

**Comparing Microleakage in Porcelain Laminate Veneers after Ultrasonic Scaling With Margins Placed 0.5mm And 1mm from CEJ – An In Vitro Study**

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**Citation of this Article:** Deepti J.V, Harini Karunakaran, Dr Sadasiva Kadandale, Dr Senthil Kumar Kumarappan, Dr Anupama Ramachandran, Dr Manu Unnikrishnan, “Comparing Microleakage in Porcelain Laminate Veneers after Ultrasonic Scaling With Margins Placed 0.5mm And 1mm from CEJ – An In Vitro Study”, IJDSIR- September - 2020, Vol. – 3, Issue - 5, P. No. 486 – 492.

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**Type of Publication:** Original Research Article

**Conflicts of Interest:** Nil

**Abstract**

**Aim:** To evaluate microleakage in porcelain laminate veneers (PLV) after ultrasonic scaling, with cervical margins placed at 0.5mm and 1mm from the CEJ, cemented with Enamel and Universal bonding agents.

**Materials And Methods:** 40 anterior teeth were prepared for porcelain laminate veneers with cervical margins at 0.5mm and 1mm from the CEJ. Samples were split into 2 groups (n=20): Enamel bonding agent (Heliobond)(Ivoclar Vivadent) and universal bonding agent (Tetric n bond

(Ivoclar Vivadent).PVS impressions were taken and IPS Emax PRESS veneers were fabricated.Tooth and veneer surface treatments were done. Enamel and universal bonding agents were applied to the appropriate groups. E max veneers were luted to the tooth using light-cure resin cement (Variolink-L) (Ivoclar Vivadent). Samples were scaled with an ultrasonic scaler device (60sec, hand pressure). The bonded specimens were stored in distilled water at 37°C for 5 days and then thermocycling was done between 5°C and 55°C for 100 cycles. Samples were then

submerged in 0.5% basic fuchsin dye for 24 hours. After sectioning the samples using a microtome, depth of dye penetration was measured in stereomicroscope (20X). Paired t-test and two-sample t-test ( $\alpha=0.05$ ) was used for statistical analysis.

**Result:** Porcelain laminate veneers bonded with Enamel bonding agent (Heliobond) had significantly lesser microleakage than Universal bonding agent (Tetric n bond). The cervical margins placed at 0.5mm from CEJ had greater microleakage than margins placed at 1mm from the CEJ but it was not statistically significant. Ultrasonic scaling has no significant effect on microleakage when margins were placed at 0.5mm and 1mm from CEJ.

**Significance:** Veneers bonded with enamel bonding agent with finish line kept at 1mm from the CEJ had lesser microleakage. Ultrasonic scaling can be safely carried out as a prophylactic procedure on porcelain laminate veneers.

**Keywords:** Porcelain laminate veneers, Enamel bonding agent, universal bonding agent, finish line, CEJ, Ultrasonic scaling, Laboratory research.

### Introduction

The development of porcelain veneers (PLV) as a conservative treatment to mask discolored teeth and to restore fractured or malaligned teeth has proved to be a boon to the practice of dentistry<sup>1</sup>. The clinical procedure for PLV's involves bonding thin restorations to the tooth surface to correct an unaesthetic appearance of the anterior teeth<sup>2</sup>. The reason PLVs are so popular is that they are very minimally invasive, and they give incredibly good esthetic results<sup>3</sup>. The marginal seal is an important criterion for the success of a veneer. Microleakage at margins may cause restoration failure as it allows bacteria, saliva, molecules, and ions between the tooth and the restoration which leads to secondary caries, discoloration at the margins, and tooth hypersensitivity<sup>1,4-9</sup>.

