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Comparison of composite resin and porcelain inlays for restoration of noncarious cervical lesions: An *In vitro* study

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ABSTRACT

Background: Composite resin (CR) currently is one of the most commonly used material in restoring noncarious cervical lesions (NCCL) due to its strength and esthetics color but has microleakage problem. The aim of this study is to compare *in vitro* the microleakage depth between CR and porcelain in restoring NCCL.

Materials and Methods: This an *in vitro* study was done by preparing cavities on the buccocervical surface of 62 extracted premolar teeth which randomly assigned to two groups (n = 31) where Group 1 was restored with nanocomposite and Group 2 was cemented with porcelain cervical inlays. They were then subjected to thermocycling before immersion in 2% methylene blue dye for 24 h. Dye penetration depths were measured using Leica imaging system For statistical analysis, independent t-test was used to analyze the results ($P < 0.05$).

Results: Porcelain cervical inlay restorations demonstrated statistically lesser microleakage depth for the cervical margins ($P = 0.018$) when compared to CR. Deeper microleakage depth at the cervical compared to coronal margins of CR ($P = 0.006$) but no significant difference of both margins for porcelain cervical inlays ($P = 0.600$).

Conclusion: Porcelain cervical inlays show lesser microleakage than CR which could be alternative treatment option in restoring NCCL with better marginal seal and esthetics.

Key Words: Composite resin, leakage, porcelain

INTRODUCTION

Noncarious cervical lesions (NCCL) are characterized by the loss of tooth substance at the cementoenamel junction[1] which could be due to erosion, abfraction, or abrasion. This is due to the nonhomogeneous tooth structure in the cervical regions that constantly subjected to occlusal loads.[2] The incidence is increasing with age which raises considerable restorative challenges to the dental practitioners.[3] Other factors such as the location of the tooth, abnormal occlusal stresses, age of the patient, and the choice of restorative materials pose significant impacts on the clinical success of these types of restorations.[4]

Several preventive and restorative treatment modalities have been proposed for NCCL where objectives of the restoration placed were for dentinal

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hypersensitivity, and esthetic considerations. Glass ionomer cement (GIC), resin-modified GIC, and several types of composite resin (CR) have been used for the restorations conventionally. GIC is less favorable due to its weaker physical properties including easily wear especially in acidic mouth condition, poorer esthetics with a limited range of shades compared to CR.[3]

The clinical use of CR has increased substantially over the past few years due to increased esthetic demands by patients, improvements in formulation and simplification of bonding procedures.[5] However, the major drawback of CR is the polymerization shrinkage issue which contributes to the formation of microleakage at the restoration margins. The presence of marginal leakage will lead to recurrent caries formation which account for approximately 50% of the clinical failure causes,[6,7] and subsequent pulpal injuries.[8] Furthermore, it may result in marginal defects which favor dental plaque accumulations and subsequent periodontal problem,[9] marginal discoloration and reduction in longevity of the restoration.[10]

Nowadays, dental porcelain as one of the esthetic restorative materials has rapidly grown in number of use because of their strength and they can replicate the color and shape of the natural dentition. They exhibit superior properties such as biocompatibility, surface hardness, light absorption, light scattering behavior, and low electrical and thermal conductivity.[11] The thermal conductivity and the coefficient of thermal expansion (CTE) are almost similar to those of enamel and dentin.[12,13] They were also resistance to wear which is major cause for NCCL. Hence, in the presence of a good marginal seal, marginal percolation is less likely to be a problem.[14]

Although porcelain is well known for its strength and esthetics, it has not been used to restore NCCL, and there is no study being carried out about this. With the above context, we had designed an *in vitro* study to compare the microleakage of porcelain with normally used CR to assess the suitability of porcelain material as a new technique for restoring NCCL. It might curb the polymerization shrinkage issue of CR which prevents staining and secondary caries formation.

MATERIALS AND METHODS

In this an *in vitro* study, 62 intact extracted human premolars were selected, and the soft tissues, calculus, and debris were cleaned before they were examined under stereomicroscope Leica Stereomicroscope KY-F55B (Germany) to detect for any cracks or fractures at the buccocervical surface. They were excluded if any cracks or fractures detected.

