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## Research Article

# Comparison of the Effect of Panavia F2, Biscem and Maxcem on Microleakage of Ceramic Inlays: An In-Vitro Study

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**Abstract:** Self-etch cements are increasingly used for cementation of ceramic restorations. This study compared the microleakage of Panavia F2, Maxcem and Biscemused for cementation of ceramic inlays to human tooth. This experimental study was conducted on 30 human premolar teeth that were divided into 3 groups of 10. Class V cavities measuring 3x2x2 mm were prepared and restored with ceramic inlays (Vista, Germany) using Panavia F2, Maxcem and Biscem cements. Specimens were then immersed in silver nitrate solution for 6 h followed by 2h in radiographic processing solution and buccolingually sectioned. The degree of microleakage was evaluated under stereomicroscope at 20X magnification. Kruskal Wallis test and SPSS version 16 software were used for data analysis. Dunn test was applied for pairwise comparison of cements. Wilcoxon Signed Rank test was used for the comparison of occlusal and gingival microleakage in each cement group. Occlusal microleakage was the lowest in Panavia F2, followed by Biscem and Maxcem, respectively ($P<0.001$). Gingival microleakage of Panavia F2 was significantly less than that of Maxcem ($P<0.001$) but was not significantly different from the gingival microleakage of Biscem. Occlusalmicroleakage of Panavia F2 was significantly less than its gingival microleakage ($P<0.05$). But, no significant difference was found between occlusal and gingival microleakage in Maxcem and Biscem. Within the limitations of this study, Panavia F2 resin cement is superior to Maxcem and Biscem for cementation of alumina ceramic inlays.
**Keywords:** Microleakage, Self-etch resin cement, Class V cavity, Ceramic inlay.

## INTRODUCTION

Microleakage is the main concern when it comes to cemented restorations and is defined as penetration of saliva and microorganisms through the tooth-restoration interface causing secondary caries, pulp irritation and post-operative tooth hypersensitivity [1]. Resin cements play a major role in success or failure of indirect restorations namely laminates, inlays and onlays. Cemented restorations have some advantages over the non-cemented systems namely less microleakage and less polymerization shrinkage [2].

Several resin cements have been introduced to the market and researchers are trying to come up with newer products with less application steps, minimal film thickness, low solubility and optimal pH. However, considering the different compositions of enamel and dentin, changing the properties of cements may result in decreased bond strength to dentin and subsequently increased microleakage [3]. In the self-etch and self-adhesive systems, dentin is conditioned and primed by the adhesives at the same time with no need for rinsing. As the result, the clinical application time is shorter in these systems and technique sensitivity is greatly decreased. In these systems, adhesion is mediated through the chemical interaction of residual hydroxyapatite crystals and functional monomers present in the composition of these adhesives [4].

Samani et al, in their review study stated that self-adhesive resin cements are optimal for the cementation of metal-free restorations because of their desirable physical characteristics and high aesthetic properties [5].

In contrast, Turp et al, in their study on adhesion of resin cements containing 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) (Panavia F2 and Clearfil) to dentin with and without the application of etch-and-rinse technique reported that etch-and-rinse technique can be beneficialfor achieving an optimal bond to dentin in both conventional and self-adhesive resin cements containing 10-MDP [6].

Numerous studies have investigated the microleakage of cements bonded to enamel and dentin and have shown that none of the cements have been able to completely prevent microleakage. Microleakage at the level of CEJ is particularly high allowing the penetration of oral fluids and bacteria through the dentin-cement interface and subsequent development of pulp injury [7-11].

This study sought to compare the microleakage of Maxcem, Biscem and Panavia F2 used for cementation of ceramic inlays.

## MATERIALS AND METHODS

This in-vitro experimental study was conducted on 30 human second premolar teeth that had been extracted for orthodontic purposes during the past one month. All teeth were cleaned with rubber cup and pumice paste and stored in 0.5% chloramine T solution for one week for disinfection. The specimens were then transferred to distilled water and kept at room temperature [12]. Using 008 fissure bur, Class V cavities were prepared measuring 2x3x2 mm in the gingival third of the buccal surfaces of teeth in such way that gingival margin was in the cement and 1 mm below the CEJ and occlusal margin was in the enamel [12-17]. Burs were changed after preparing 5 cavities. Specimens were randomly divided into 3 groups of 10 and impressions were made using an impression tray and addition silicone impression material (Panasil ®, Kettenbach, Germany). In-ceram alumina porcelain inlays were fabricated (Vita, Germany)(Figure 1). After sandblasting in the laboratory, try-in and application of ceramic silaneprimer (3M, ESPE, USA) on the bonding surface, each group was treated as follows:

*Group A. Use of Panavia F2 (Kuraray, Japan) cement:*

After mixing one drop of 1 and 2 ED primerand applying it to the cavity, equal amounts of the two pastes were mixed and filled the cavity. Inlay was seated in the cavity using mild finger pressure. Excess cement was removed using a microbrush soaked with the bonding agent and then the restoration was light cured from each side for 40s. Specimens were then transferred back to the distilled water container and stored for 24h at room temperature [18].

