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Effect of Ultrasonic Scaling on Debonding of Lithium Disilicate Glass Ceramic Laminate Veneer Restorations Cemented to Tooth Structures: in Vitro Study

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Abstract **Background:** This in vitro study was conducted to investigate the effect of ultrasonic scaling on debonding of lithium disilicate glass ceramic laminate veneers restorations cemented to tooth structure. **Materials and Methods:** 16 extracted sound upper anterior teeth were prepared to receive laminate veneer restorations. They were randomly assigned into 2 groups (n=8), as in group Non-US , the cemented fabricated laminate veneers were not exposed to ultrasonic scaling and in the ultrasonic group (US) the cemented fabricated laminate veneers were exposed to ultrasonic scaling. The GC Initial LiSi Press Lithium disilicate glass ceramics laminate veneers were fabricated according to manufacturer instructions. The debonding force test was applied after cementation and after ultrasonic scaling using Instrone testing machine. The obtained data were tabulated and analyzed statistically. Differences were considered significant at P<0.05. **Results:** the recorded values of the debonding force mean ±SD for Non-US group were (79.5288 ±16.5228N) and mean ±SD values recorded for US group were (54.0713 ±8.2647 N). The T test showed significant difference between 2 groups (p value=0.0016) and 95% CI (29.45±14.0057). **Conclusion(s):** Within the limitations of this study, it was found that ultrasonic scaling significantly affect the debonding force of cemented laminate veneers.

Keywords: *debonding force, laminate veneers, lithium disilicate ceramics, press ceramic ultrasonic scalar*

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1. Introduction

Laminate veneer restorations represent a conservative alternative to full coverage restorations for esthetic rehabilitation of anterior teeth [1] as they nearly leave all enamel intact [2]. Generally, the glass based ceramic veneers provide better esthetic and mechanical properties than the feldspathic veneers. Their improved prosperities are due to the interaction between the crystals and glassy materials as well as the size of the crystal, where finer size have more strength [3].

The addition of leucite and lithium disilicate fillers increase the strength and improve the esthetic by their optical prosperities and acid sensitivity, where the pressed ceramics by heat-treatment or lost- wax have less porous and higher crystalline contents to produce a homogenous material [4]. The lithium disilicate reinforced ceramics are considered true glass ceramics mimic the natural teeth with crystal contents more than 70% and crystal size is refined with subsequent improvement of flexural strength and translucency with wide range of esthetic applications involving full coverage and veneering of anterior teeth [5].

The porcelain veneer restorations provide a long term satisfactory and successful results for up to 8 years follow up in terms of color stability and gingival health, while composite resin veneers have limited life for 4 years due to polymerization shrinkage and color changes [6].

The clinical success of glass ceramic veneers can be attributed to many factors, including cementation technique, where the retention of lithium disilicate aided by etching of both the enamel surface and the ceramic veneer surface to create micromechanical interlocking together with chemical bond using the universal adhesives [7]. Survival of ceramic veneers depends on patient's maintenance, including professional cleaning 3-4 times per [1].

Scaling and root planning (SRP) is an essential procedure to control the biofilm accumulation, in order to maintain and preserve the periodontal health [8]. It is recommended to professionally clean the teeth restored by laminate veneer restorations to prolong their durability [6].

The in vitro studies showed superior properties of ultrasonic scaling over the hand instrumentation, in terms of effective mechanical removal of dental plaque and calculus, bactericidal effect, water lavage in addition to better clinician ergonomics [9]. However, there are damaging effects of the ultrasonic scalers, which might be attributed to the instrumentation time, the tip angulation and design and the lateral force [10,11].

While reviews recommend to avoid ultrasonic scaling to veneers [1,6], there is no study investigating the possible effect of ultrasonic scaling on ceramic veneer restoration and therefore, in this study we investigated the effect of ultrasonic scaling on bonding of lithium disilicate laminate veneer restoration cemented to tooth structure in vitro.

