsum mold for the feldspathic porcelain specimens. After mixing feldspathic porcelain powder and modeling fluid, the mixture was placed in the mold and fired in a furnace (EP 3010 programat) following the manufacturer's firing program.

## Final Checking

The feldspathic porcelain specimens were checked for dimensional accuracy using a digital caliper before glazing. A feldspathic porcelain glaze was applied fig1(A) using a ½ inch brush before firing in a ceramic furnace(Ivoclar programat furnace) following the manufacturer instructions 403(°C) Initial temperature With Heating rate (°C/min) 60 / Preheating time (min) 6 / Final firing temperature 770(°C) / Holding time (min) 1.5 fig1(B).

### **Sandblasting group (G1&G4)**

The surfaces were marked with a marker to ensure that the abrading powder reached the whole surface when the marking is removed. A laboratory air-abrasion apparatus made by Renfert GmbH (S/N: A1292265, Bj.:2017, Germany) was used to sandblast the ceramic surface with 50  $\mu\text{m}$  aluminum oxide particles for two seconds at a 45° angle, 90 psi pressure, and 10 mm from the surface. Figure 1(C), (D)

### **Acid etching group (G3&G6)**

The surface of the specimens were etched with 9.6% Hydrofluoric acid in a proprietary gel base (BISCO, Inc., 1100 W. Irving Park Rd., Schaumburg, IL 60193, USA) for 1 minute, rinsed thoroughly with tap water for 30 second and then gently air dried. Silane coupling agent were applied using small brush and be allowed to dry for 20 second.

### **Sandblasting and acid etching group (G2&G5)**

All the previous steps in the other groups applied here combined, starting with sandblasting then applying hydrofluoric acid and silane. A thin coat of the Universal bond (Bisco) were applied using small brush on the entire ceramic surface of all treated specimens. Then All the specimens were subjected to light cure for 10 sec according to manufacturer instructions. The entire bracket base were coated with composite (green glow from ormco) which will made it easier for us to observe ARI, placed on the ceramic block by One operator and a bracket positioner were used for standardizing the procedure. excess composite was removed by a dental explorer. The composite were then light cured by C02-C LED curing light with a 10mm direct light source headset on Full mode – 1,200 mW/cm<sup>2</sup> for 40 seconds with 3m elipar light cure device.

### **Aging and Thermo-cycling**

Thermo cycling was performed in the Dental Biomaterials department, Faculty of Dentistry, Mansoura University by a special device (THE 100 SD mechatronic thermocycler Germany). All samples were kept in an incubator at 37°C temperature for 24 hours after bonding. Then, thermo-cycled for 1000 cycles between 50 C and 55o C  $\pm$  4 °C distilled water baths, the dwell time between baths was 20 seconds.

### **Bond strength testing**

A rectangular interface shear test was specially designed to examine the bond strength. All specimens were separately fixed on the lower fixed compartment of the Using computer software (Bluehill Lite; Instron Instruments), the force needed to remove the bracket was measured using an Instron Universal Testing Machine (Model 3345; Norwood, USA) with a 5kN load-cell. Using a specially designed metallic housing device with a central chamber that the ceramic plate could fit into, the specimens were installed on the lower fixed compartment of the testing apparatus (dimensions: 14x12x2 mm). Each specimen was subjected to a compressive force using a mono-beveled chisel that was fixed to the testing apparatus's upper movable compartment. Figure 1(E) At a crosshead speed of 0.5 mm/min, the load was applied in that direction. The tip of the chisel was adjusted so that it only touched the bracket's base. Newton (N) was used to record the maximum failure load. A sharp decline along the load-deflection curve, captured by computer software (Nexygen-MT; Lloyd Instruments Ltd.), validated this. The bond strength in MPa was then calculated by dividing the highest failure load by the bracket base surface area, which was determined with a digital caliper. Figure 1(F).