*Group B. Use of Biscem (Bisco, USA) cement:*

After mixing the base and catalyst of Biscem in equal amounts for 15s and achieving a uniform color paste, cement was applied to the internal surface of the restoration using an applier. The cavity was also filled with the cement. Inlay was then placed in the cavity using manual passive pressure. Excess cement was removed by a microbrush and the restoration surface was cured for 40s. Specimens were then placed in distilled water at room temperature for 24h [19].

*Group C. Maxcem (Kerr, USA):*

After mixing the base and catalyst of Maxcem in equal amounts, adequate amount of cement was injected into the cavity and the restoration was seated with adequate pressure. Curing was done for 1 to 2 second(s); excess cement was removed and each margin was cured for 40s [20].

All specimens were stored in distilled water at room temperature (23±2°C) for 24 hours and then underwent 1000 rounds of thermocycling between 5±2°C to 55±2°C with 30s of swell time [12]. Next, the teeth apices were sealed with sticky wax and all teeth surfaces except for the restoration surface and 1mm margin around it were coated with 2 layers of nail varnish. Specimens were immersed in 50 w% silver nitrate solution for 6h followed by 2h in radiographic processing solution under fluorescence in order to enhance the reduction of silver ions. Next, using diamond discs with 0.2 mm diameter (Diatec, Germany), the cavities were buccolingually sectioned in half and the dye penetration was evaluated using a stereomicroscope (Nikon, Japan) with 20X magnification. Degree of microleakage was categorized as follows:

Zero degree: No microleakage
Degree 1: Dye penetration up to one-third of cavity all
Degree 2: Dye penetration up to two-third of cavity wall
Degree 3: Dye penetration into the entire cavity wall without extension to axial wall
Degree 4: Dye penetration into the axial wall

For the comparison of occlusal and gingival microleakage between the 3 resin cements, Kruskal Wallis test was used. Dunn test was applied for pairwise comparison of cements and Wilcoxon Signed Rank test was used for comparison of occlusal and gingival microleakage in each cement group. Data were analyzed using SPSS version 16 software.

## RESULTS

A total of 30 human second premolar teeth were evaluated in the three groups of Panavia F2, Maxcem and Biscem. Using Kruskal Wallis test, significant differences were found in the occlusal and gingival microleakage in the 3 cements. Occlusalmicroleakage was significantly different between the 3 cements ($P<0.001$) and occlusalmicroleakage of Maxcem was the highest followed byBiscem and Panavia F2, respectively ($P<0.05$). In the Panavia F2 specimens, occlusalmicroleakage was significantly less than gingival microleakage ($P=0.007$) but difference in microleakage between occlusal and gingival margins in

Biscem and Maxcem was not statistically significant. No significant difference existed between Panavia F2 and Biscem and also Maxcem and Biscem in terms of gingival microleakage. However, gingival microleakage was significantly higher in Maxcem than Panavia F2 (P=0.021).

**Table-1: Frequency of degree ofocclusal microalgae in the three understudy resin cements**

| Degree of microleakage | 0 | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|
| Panavia | 7 | 2 | 1 | 0 | 0 | 10 |
| Biscem | 0 | 3 | 4 | 2 | 1 | 10 |
| Maxcem | 0 | 0 | 0 | 0 | 10 | 10 |
| Total | 7 | 5 | 5 | 2 | 11 | 30 |

**Table-2: Frequency of degree of gingival microleakage in the three understudy cements**

| Degree of microleakage | 0 | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|
| Panavia | 1 | 3 | 2 | 1 | 3 | 10 |
| Biscem | 0 | 1 | 3 | 2 | 4 | 10 |
| Maxcem | 0 | 0 | 0 | 2 | 8 | 10 |
| Total | 1 | 4 | 5 | 5 | 15 | 30 |

**DISCUSSION**

Self-adhesive resin cements are now increasingly used for fixed partial dentures, inlays and onlays due to their simple clinical procedure. These cements have overcome the technique sensitivity of multiple-step adhesive systems. Self-adhesive resin cements can provide adequate bond strength to enamel and dentin comparable to that of conventional systems [21]. In this study we compared the microleakage of Panavia F2, Maxcem and Biscem for cementation of ceramic inlays and found that Panavia F2 had the lowest and Maxcem had the highest occlusalmicroleakage. Our study results were in accord with the findings of Sadar et al, who showed significant differences in microleakage of Maxcem with 3 other resin cements. Specimens cemented by Maxcem showed higher microleakage than 3 other resin cements [8]. Our findings were also in agreement with those of Trajenberg et al. They demonstrated that Panavia F2 had the lowest microleakage for cementation of all ceramic crowns [22]. This agreement between our results and those of previous studies indicates correct methodology and control of confounding parameters namely thermocycling and surface treatment of ceramics in our study.