A V-shaped cavity was prepared on the buccocervical surface, 1 mm above the cementoenamel junction with dimensions of 5 mm long × 3 mm wide × 2 mm deep in enamel and dentin, occlusocervically using a rectangular shape clear plastic template for the outline. They were prepared manually using tapered fissure-shaped diamond burs (FG 859, Edenta AG, Switzerland) in a high-speed handpiece (Blen Air, Swiss). Each bur was replaced after every five preparations.[15]

The samples were randomly assigned to two groups: Group 1 (G1) and Group 2 (G2) with 31 teeth each using simple random sampling method. The cavities for G1 were restored with nanocomposite Filtek Z350 (3M ESPE, USA) and G2 were cemented with IPS e.max Press porcelain cervical inlays (Ivoclar Vivadent, USA). For teeth in G1, the cavity was etched with Scotchbond Etchant (3M ESPE, USA) for 15 s and applied with Adper Single Bond 2 adhesive (3M ESPE, USA) using microbrush and light-cured for 20 s. They were then filled with Filtek Z350, shade A2 (3M ESPE, USA) before light-cured for 40 s. Polishing was done after 24 h using Sof-Lex discs (3M ESPE, USA) from coarse to fine grade.

For teeth in G2, the waxed-up was done for the cavities and investing was carried out with IPS PressVEST Speed. The cold IPS e.max Press ingot with medium opacity shade 0 (Ivoclar Vivadent, USA) was used in the IPS Empress - EP 600 press furnace (Ivoclar Vivadent, USA). The selected press program was according to manufacturer's recommended parameters to produce the porcelain cervical inlays. For cementation, the cavity was air-dried, acid etched with Scotchbond etchant (3M ESPE, USA) for 15 s, followed by water rinsing for 10 s. Silane (Ultradent, USA) was applied on the fitting surface of the porcelain cervical inlays before cementing with the Panavia F 2.0 paste (Kuraray Medical Inc., Japan) and Oxyguard II was used to cover and left for 3 min.

All the restored samples were stored in distilled water at room temperature for 24 h and then thermocycled for 500 cycles between 5°C and 55°C temperature.[15] Nail varnish was used to paint the teeth except 1 mm

around the margins of the restorations.[15] They were vertically placed in a 2% solution of methylene blue for 24 h, with all the root apices above the solution to avoid dye penetration through improper insulated root areas.[16] After immersion, the specimens were cleaned under running water and sectioned buccolingually at the middle of restoration using hard tissue cutter (EXAKT, Germany).

Microleakage depth was measured in μm at coronal and cervical margins using Leica stereomicroscope KY-F55B (Germany) imaging system at ×5 magnifications due to the differences in enamel prism orientation at both areas. Each measurement was measured by 2 examiners, and the inter-examiner reliability was 82%. All the data were then collected and analyzed with Independent *t*-test using IBM Statistical Package of the Social Sciences version 17.0.

RESULTS

The means and standard deviations (SDs) of the depth of dye penetration in micrometer (μm) for each group were presented in Tables 1 and 2. Independent *t*-test indicated that there was significantly lesser microleakage depth for porcelain cervical inlays at the cervical margins ($P = 0.018$) but not the coronal margins ($P = 0.669$) in comparison with CR.

Results showed more microleakage significantly different statistically ($P = 0.006$) at the cervical margin of CR whereas no difference at both coronal and cervical margins for porcelain cervical inlays ($P = 0.600$). The dye penetrations were shown in Figures 1 and 2.