2. Materials and Methods

2.1. Ethical Statement

Faculty of dentistry Bani-Suef University Research Ethics Committee (FDBSU-REC) has reviewed the protocol and Approval number: #FDBSUREC/14042019/AA.

2.2. Teeth Collection and Preparation

16 extracted natural human upper central incisor teeth were collected from oral and maxillofacial surgery department, Misr University of science and technology (MUST). A digital caliber was used to measure teeth dimensions (10 mm in length, 7mm mesio-distal diameter at the level of the cervical (CEJ) and 8.5 mm mesio-distal diameter incisally.

They were examined for any cracks, factures or carious lesions, where only sound teeth were included. Thereafter, they were cleaned, sterilized and mounted in a specially designed and constructed cylindrical mold of green chemical cure resin powder and liquid Acrostone (dental factory, Industrial zone, Madinat Alsalam, Egypt), with 12 mm diameter, and 20 mm height in a vertical direction.

The labial surface of each tooth was prepared in two planes, using 0.3 depth cutting diamond stone and tapered diamond stone. 0.3 chamfer finish line and wrap around incisal edge preparation were made. Proximally preparation was extended slightly to the contact area, Amount of tooth preparation was checked using the split-silicone template. All teeth blocks were stored in saline solution at room temperature.

2.3. Laboratory Procedures

An individual poly-vinyl siloxane impression (Virtual, Ivoclar-vivadent) was taken, for each prepared tooth sample then it was poured using (type IV) for stone die fabrication.

The laminate veneers press glass ceramic was fabricated according to the manufacturer instructions (GC Initial LiSi Press Lithium Disilicate Glass Ceramics, GC Corporation, Tokyo, Japan).

2.4. Bonding Procedures of Laminate Veneers Press Glass Ceramic

Each one of the fabricated dental laminate veneers press glass ceramic was etched for 90 seconds, with hydrofluoric etchant 5g (9.5%HF) buffered hydrofluoric acid gel (Bisco, Inc 1100W. Irving park Rd. Schaumburg, IL 60193 847-534-6000 USA), then it was rinsed with a copious amount of water, and it was dried by air syringe. A layer of silane was applied according to the manufacturer instructions (Pentron clinical, Technologies, LLC, and 68 N. Plains Industrial Rd. Wallingford, CT USA 06492.203-265-7397), and then it was dried with air syringe. The bond was applied for 20 sec, primer adhesive c&b 6ml\6gm (Pentron clinical, Technologies, LLC, and 68 N. Plains Industrial Rd. Wallingford, CT USA patent No. 203-265-7397).

The prepared tooth surface was etched for 30 seconds with 37% phosphoric acid Etchant gel (Charm Etch, 37(LV) DENTKIST, Inc, 1412004 Korea), it was removed with water spray and air-dried. A bonding agent was applied to the prepared tooth surfaces (primer adhesive c&b 6ml\6gm (Pentron clinical, Technologies, LLC, and 68 N. Plains Industrial Rd. Wallingford, CT USA patent No. 203-265-7397).

Finally, the laminate veneers press glass ceramic was cemented with light - polymerizing flow composite 4 x 1.2gm syringe w/ tips (Master-Dent lc, Dentonics INC, USA 8382 REF: 19-414-A1) according to the manufacturer's instructions with figure pressure that was maintained for 15 minutes. All Laminate veneer press glass ceramic was cemented using finger pressure and maintained for 15 minutes. The excess cement was removed, and the light cure unit (Ledition Germany) was used for 20s in all directions. The margins were finished using flexible polishing discs (Sof- Lex XT Pop-On, 3M ESPE). The all cemented samples were stored in a saline solution.

They were randomly assigned into two groups with eight samples were included in each one. The first group was Non- ultra sonic (Non- US) group in which, the cemented fabricated laminate veneers were not exposed to ultrasonic scaling and the second group was Ultra sonic (US) group in which, the cemented fabricated laminate veneers were exposed to ultrasonic scaling.