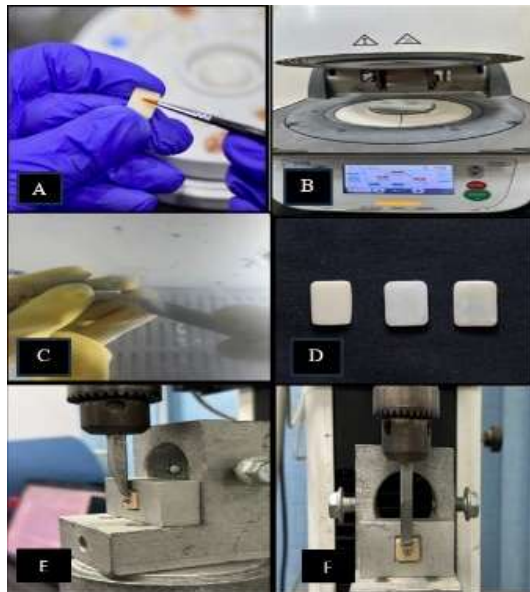


Figure 1 : (A) distributing the glaze layer, (B) EP 3010 programat , Ivoclar Vivadent, Schaan, Liechtenstein furnace, (C) sandblasting process of the specimens, (D) The specimens after sandblasting, (E) specimens mounted on the lower fixed compartment of the Instron universal testing machine, (F) specimens subjected to loading

### Mode of failure

Artun and Bergland's Adhesive Remnant Index (ARI) score, which represents the quantity of composite that remains on the ceramic specimen surface, was used to determine the mode of failure. To identify the mode of failure, two observers—an orthodontist and a restorative dentist—each independently examined the specimens. The same observers will reevaluate each sample in two weeks. Each subgroup's mean value was computed, and the lowest and greatest values were identified in fig (2).

The samples were evaluated using light microscope to determine the ARI. The measurements were recorded, using scores from 1 to 5 as follows fig (2).

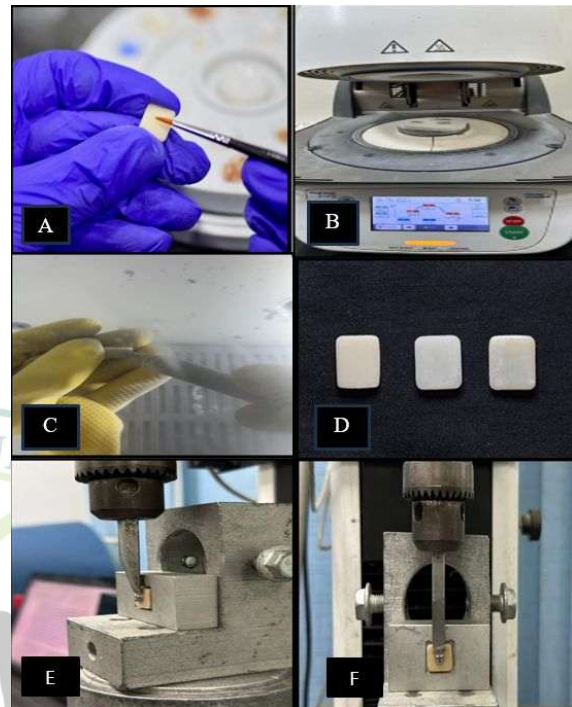


Figure 2: observing the composite remnants (ARI) under microscope

1: All adhesive remains on the ceramic surface with the replica of the bracket base (100%).

2: More than 90% of the adhesive remaining on the ceramic surface (>90%).

3: Less than 90%, but more than 10% of the adhesive remains on the ceramic surface

4: Less than 10% of the adhesive remaining on the ceramic surface (<10%).

5: No adhesive remaining on the ceramic surface (0%).

### Results

1- The descriptive statistics of SBS values are presented in table(2) . The highest mean SBS value was found to be  $7.83 \pm 0.79$  megapascals (MPa) on average for the feldspathic porcelain group that had sandblasting treatment. Conversely, the zirconia group treated with hydrofluoric acid and sandblasting had the lowest mean SBS (mean  $\pm$  SD  $5.29 \pm 1.67$  megapascals, or MPa).