Table 1: Comparison of mean (standard deviation) of dye penetration in μm between composite resin and porcelain at both margins

	Mean (SD)		Mean difference (95% CI)	df	*t*-statistic	*P*
	Filtek Z350	Porcelain				
Coronal (31)	928.87 (733.41)	1001.58 (591.60)	−72.71 (−411.24-265.81)	60	−0.430	0.669
Cervical (31)	1383.26 (484.41)	1075.67 (511.68)	307.60 (54.45-560.73)	60	2.431	0.018*

t-test. *$P<0.05$ is considered to be significant. SD: Standard deviation; CI: Confidence interval of the difference

Table 2: Mean (standard deviation) of dye penetration in μm at both margin in composite resin and porcelain

Material (*n*)	Mean (SD)		Mean difference (95% CI)	df	*t*-statistic	*P*
	Coronal	Cervical				
Filtek Z350 (31)	928.87 (733.41)	1383.26 (484.41)	−454.39 (−770.17-138.62)	60	−2.878	0.006*
Porcelain (31)	1001.58 (591.60)	1075.67 (511.68)	−74.08 (−355.09-206.93)	60	−0.527	0.600

t-test. *$P<0.05$ is considered to be significant. SD: Standard deviation; CI: Confidence interval of the difference

DISCUSSION

For centuries, the researchers and the scientists keep searching for an ideal esthetic material in restoring the teeth. CR and the acid etch technique represent two breakthroughs from the previous researches. However, CR which undergoes a process of free radical polymerization of the methacrylate groups will subsequently lead to a reduction in volume, causing polymerization shrinkage that may vary from 1% to 5% in volume.[17] This is consistent with the result of our study revealing that CR restorations demonstrate more marginal leakage in comparison with porcelain at cervical margins of NCCL. The adverse effect of polymerization shrinkage produces defects in the composite-tooth bond, leading to marginal gap formation, marginal leakage, postoperative sensitivity, recurrent caries, and eventually bond failure. On the other hand, porcelain itself is a stable material that will not undergo polymerization shrinkage process and resistance to wear. Thus, the marginal leakage of porcelain restorations is statistically lesser than CR.

Marginal leakage also is believed to be the result of a difference in the CTE between restorative material and tooth. It is a measurement of the degree of expansion when heated and contraction when cooled of a given material. The lower the CTE, the lesser changes in size of the material when it is subjected to temperature changes.[18] The CTE of the crown of human teeth is 11.90 (SD 4.42) × 10^{-6}/°C,[12] while the IPS e.max Press has CTE of 10.15 ± 0.4 × 10^{-6}/K;[13] whereas for CR the CTE ranges from 22.5 to 45 × 10^{-6}/°C.[19] It is obviously a wiser option to choose restorative materials with CTE approximately the same to the human teeth, such as the porcelain materials which will result in lesser gap formation between the porcelain-tooth interfaces during thermal changes in the oral environment.

In this study, the IPS e.max Press (Ivoclar Vivadent, USA) was used; which is a lithium disilicate glass ceramic ingot composed of quartz, lithium dioxide, phosphor oxide, alumina, potassium oxide, and other components for the use

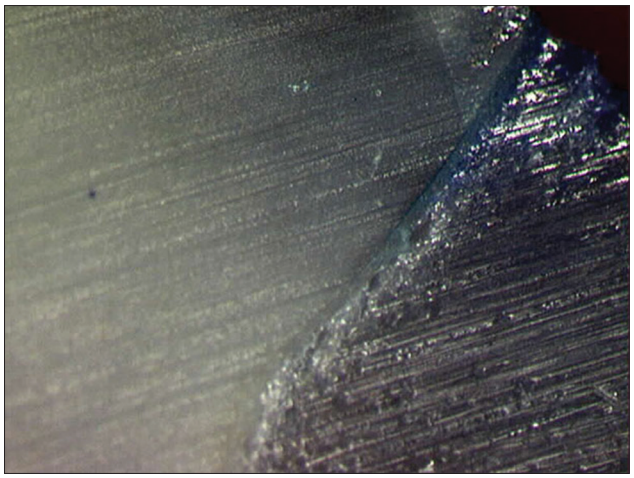

Figure 1: The dye penetration at cervical margin of composite resin (×5).