2.5. The Application of Ultrasonic Scaling in "Ultra Sonic" Group

A piezoelectric ultrasonic scaler (Woodpecker ultrasonic scaler UDS-J2, China) with stainless steel scaling tip (G2), was used to scale the laminate veneer restorations of 8 cemented samples of ultrasonic group. A standardized scaling technique was applied, as the lateral side of the tip was adapted for the scaled laminate surface with angle ≤15°, at full power (30.000 cps) under sufficient cooling with distilled water for 60 seconds.

2.6. Debonding Force Test

Each sample was mounted , individually , on a computer controlled materials testing machine (Model 3345; Instron Industrial Products, Norwood, MA, USA) with a load cell of 5 kN and the data were recorded using computer software (Instron® Bluehill Lite Software), where the sample was secured to the lower fixed compartment of the testing machine by tightening screws (Figure 1).

Figure 1. Instron

Figure 2. Debonded laminate veneer sample

The debonding force test was done by a compressive mode of load applied incisaly using a metallic rod with a round flat tip (2 mm diameter) attached to the upper movable compartment of the testing machine traveling at cross-head speed of 1mm/min, with tin foil sheet in-between to achieve homogenous stress distribution and minimization of the transmission of local force peaks. The load was applied at 135° angle (through fixing the sample in specially designed 45o angle jig), Figure 2.

The load at failure was manifested by the total separation of veneer and confirmed by a sharp drop at load-deflection curve recorded by the computer software (Bluehill Lite Software Instron® Instruments) and the load required to totally debond veneer was recorded in Newton.

2.7. Statistical Analysis

Data analysis was performed in several steps. Initially, descriptive statistics for each group results. Unpaired t-test was done between groups using Graph-Pad InStat statistics software for Windows (www.graphpad.com). P values ≤0.05 are statistically significant in all tests. The confidence interval of difference means was calculated by online calculator (https://www.socscistatistics.com/confidenceinterval/default4.aspx).

3. Results

Descriptive statistics, showing mean values, standard deviations (SD) and 95% confidence intervals (low and high) values for debonding forces measured in Newton (N) recorded for both groups are summarized in Table 1 and graphically represented in Figure 3.

There was a significant difference between non ultrasonic and ultrasonic groups ***(p-value 0.0016).)*** Means and SD of both US and Non US, coefficient interval and the comparison between 2 groups as indicated by unpaired t-test.

Table 1. deboning force of non-ultrasonic and ultrasonic groups

Variable		Mean± SD	95% CI	Statistics	
				t-value	P value
Groups	Without US_group	79.5288±16.5228 N	29.45±14.0057	-3.90	0.0016
	After_US group	54.0713±8.2647 N			

Significant P Value P≤0.05

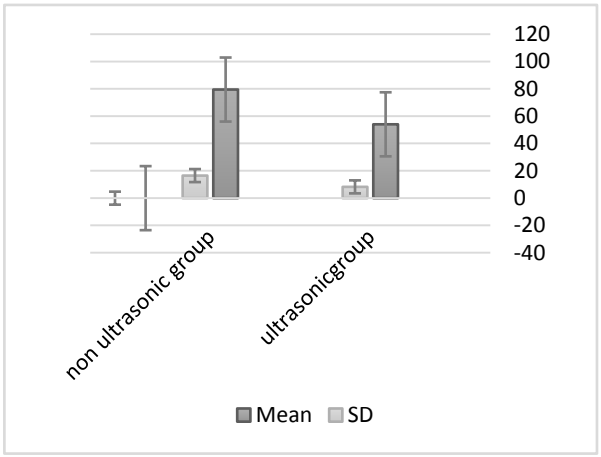

Figure 3. Column chart showing debonding force results mean values for both groups

4. Discussion

The ceramic veneer restorations provide a highly esthetic solution for anesthetic anterior teeth in a conservative way and with survival rate up to 10 years Ohashi [11] et al [12] evaluated and compared of the characteristics of three pressable lithium disilicate glass ceramic materials (GC Initial LiSi Press (LiSi; GC), IPS e.max Press (e.max; Ivoclar Vivadent), and Vintage LD Press (LD; Shofu) and they concluded that the physical properties of the three lithium disilicate glass ceramic materials differed significantly. In addition, they indicate that Li Si possesses superior physical properties and chemical stability as a dental material.