**Table 2: Descriptive statistics of SBS This study involved 6 groups as shown in the following flow chart**

| Ceramic materials And surface treatment                   | Mean $\pm$ SD   | SE    | 95% CI of the mean | Median (IQR)    | Minimum-maximum |
|-----------------------------------------------------------|-----------------|-------|--------------------|-----------------|-----------------|
| Feldspathic porcelain sand blasting G1                    | 7.83 $\pm$ 0.79 | 0.251 | 7.25-8.39          | 7.79(7.13-8.45) | 6.73-9.21       |
| Feldspathic porcelain hydrofluoric acid +sand blasting G2 | 5.34 $\pm$ 0.68 | 0.216 | 4.85-5.83          | 5.25(4.84-5.93) | 4.19-6.34       |
| Feldspathic porcelain hydrofluoric acid G3                | 6.82 $\pm$ 0.96 | 0.302 | 6.14-7.50          | 6.69(6.12-7.55) | 5.26-8.38       |
| Zirconia sand blasting G4                                 | 7.28 $\pm$ 0.97 | 0.306 | 6.59-7.98          | 7.48(6.48-8.16) | 5.57-8.26       |
| Zirconia hydrofluoric acid +sand blasting G5              | 5.29 $\pm$ 1.67 | 0.527 | 4.09-6.48          | 4.49(4.0-6.86)  | 3.36-7.98       |
| Zirconia hydrofluoric acid G6                             | 5.36 $\pm$ 1.65 | 0.522 | 4.18-6.54          | 5.52(4.32-6.84) | 1.81-7.04       |

2- There were significant differences in SBS between the two ceramic materials (p) value <0.086\* with higher value of SBS in feldspathic porcelain group 6.66 $\pm$ 1.31 over zirconia group 5.98 $\pm$ 1.69

3- There were statistically significant differences in changing the method of surface treatment higher SBS in sandblasting 7.56 $\pm$ 0.905 megapascals (MPa), and the lowest mean SBS in hydrofluoric acid and sandblasting group 5.32 $\pm$ 1.24 megapascals (MPa), as shown in table (3).

4- There was a significant difference in ARI scores between the study groups .The ARI scores are presented in Table(4).

**Table 3 : Comparison between the mean SBS values of the two ceramic materials and the surface treatment methods**

| Ceramic materials                      | Mean $\pm$ SD    | SE    | 95% CI of the mean | Median (IQR)     | Minimum-maximum | p value |
|----------------------------------------|------------------|-------|--------------------|------------------|-----------------|---------|
| Feldspathic porcelain (n=30)           | 6.66 $\pm$ 1.31  | 0.238 | 6.17-7.15          | 6.69 (5.66-7.64) | 4.19-9.21       | <0.086* |
| Zirconia(n=30)                         | 5.98 $\pm$ 1.69  | 0.309 | 5.35-6.61          | 6.28 (4.47-7.46) | 1.81-8.26       |         |
| Surface treatment methods              | Mean $\pm$ SD    | SE    | 95% CI of the mean | Median (IQR)     | Minimum-maximum | p value |
| Sand blasting(n=20)                    | 7.56 $\pm$ 0.905 | 0.202 | 7.13-7.98          | 7.53 (6.97-8.19) | 5.57-9.21       | <0.001* |
| Hydrofluoric acid(n=20)                | 6.09 $\pm$ 1.51  | 0.338 | 5.38-6.79          | 6.57 (5.27-6.99) | 1.81-8.38       |         |
| Hydrofluoric acid +sand blasting(n=20) | 5.32 $\pm$ 1.24  | 0.277 | 4.73-5.89          | 5.05 (4.37-6.13) | 3.36-7.98       |         |

**Table 4: Comparison of ARI score proportions between the study groups Data are presented as frequency and percent. (P) value was obtained by Chi-Square test. For comparison of column proportions with Bonferroni adjustment**

|        |                                                           |   | adhesive remnant index lab |      |      |      |      | Total |         | P |
|--------|-----------------------------------------------------------|---|----------------------------|------|------|------|------|-------|---------|---|
|        |                                                           |   | 1.00                       | 2.00 | 3.00 | 4.00 | 5.00 |       | 2       |   |
|        |                                                           |   | 0                          | 0    | 0    | 0    | 0    |       | 7       |   |
| Groups | Feldspathic porcelain sand blasting G1                    | n | 6                          | 4    | 0    | 0    | 0    | 10    | <0.001* |   |
|        |                                                           | % | 66.7                       | 21.1 | 0.0  | 0.0  | 0.0  | 16.7  |         |   |
|        | Feldspathic porcelain hydrofluoric acid +sand blasting G2 | n | 0                          | 5    | 3    | 2    | 0    | 10    |         |   |
|        |                                                           | % | 0.0                        | 26.3 | 60.0 | 16.7 | 0.0  | 16.7  |         |   |
|        | Feldspathic porcelain hydrofluoric acid G3                | n | 3                          | 6    | 1    | 0    | 0    | 10    |         |   |
|        |                                                           | % | 33.3                       | 31.6 | 20.0 | 0.0  | 0.0  | 16.7  |         |   |
|        | Zirconia sand blasting G4                                 | n | 0                          | 0    | 0    | 6    | 4    | 10    |         |   |
|        |                                                           | % | 0.0                        | 0.0  | 0.0  | 50.0 | 26.7 | 16.7  |         |   |
|        | Zirconia hydrofluoric acid +sand blasting G5              | n | 0                          | 1    | 0    | 2    | 7    | 10    |         |   |
|        |                                                           | % | 0.0                        | 5.3  | 0.0  | 16.7 | 46.7 | 16.7  |         |   |
|        | Zirconia hydrofluoric acid G6                             | n | 0                          | 3    | 1    | 2    | 4    | 10    |         |   |
|        |                                                           | % | 0.0                        | 15.8 | 20.0 | 16.7 | 26.7 | 16.7  |         |   |
| Total  |                                                           | n | 9                          | 19   | 5    | 12   | 15   | 60    |         |   |
|        |                                                           | % | 15.0                       | 31.7 | 8.3  | 20.0 | 25.0 | 100.0 |         |   |