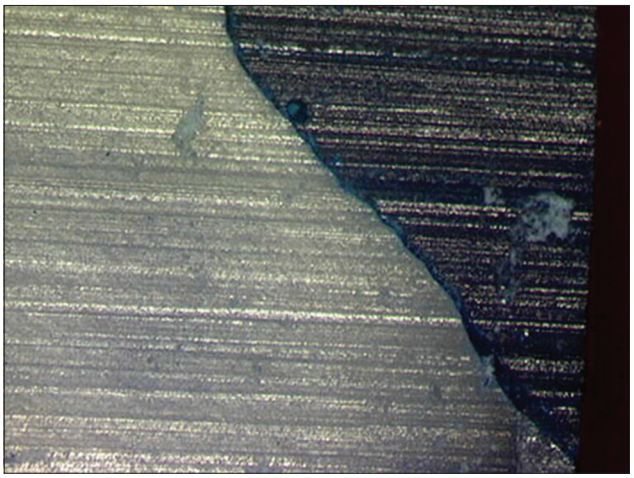

Figure 2: The dye penetration at cervical margin of porcelain (×5).

with the press technique. This composition yields a highly thermal shock resistant glass ceramic due to the low thermal expansion that results when it is processed. In addition, IPS e.max Press is processed in the dental laboratory with the known Empress pressing equipment which is well distinguished for providing a high accuracy of fit.[18] Panavia F 2.0 (Kuraray Medical Inc., Japan) was chosen as adhesive resin due to its lower degree of microleakage and high bond strength to tooth structures and ceramics.[20]

Silane coupling agent used also improves the bonding of Panavia F 2.0 adhesive resin cement to porcelain. This dual function monomer consisting of a hydroxyl group that reacts with the porcelain surface and a methacrylate group that copolymerizes with the resin matrix of the composite. It acts as a good wetting agent besides contributing to the actual formation of covalent chemical bonds at the involved interfaces[21] where all of these factors contribute to a better marginal fit of porcelain restorations.

Filtek Z350 Universal Restorative (3M ESPE, USA) is a nanocomposite, displays high polish retention of a microfill while maintaining the strength and wear properties of a modern hybrid which are suitable in restoring NCCL.[22] However, the composite-tooth interface is under stress due to polymerization shrinkage leading to marginal gap formation. Contrast with porcelain restorations, the only shrinkage that occurs is in the thin layer of luting cement; so porcelain is a newer and better alternative material for treatment of NCCL.

The difference in depth of microleakage of coronal and cervical margins in CR is likely due to prismatic, rod-like apatitic morphology of human enamel. This structural anisotropy gives variation in enamel bonding might influence the bonding ability of the current adhesive systems.[23]

Enamel consists of organic and inorganic components where the inorganic component, is hydroxyapatite that varies from 86% to 98% depending on the age. Application of 37% phosphoric acid removes about 10 microns of enamel to expose prisms of enamel rods. Due to the preferential loss of material from the prism core, this creates the classic honeycomb effect.[24] The relatively lower bond strengths obtained from cervical enamel probably resulted from its aprismatic structure, which appears to be more resistant to dissolving in acids than prismatic midcoronal enamel.[25] A reduction of resin tags formation will subsequently lead to less retention and more microleakage. Hence, the cervical margins (cervical enamel) of CR revealed more marginal leakage than the coronal margins (midcoronal enamel).

Even though porcelain cervical inlays might involve more complex procedures and slightly extra cost, but when the benefits are outstanding and really effective, it is worth to use this new technique. For that, we recommend porcelain cervical inlays as a new and better alternative treatment for NCCL. However, the conditions in the oral cavity are different from laboratory conditions the thermocycling procedure was used to simulate the oral environment. Hence, in future long-term *in vivo* clinical study should be carried out to really observe the benefits.

CONCLUSION

Within the limitations of this *in vitro* study, it could be concluded that porcelain is better than CR in the

aspect of microleakage to restore NCCL. Hence, porcelain cervical inlays will be a good treatment option to restore such lesions with better marginal seal and strength besides giving supreme esthetics in matching the polychromatic nature of human teeth. The use of porcelain cervical inlays may conservatively curb the major challenge of CR which is the polymerization shrinkage which subsequently causes microleakage and bond failure.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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