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The Effect of 35% Carbamide Peroxide Strength of Lithium Disilicate Faced Zirconia Dental Restoration: A Pilot Study

Keywords
Carbamide Peroxide, Home Bleach, Lithium Disilicate, Shear bond strength, Zirconia, zirconia Veneer

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ABSTRACT

Objective: The purpose of the paper was to study the influence of 35% Carbamide Peroxide (CP) external coat on the shear bond strength (SBS) of the lithium disilicate veneered zirconia restoration. This work investigates whether the bleaching is possible for such a restoration without leading to future failure.
Materials and Method: A total of 20 specimens were fabricated in this pitot study. The specimens were subdivided into two groups: 10 specimens without bleaching coat and the other 10 specimens were coated with 35% CP whitening gel.
Result: The mean value of the SBS showed the highest bond was represented in the group of bleached specimens (191). While, Mann-Whitney U test (non-parametric test) showed that the p-value for the two groups is not significant (p-value 0.172), means that there is no clear difference in the shear bond.
Conclusion: The pilot study revealed that there is an increase in the mean value of SBS between zirconia and lithium disilicate in the treated group but considered as a non-significant difference. SEM showed a clear surface change in the bleached veneering material which might enhanced the bonding strength with the core.

INTRODUCTION

With a social media invasion and the increased beauty advertisings through celebrities and famous actors, the people interest about teeth whitening has become important as one of the beauty standards. Many patients choose bleaching treatment for esthetical reasons. Some of them want whiter teeth. Whereas, elimination of the intrinsic discoloration was the choice of the others. Such discolorations caused by smoking, drinking tea, coffee or red wine [1]. For treating discolored teeth, popular materials were used, such as Hydrogen Peroxide (HP) and CP or Sodium Perborate (SPB) [2]. The same active ingredient can be used in home bleaching kits at concentrations of 10%-15% or in-office at a concentration of 35%. Higher concentrations can cause more harm to the essential pulpal tissues and accelerate diffusion. Because it combines pulp safety and whitening efficiency, low concentrated agent home bleaching has gained popularity since its launch in the 1990s.
Those patients with replaced teeth prefer all-ceramic over porcelain fused to metal restorations, and this evidence has been given by a large number of available studies [3,4,5]. They considered as a good alternative to PFM crowns/bridges [6] and clinical results were provided by Etman and Woolford [7,8]. Although, all- ceramic materials are considered as high-strength, natural-colored materials for dental restorations. Yet, color matching between restorative materials and tooth still remains a challenging matter as the optical properties of the natural teeth cannot be preserved due to darkening with older ages [9]. Although bleaching solutions are intended to be used to whiten natural teeth, they may unintentionally come into touch with dental materials used to restore teeth in the aesthetic area.

Previous research indicates that bleaching agents clearly affect the surface roughness, microhardness, glossiness, tint, and flexural strength of different dental restorative materials. The kind of ceramic material, surface treatment (auto-glazed, overglazed, or simply polished), bleaching agent concentration, and application time all affect the color, surface roughness, and microhardness of ceramic materials [10,11]. A lot of studies focused on the optical properties of different ceramic materials, yet further studies are needed to examine all-ceramic restoration especially zirconia with lithium disilicate facing type. Therefore, the aim of this pilot study is to assess the effect of 35% CP home bleaching agent on the SBS of not glazed zirconia/e-max materials.

MATERIALS AND METHOD

Sample Description

Based on the study of [12], specimens were designed in a bar like the rectangular shape. They were made from a partially sintered zirconia IPS e.Max ZirCAD, Ivoclar Digital blank (Yttrium-stabilized zirconium oxide for CAD/CAM technology) (Ivoclar digital, Germany), (LOT No. X08278). It was natural tooth shaded blank and had a low translucency (LT). The specimen fabricated with dimensions of 9 mm Length (L) × 4mm Height (H) × 4mm Width(W) that associated to international organization for standardization 1999 (Fig.1) [13]. Surface of the rectangular samples (4mm X 4mm) were veneered with E.Max ceramic (Ivoclar vivadent AG, Liechtenstein) according the manufacture instruction. The final length of the veneer ceramic was 3mm.