## Discussion

The objective of this study was to evaluate and compare the shear-bond strength (SBS) of metallic orthodontic brackets bonded to zirconia and feldspathic porcelain crowns using different surface

treatment protocols . and to investigate whether the application of pretreatment on the zirconia and feldspathic porcelain had any influence on the shear bond strength (SBS).

Zirconia has emerged as a preferred material in prosthetic dentistry due to its strength, biocompatibility, and aesthetic properties. However, one of the challenges in utilizing zirconia in orthodontics lies in effectively bonding metal brackets to zirconia restorations because it is a polycrystalline none etchable ceramic. As metal brackets are typically required for orthodontic procedures, establishing a strong and durable bond to zirconia is crucial to ensure the longevity and effectiveness of orthodontic treatment

The purpose of choosing zirconia versus feldspathic porcelain because both are the most common materials used among our population.

The efficacy of conventional orthodontic bracket bonding techniques is compromised when bonding to non-traditional surfaces like zirconia. This often leads to untimely bracket debonding, which hinders the progress of treatment, prolongs treatment duration, and consumes a significant amount of clinical chair time. Consequently, extensive research efforts have been undertaken to enhance the characteristics of dental materials and treatment methodologies, with the aim of establishing bracket bonds that exhibit enhanced stability and durability to material such zirconia crowns<sup>11,12</sup>

After all orthodontic treatment is finished, the brackets should be carefully removed from the restoration surfaces without compromising the integrity of the restorative material. Super bond strength is therefore not recommended. In clinical practice, the SBS range of 6–8 mega Pascals is adequate for orthodontic attachments affixed to tooth surfaces<sup>13</sup>

The samples underwent artificial ageing and thermocycling. The specimens underwent 1000 cycles of thermocycling. This was significantly higher compared to prior studies that assessed the bond strength between ceramics and brackets, which either did not subject the specimens to any thermocycling<sup>14,15</sup> or performed a maximum of 500 cycles.<sup>11,16</sup> A greater quantity of thermal cycles can more accurately represent the conditions of the oral environment and the decline in mechanical properties resulting from the ageing process.<sup>17</sup>

In this study the glazed surface was not removed. Owing to the various complexity accompanied with deglazing, it is comforting to realize that sufficient bond strengths were obtained with glazed feldspathic porcelain.<sup>18,19</sup> Also, Bourk et al in their study suggested that deglazing before bonding does not add any benefits over alternative protocols. Moreover, it is a less destructive bonding technique.<sup>20</sup>

In the present study, the results showed that there was a significant difference between the SBS obtained using different ceramic materials and different surface treatments. Higher SBS has been shown within feldspathic porcelain group this might be due to the glass content and silica particles madding both chemical and micromechanical bond within the feldspathic porcelain

Zirconia SBS showed higher value when treated by sandblasting or HF acid and silane than when treated with both methods

Lowest value of SBS recorded in G2&G5 when treated with HF acid+silane and sandblasting at the same time because over conditioning of any substrate lead to non-favorable irregularities (deep and narrow) which lead to improper wetting of the substrate by the adhesive due to air pocketing , and the opposite in case of