Adequate bonding between tooth and porcelain veneer is necessary to eliminate microleakage<sup>1</sup>. Composite resins are frequently used as luting agents for the cementation of PLV<sup>12</sup>. Enamel and dentin bonding are quite different in nature. Several reasons account for this difference in enamel and dentin bonding. The water content of dentin is considerably higher than that in enamel, which makes adhesion more complex<sup>11,13,14</sup>. Enamel bonding agents consist of Bis -GMA or UDMA resins (Hydrophobic resins) with diluents like TEGDMA to lower their viscosity. The universal adhesives are similar to single step self-etch adhesives. They can be used in both etch-&-rinse or self-etch mode to enamel and dentin. Universal adhesives consist of Bis - GMA, UDMA, HEMA (hydrophilic) in ethanol, phosphonic acid acrylate, and nanofillers. Intra enamel preparation of veneers—may extend subgingivally in case of surface defects like discoloration, gingival recession, cervical abrasion extending margins close to the CEJ<sup>10</sup>. In this study, the preparation margins were placed at 0.5mm and 1mm from the CEJ. Ultrasonic scalers are commonly used for removing plaque and calculus from the tooth surface. The vibrational forces produced by ultrasonic scalers may disturb the bond formed at the crown margin. A previous study reported that ultrasonic scaling with a piezoelectric unit caused microleakage at the cementum margin of Class V restorations<sup>15</sup>. Ultrasonic scaling has also been found to cause mechanical removal or roughening of the marginal interface which can lead to microleakage<sup>16</sup>. The null hypothesis in this study is that there is no difference in microleakage in porcelain laminate veneers bonded with enamel bonding agent and a universal bonding agent. The second null hypothesis is that there is no difference in the microleakage when the cervical margins are located at 0.5mm or 1mm from the CEJ.

### Materials and Methods

Tooth selection and preparation: Forty intact Maxillary central incisors were included in this in-vitro study. The teeth were extracted due to periodontal reasons and they were stored in a physiologic saline solution. The exclusion criteria are restorations, caries, cracks or fracture lines, cervical abrasions, and hypo calcified lesions. Teeth were examined for caries using an explorer. Hand scaling was done to remove calculus and the teeth were examined under X 2.5 magnification (VHX 600, Keyence, Osaka, Japan) to check for micro cracks. The chosen teeth samples were notched at the roots and embedded on the auto polymerizing acrylic block for increased control during tooth preparation. 40 selected Maxillary central incisors teeth were prepared for receiving porcelain laminate veneers with cervical margins 0.5mm and 1mm from the CEJ (Figure 1- a). Specimens were divided into 2 groups (n=20): Enamel bonding agent (Heliobond, Ivoclar Vivadent) and universal bonding agent (Tetric n bond universal, Ivoclar Vivadent). They were further divided into the ultrasonic scaling group and the control group (Table1). Only intra enamel veneer preparations were done. The finish line was kept as a 1 mm chamfer. The veneers were manufactured with a thickness of 0.6mm and a 100 µm cement gap. Poly Vinyl Siloxane impressions were taken, and IPS Emax PRESS veneers were fabricated from the laboratory.

**Tooth And Veneer Surface Treatment**

The prepared tooth surface was etched with 37% phosphoric acid (IPS ceramic etching gel, Ivoclar Vivadent)) for 15 seconds (Figure 2). Enamel bonding agentm / universal bonding agent was applied using a micro brush to appropriate groups. The surface of the veneer was treated with 5% HF (IPS Ceramic etching gel, Ivoclar Vivadent) using a micro brush for 20 seconds. Acid was removed with air-water spray for 30 seconds. It was followed by a silane coupling agent (Monobond plus, Ivoclar Vivadent) which was applied on the veneer surface using a micro brush for 15 seconds (Figure 1-b and c). The veneers were luted with light cure resin cement (Variolink veneer, Ivoclar Vivadent). The

veneers were seated completely, and the excess cement was removed with a micro brush and then cured (Figure 1-d).

**Ultrasonic Scaling And Dye Penetration**

Ultrasonic scaling was performed in the ultrasonic scaling group with a piezoelectric device (UDS -J Piezo Ultrasonic scaler, woodpecker) with a scaling tip (model G2, Dentmark). Scaling was done at full power with distilled water. The bonded specimens were stored at 37°C in distilled water for 5 days and subjected for thermocycling between 5°C and 55°C for 100 cycles. Samples were then submerged in 0.5% basic fuchsin dye for 24 hours. Dyed samples were sectioned buccolingually using a microtome. Depth of the dye penetration was measured from the CEJ by careful examination using a stereomicroscope in millimeters.

(figure 2)

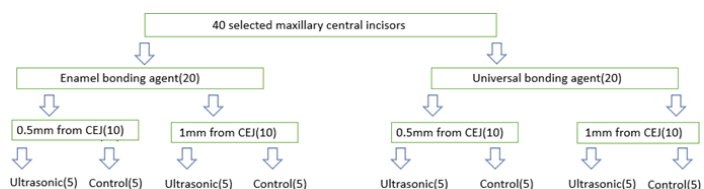


Table 1: Sample size and division of groups



Figure 1: a) Tooth preparation with cervical margins at 0.5mm and 1mm from the CEJ b) and C) Surface of the veneer treated with 5% HF and silane coupling agent d) E max veneer luted to tooth structure