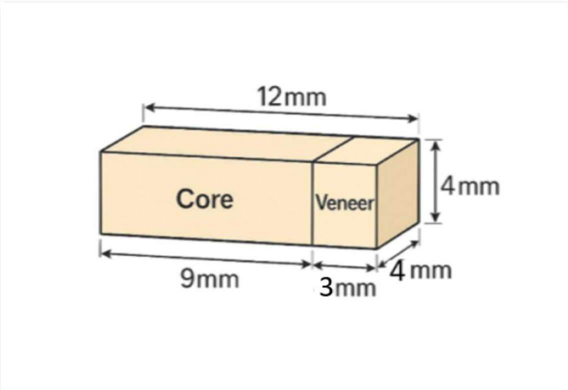

Fig. 1: Specimen dimensions

Sample grouping and experiment

20 specimens were fabricated and divided into two subgroups; the first group which represents the control group without whitening treatment and stored in the distilled water, while the second group treated with home whitening gel 35% concentration of CP (Opalescence, USA). This concentration was chosen for its shorter wear time and touch ups recommended for the clients. The bleaching agent was applied as an external coating according to the manufacturer instruction 60 min per day, for 7 days [14]. It is crucial to note that neither material's inner bonding surface was treated. In order to replicate the intra-oral condition, the specimens were washed with water for ten seconds after each application and kept in distilled water at 37 °C until the subsequent application. The whitening gel was applied using a brush that was uniformly thick (0.5-1.0 mm) on the polished specimen surfaces. Both the experimental and control groups underwent the SBS test. Before analysis, each specimen was thoroughly cleaned and dried.

Shear bond strength test

SBS test for 20 specimens was performed using a "Universal testing machine" (LARYEE, 50kn, 1202001, China, 2012) at a crosshead speed of 1mm/min until specimen fracture. Each specimen was secured tightly in 90º and the force was vertically applied with a stainless-steel chisel rod to the bonding interface between the edge of core and ceramic veneer. The maximum force that led to specimen fracture recorded in Newton (N) and the SBS in Megapascal (MPa) was calculated according to the following formula:

Shear bond strength (MPa) = Maximum force (N)/ bonding surface area (2mm) [15].

RESULTS

The "mean and standard deviation" (SD) of the SBS values were listed in Table 1, and "Mann-Whitney U test" (non-parametric test) in Table 2 which showed that the p-value for the two groups is not significant >0.05 proving that there is no clear difference in the shear bond. A visual summary was provided through the boxplot including median, interquartile range and outliers, Figure 2.

Table 1: "Mean and standard deviation" (SD) for SBS values in MPa

Studied groups	n	Mean ± Sd.	Min.	Max.
Zirconia with e.max veneer without bleaching	10	185.5 ± 62.11	120	350
Zirconia with e.max veneer with bleaching	10	191 ± 18.22	170	225

Table 2: "Mann-Whitney U test" (non-parametric test) for the tested groups

Groups	U statistic	P-value
Zirconia with e.max veneer without bleaching vs. Zirconia with e.max veneer with bleaching	31.5	0.172 (N.S.)