According to manufacturer pamphlet, the GC Initial™ LiSi Press is one of the most recent pressable ceramic materials and it is considered the first lithium disilicate

ceramic with High Density Micronization (HDM technology), applying equal dispersion of lithium disilicate micro-crystals to fill the entire glass matrix rather than using traditional larger size crystals that do not take full advantage of the matrix structure, where the result is ultimate combination of strength and aesthetics, making GC Initial™ LiSi Press is perfectly suitable for all types of restoration through all levels of transparency.

The bacteria populate any surface, especially artificial surfaces as restorative materials where the surfaces characteristics, including the surface roughness, and restoration margins affect the bacterial adhesion, resulting in gingivitis and periodontitis. Therefore, periodontal maintenance by regular professional hygiene, including ultrasonic scaling, stainless steel curettes and polishing pastes, are used to control the bacterial adhesion increasing the durability of restorations. However, all might affect the restorations with some degree [13].

While the reviews of clinical studies recommend not to use the ultrasonic scaling for ceramic veneer restorations [1,6], they don't provide what are the possible causes. However, there was an in vitro study by Checketts, et al [14], showed that the effect of ultrasonic scaling and the stainless steel curette are nearly similar with both groups showed significantly higher bacterial adhesion than control.

According to the clinical studies, the ultrasonic scaling revealed many advantages over the hand instrumentations in terms of time saving by about 20-50%, more patient and clinician acceptance with the same effects on tissues healing [15]. The piezoelectric ultrasonic create a linear vibration pattern which have less adverse effects on surface roughness of resin restorations than magneto restrictive ultrasonic with elliptical vibration pattern [16] and also, it has less heating effects, more ease of use and quitter operations [17].

Most of studies investigated the effect of scaling whether hand instrumentation [14] or sonic and ultrasonic scalers on surface roughness of gold alloy III, lithium dislocate and zirconia [18] and metal fixed restoration including titanium and nickel-chromium [19] and the micro leakage around zirconia crowns [20]. Therefore, the current in-vitro study examined the effect of an ultrasonic scaler with a stainless steel tip on the retention of press glass ceramic laminate veneer materials cemented to enamel of the tooth structure.

The results of the current study showed that ultrasonic scaling, using piezoelectric ultrasonic scaler for one minute with standard conditions (the angle between the tip and laminate veneer surface was ≤15°, at full power (30.000 cups) under sufficient cooling with distilled water) affects the retention of dilithium silicate veneers. This is consistent with study by Melo Filho AB et al, [21] who showed that the ultrasonic scaling affected the retention of the cemented crown by zinc phosphate, but with longer time of application for 15 minutes and submitted thermal cycle.

The ultrasonic scaling vibrations may induce fracture of the cement that fills the irregularities of both tooth surface and veneer surface and subsequently it affects the retention of the veneer to the tooth [20].

Within the limitations of this study, including the limited number of samples and difference from oral environment, it is recommended not to use ultrasonic scaling for periodontal maintenance of lithium disilicate. Also, we recommend further study to apply the standard ultrasonic scaling for removal of the veneer without fracture.

5. Conclusions

Within the limitations of this study, it was found that ultrasonic scaling affect significantly on the retention of cemented laminate veneers.

Author Contributions

Conceptualization: Abo El-Magd A. Data curation: Abo El-Magd A. Formal analysis: Abo El-Magd A & Mohammed E. Funding acquisition: Abo El-Magd A& Mohammed E. Investigation: Abo El-Magd A & Mohammed E. Methodology: Abo El-Magd A. Project administration: Abo El-Magd A. Resources: Abo El-Magd& Mohammed E. Software: Abo El-Magd A &Mohammed E. Supervision: Abo El-Magd A Validation: Abo El-Magd A & Mohammed E. Visualization: Abo El-Magd A. Writing - original draft: Mohammed E l. Writing - review & editing: Mohammed E.

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