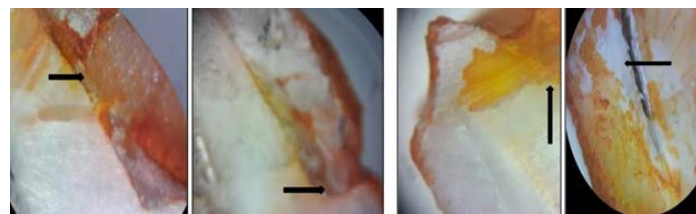


Figure 2: Dye penetration is seen in stereomicroscope in 20X magnification

**Statistical Analysis:** Paired t-test and two-sample t-test (α=0.05) were used for statistical comparisons

**Results**

Enamel bonding agent group (Heliobond) had lesser marginal leakage than Tetric N bond (Universal bonding agent) group which was statistically significant ( Table 2 ) Microleakage at the cervical margins at 0.5mm from the CEJ was greater than the margins at 1mm from the CEJ for both enamel and universal bonding agent, but no statistical significance between groups with respect to the margins. (Figure 3) Ultrasonic scaling has no significant effect on microleakage when margins were placed 0.5mm and 1mm from CEJ in the universal bonding agent group (Table 3). In the enamel bonding agent group there was no significant difference in the ultrasonic scaling and the control subgroup when the margins were placed at 1mm from the CEJ however ultrasonic scaling showed a significant difference when the margins were kept at 0.5mm from the CEJ ( Table 4).

Table 2

**T-Test**

**Group Statistics**

Type	N	Mean	Std. Deviation
Microleakage score Enamel bonding agent	20	1.20	.894
Universal bonding agent	20	2.80	1.152

Table 3

**T-Test Universal bonding agent & 0.5mm from CEJ**

**Group Statistics**

Group	N	Mean	Std. Deviation
Microleakage score Ultrasonic	5	3.60	1.673
Control	5	3.20	.837

**T-Test Universal bonding agent & 1mm from CEJ**

**Group Statistics**

Group	N	Mean	Std. Deviation
Microleakage score Ultrasonic	5	2.40	.548
Control	5	2.00	.707

Table 4

**T-Test Enamel bonding agent & 0.5mm from CEJ**

**Group Statistics**

Group	N	Mean	Std. Deviation
Microleakage score Ultrasonic	5	2.20	.837
Control	5	1.40	.548

**T-Test Enamel bonding agent & 1mm from CEJ**

**Group Statistics**

Group	N	Mean	Std. Deviation
Microleakage score Ultrasonic	5	.60	.548
Control	5	.60	.548

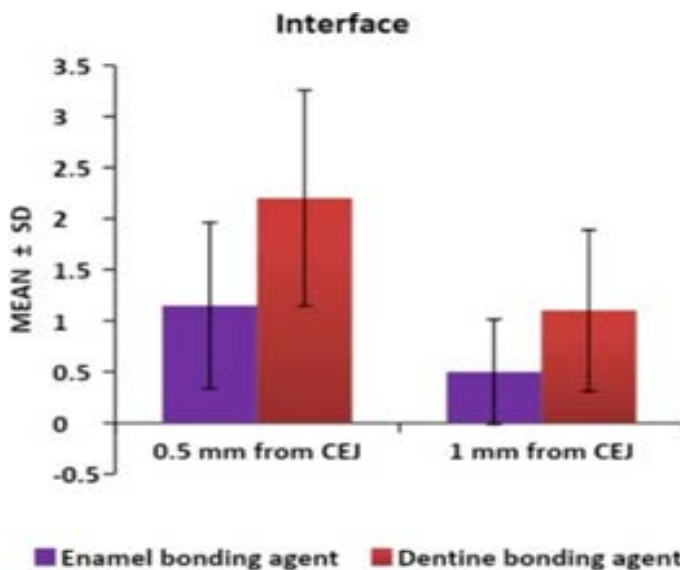


Figure 2

**Discussion**

The success of a porcelain laminate veneer depends upon its sealing ability. The PLV has advantages of both high aesthetics and conservative treatment<sup>17</sup>. Studies report 92% - 94.4% clinical survival rate at five years and 64%-93.5% at 10 years for PLV restorations<sup>18</sup>. The primary reasons for clinical failures of PLV are fractures, debonding, marginal defects, and discolorations. The marginal leakage often leads to partial debonding, discoloration, and fracture<sup>19</sup>. Various methods to evaluate microleakage are dye penetration, bacteria leakage, radioisotopes infiltration, and dye extraction. The dye penetration method allows the direct observation of dye penetration under magnification and gives information about the internal seal by the luting cement. Hence, this method was utilized during the study to access the microleakage. Basic fuchsin dye has a molecular weight less than the average diameter of the oral bacteria cell; hence it helps detect the small marginal discrepancy<sup>17</sup>. The results of this study showed that the Enamel bonding agent (Heliobond) group had lesser marginal microleakage than the