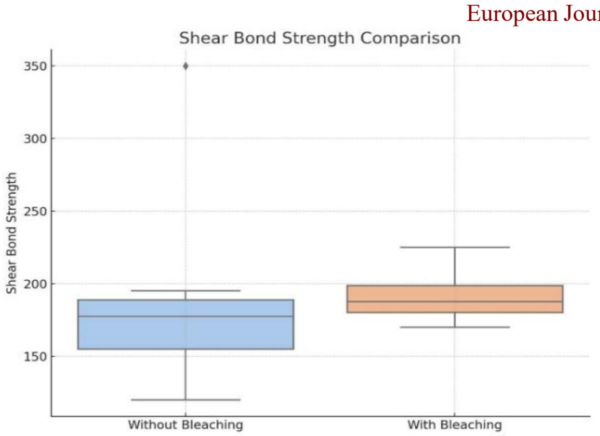

Fig. 2: Boxplot of the groups SBS test

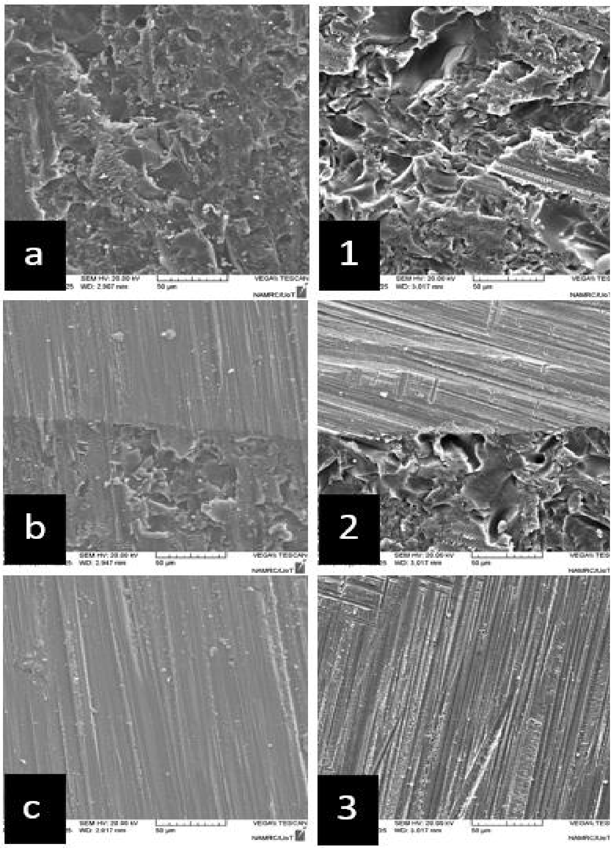

Fig. 3: "Scanning electron microscope" images at 1.00 kx for lithium disilicate (a and 1), junction of lithium disilicate and zirconia (b and 2), and zirconia (c and 3). Left column: images represent the materials surface before treatment with 35% CP, while, right column: images represent the materials surface after treatment

The "Scanning Electron Microscope" (SEM) images in Figure (3) showed the surface topography of the specimen treated with 35% CP which was obviously rougher compared to the non-treated specimen.

DISCUSSION

This pilot study investigated the SBS of the zirconia specimens veneered with lithium disilicate (IPS e-max) ceramic material after treatment with home bleach of 35% CP. It is noteworthy that this medium concentration was used because it is suitable as it requires short time with immediate results. The bleaching treatment in the current study was in contrast to the previous published papers, as the bleaching agent was applied as an outer coating only, keeping the junction at the inner surface between both materials untreated. This method flipped the results unexpectedly. The mean values of the tested groups showed the following results; 185.5 for non-bleached group and 191 for the bleached one. Even though the "Mann-Whitney U test" (non-parametric test) revealed a non-significant result, this minimal rise cannot be neglected. SEM images of the treated lithium disilicate part showed a noticeable surface irregularity compared to non-treated ones. The bleaching agent has oxidative properties that may mimic the acidic effect of hydrofluoric etching which results in increased surface roughness [16]. The SEM verifies that these surface alterations show that the bleaching chemical has penetrated further into the surface, creating an uneven surface with varying heights and depths. This was consistent with earlier research showing that bleaching increased the surface roughness of ceramics [17,18,19]. Free radicals from peroxide breakdown produced by bleaching agents can promote the dissolution of the ceramic matrix as the oxidative degrade the outer glass phase mildly without dissolution of crystalline phase, increasing roughness. This would modify the surface energy by forming hydroxyl groups and enhancing wettability and shear bond with zirconia material [20]. In contrast, the zirconia part of the specimen showed minimum or no surface changes under the "scanning electron microscope". The little increase in the SBS between zirconia and lithium disilicate cannot be explained by the improvement of micromechanical retention after zirconia surface treatment, as it has been found that acidifying or alkalizing the zirconia surface does not alter its surface roughness. Basically, this is may be due to non-glassy, crystallinity, non-polar and chemically inert nature of zirconia [21]. This may be the only reason which might explains the outcomes of this study and support our findings about unpredictable slight increase in the SBS. Moreover, there are no studies related to SBS investigation after external bleaching. On the other hand, based on the SEM images related to zirconia surface roughness, there are agreement with Tavangar et al. 2021 [22], in which their study examined the mechanical and optical properties in zirconia after exposing it to both office and home bleaching agents. And also, with the study of Alshali et al. 2023 [23] which found that the surface roughness of zirconia reinforced lithium silicate was not significantly affected by the different bleaching treatments. Therefore, the slight increase in the SBS in this study may refers to the oxidative modifications on the lithium disilicate veneer confirmed by SEM rather than changes in zirconia, even if the applied bleaching agent was on the external surface only. Further studies required whether in-vitro or in-vivo to examine SBS of veneers and more different restorations after bleaching treatment with different CP concentrations.

CONCLUSION

1.There is a slight increase in the SBS between zirconia and lithium disilicate after bleaching with 35% CP, but statistically considered as non-significant.

2.Depending on SEM images there are clear changes in the surface of lithium disilicate which refers to surface roughness, whereas, no changes appeared on the zirconia surface.

3.The explanation of minimum increase in the SBS may be due to the oxidative modifications of the veneer material.

Study limitation

There are three limitations faced by this pilot study. Firstly, the surface roughness test was excluded due to the bi-layered nature of the specimen. Thus, values could not be reliably assigned to a single material and the study depended on the SEM results. Secondly, small sample size due to the materials expense. And lastly, the limited or no studies proposed about SBS after external bleaching treatment, especially for veneers and other dental restorations.

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