G1,G3,G4,G6 the selection of one type of surface treatment will result in shallow and wide microscopic roughness to better wettability of the substrate and leading to increased SBS<sup>21</sup>

All the tested groups in spite of the type of ceramic material or surface treatment. A universal bonding agent was used that contains MDP (10-methacryloyloxydecyl dihydrogen phosphate) is particularly effective because MDP forms a strong chemical bond with feldspathic porcelain (or other ceramics). MDP works by interacting with the metal surface of the bracket to create a durable bond<sup>22</sup>

Reynolds stated that a minimum bond strength of 5.9–7.9 megapascals (MPa), could result in successful clinical bonding. This keeps the bracket attached to the tooth for the length of the treatment without being excessively strong as to not damage the underlying substrate while detaching the brackets when the treatment is finished<sup>23</sup>

These outcomes were comparable to those of a prior study by Buyuk et al., which discovered that adhesion techniques and the types of ceramic materials—feldspathic ceramic, resin nanoceramic, and hybrid ceramic—had a major impact on the bond strength. However, the conditioning techniques didn't.<sup>1</sup>

However, Dilber et al. discovered that the substrate treatment process had a substantial impact on the average SBS values, but not the ceramic material.<sup>24</sup>

Furthermore, Biglic et al. came to the conclusion that the type of feldspathic porcelain crown might cause the SBS of a bracket attached to various ceramic substrates to display varying values.<sup>25</sup>

El-Banna, et al found that surface treatments (sandblasting, and chemical treatments) to improve the bonding of orthodontic metal brackets to zirconia.

Sandblasting with aluminum oxide particles (50 µm) and the use of universal bond containing MDP (10-methacryloyloxydecyl dihydrogen phosphate) were found to significantly enhance the shear bond strength.<sup>26</sup>

Wongrachit et al., however, investigated how acid surface treatments affected the shear bond strength of metal brackets to zirconia ceramics and found that two-minute basic etching techniques using HF resulted in insufficient SBS of metal brackets to zirconia.<sup>27</sup>

Using a universal adhesive, Pouyanfar et al. investigated the shear bond strength of metal brackets to zirconia with various surface treatments. They found that sandblasting and acid etching had no discernible effects on the shear bond strength of zirconia to metal brackets. Regardless of the kind of surface preparation, the use of Universal Adhesive in this investigation produced a respectably high SBS in every group.<sup>28</sup>

Vikas V. et al. Ceramic brackets attached to three distinct varieties of feldspathic porcelain were evaluated for shear bond strength. The group that received hydrofluoric acid surface treatment had the best bond strength for attaching brackets to feldspathic porcelain crowns. The surface of crowns that had been etched with hydrofluoric acid and silane primer applied had the best zirconia bond strength.<sup>7</sup>

Amer JY et al. investigated how various surface treatments and bonding techniques affected the shear bond strength between metallic orthodontic brackets and monolithic zirconia. They came to the conclusion that the surface treatment had a significant impact on the SBS between zirconia crowns and metallic brackets. The highest SBS was obtained using sandblasting. Bond failure resulted from

bonding to untreated glazed zirconia surfaces.<sup>29</sup>

Abdelmoniem et al, studied the efficacy of universal adhesive for bonding resin to zirconia surface and concluded that Air-borne particle abrasion combined with 10-MDP universal bond conditioning is the most reliable surface treatment for zirconia restorations.<sup>10</sup>

The combination of increased surface area from mechanical treatment and chemical bonding with both 10-MDP and silane demonstrated the highest shear bond strength in a study by Kim J. et al. to assess the impact of different forms of mechanical and chemical preconditioning on the shear bond strength of orthodontic brackets on zirconia restorations. By expanding the surface area, aluminum sandblasting enhanced the mechanical bonding.<sup>30</sup>

## Conclusion

1-The two ceramic materials produced SBS with significant differences with higher value in feldspathic porcelain. Sandblasting significantly increase SBS in both materials, zirconia and feldspathic porcelain.

2-Sandblasting combined with HF etching and silane at the same time can significantly decrease SBS compared to etching with HF or roughening the surface with sandblasting separately.

3- Both material types and surface treatment methods did affect the SBS value.

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## Data availability

The data that support the findings of this study are available from the

corresponding author, upon reasonable request.

## Ethics approval

No approval of research ethics committees was required to accomplish the goals of this study because it was an invitro study

## Competing interests

The author has no competing interests to declare

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