Tetric N bond (Universal bonding agent) group which was statistically significant. Frankenberger et al reported self-adhesive cement had poor marginal integration as a luting agent for ceramic inlays<sup>20</sup>. A previous study reported that etch and rinse adhesives had better enamel sealing of cemented veneers than self-etch adhesives<sup>21</sup>. The universal adhesives like self-etch adhesives are composed of mono-multi methacrylate monomers like Bis-GMA, UDMA, and hydrophilic monomers like HEMA<sup>22</sup>. The hydrophilic acid monomers have been found to cause water absorption, swelling which can compromise the mechanical strength and dimensional stability at the resin tooth interface<sup>23</sup>. The universal adhesive polymers like self-etch adhesives are designed in such a way that they do not require any pre-conditioning of enamel or dentin. Due to this smear layer is enveloped into the bond structure. Incomplete infiltration of primers within the hybrid layer allows the nano-leakage<sup>24</sup>. Microleakage at the cervical margins at 0.5mm from the CEJ was significantly greater than the margins at 1mm from the CEJ for both enamel and universal bonding agent groups, although the intragroup difference was greater in an enamel bonding agent. A previous study has reported that the tooth-resin interface at the cervical area had significantly higher microleakage than all other enamel-composite resin interfaces<sup>17</sup>. Increased microleakage towards the cervical area of the tooth could be due to the variations in the microstructure of the cervical enamel, such as deviation in the orientation of the enamel prisms and thinner enamel. The orientation of the enamel rods has been claimed to affect bond strength to acid-etched enamel<sup>25</sup>. Rosentritt et al. reported similar marginal adaption between self-adhesive, self-etch, and etch and rinse resin cements in dentin<sup>26</sup>. Greater Intragroup difference in the enamel bonding agent compared to the universal bonding agent could be due to the thinness of the enamel in the cervical area and the presence of a greater amount of dentin<sup>25</sup>. The results of this study showed ultrasonic scaling had no significant difference in microleakage when the

margins were placed at 0.5mm and 1mm from the CEJ in the universal bonding agent group. In the enamel bonding agent group there was no significant difference in the ultrasonic scaling and the control subgroup when the margins were placed at 1mm from the CEJ however ultrasonic scaling showed a significant difference when the margins were kept at 0.5mm from the CEJ. Overall, the universal bonding agent group with cervical margins at 0.5mm and 1mm from the CEJ with or without ultrasonic scaling had a greater microleakage than the enamel bonding agent group. Goldstein et al., reported composite-enamel margins were unaffected by ultrasonic scaling however there was increased microleakage at the composite-cementum interfaces<sup>15</sup>. All margins in this study were located on enamel. Sorrentino et al reported ultrasonic scaling caused mechanical removal or roughening at the marginal interface<sup>16</sup>. Increased microleakage at 0.5mm from the CEJ in the enamel bonding agent could be due to the thin enamel in the cervical area and the presence of more dentin. Several studies have reported that clinical outcomes like marginal discoloration, hypersensitivity, and secondary caries did not correlate directly to dye penetration. No single laboratory test can predict the clinical outcome of restorations, but laboratory tests provide researchers and clinicians insight into factors that may influence future clinical outcomes in patients<sup>27,28</sup>.

### Conclusion

Within the limitations of this study the following conclusions were obtained:

Porcelain laminate veneers bonded with Enamel bonding agent (Heliobond) had lesser marginal microleakage than the universal bonding agent (Tetric n bond).

The cervical margins placed at 0.5mm from CEJ had greater microleakage than the margins placed at 1mm from the CEJ. Ultrasonic scaling has no significant effect on microleakage when margins were placed 0.5mm and 1mm from the CEJ. Hence ultrasonic scaling can be carried out as a prophylactic procedure on porcelain laminate veneers.

### Clinical Significance



PLV's bonded with enamel bonding agent with finish line kept at 1mm from the CEJ had significantly lesser microleakage than universal bonding agent at 0.5mm from the CEJ. Ultrasonic scaling can be safely carried out as a prophylactic procedure on porcelain laminate veneers.

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