In a study by Cardoso et al, it was stated that self-etch systems had high microleakage and weak bond to enamel and dentin [15]; which is in contrast to our findings. This difference may be attributed to the fact that Curdaso et al, compared self-etch and total-etch systems; whereas, we compared self-etch cements. Different size of cavities and type of tooth may also play a role in this respect [23].

Class V cavities have the highest value of C-factor and therefore, have the best design for testing the restoration microleakage[12]. Thus, in our study, Class V cavities were prepared in all specimens in such way that one restoration margin was in the enamel and the other below the CEJ to separately assess the microleakage in enamel and dentin margins.

Cements used in our study were all self-etch resin cements. Panavia F2 has two components (two-step)while Biscem and Maxcem are one-step cements. Self-etch cements have eliminated the process of acid etching with 37% phosphoric acid and application of dentin bonding agents (total etch systems). Self-etch cements form a micromechanical bond to the tooth structure and restoration. In comparison with conventional cements, self-etch cements are insoluble in the oral environment and are associated with less post-operative tooth hypersensitivity [24].

In order to prevent the collapse of collagen and problems associated with washing and drying of enamel and dentin, self-etch cements simultaneously etch and prime enamel and dentin and their bonding agent penetrates into the network. The only difference is that this process is done in two steps in Panavia F2. First, etching and priming are done simultaneously and then the cement is applied; whereas, in Biscem and Maxcem, all three agents are applied at once to the tooth surface.

The three types of resin cements used in our study contain fillers; the only difference is that Panavia F2 contains barium glass particles whereas Maxcem and Biscem do not have them.

In vitro microleakage studies can provide us with information regarding the sealability of restorative materials for future use in the clinical setting. Wahab et al. performed thermocycling to simulate aging and increase themicroleakage. Stresses that are applied to the restorative materials during thermocycling can cause cracks on the bonding surface [25] and reduce the bond strength of resin cements to tooth and ceramic surfaces [26]. Assessment of dye penetration at cavity margins and its classificationin the form of quantitative amounts (mm) may be erroneous due to the difference in size and shape of teeth. Non-parametric scoring provides a better scale for microleakage evaluation. Since the dentinal tubules have a mean diameter of 1.65 microns [27, 28], silver nitrate is more appropriate for measurement of degree of microleakage and use of methylene blue and Fuchsin may be associated with errors and false positive results.

Evaluation of the chemical structure of the 3 understudy cements shows that Panavia F2 contains HEMA, 10MDP, methacryl-5 aminosalicylic acid, water and accelerator. Its paste contains hydrophobic aromatic dimethacrylate, barium glassfillers and accelerator. However, Biscem contains Bis-GMA, UDMA, glass fillers and phosphoric acid monomers.

Presence of phosphate monomers in Panavia F2 and Biscem resin cements enables a chemical bond with metal oxides namely aluminum oxide and zirconium oxide present in ceramics [29]. Maxcem contains GDPM to improve its wettability but lack of phosphate monomers and their replacement with acidic monomers that polymerize along with adhesive monomers explain the weaker chemical bond to tooth structure and ceramic and greater microleakage at the occlusal and gingival margins of restorations cemented with Maxcem [23]. The complex chemical structure of methacryloyloxydecyldihydrogen phosphate causes decalcification of tooth structure and simultaneous penetration of this cement into the tooth surface. Thus, it has the potential to form a chemical bond with calcium in hydroxyapatite (HA) crystals. This potential leads to formation of a stronger bond [24].

Higher viscosity of the paste in Maxcem and Biscem limits their penetration into microscopic porosities. In the gingival margin, penetration of cement into the collagen network is critical and the mentioned limitation is probably responsible for the observed difference in microleakage between Maxcem and Panavia F2 in our study. Biscem has a moderate viscosity less than that of Maxcem and as the result, level of microleakage in this cement ranked in between the two cements of Panavia F2 and Maxcem. One-step self-etch resin cements have higher concentrations of acid derivatives and methacrylate phosphoric acid esters, water and organic solvents in order to be able to simultaneously etch enamel and dentin and penetrate into them. Due to the hydrophilic nature of these cements, they act as permeable membranes with high water sorption during polymerization leading to higher degree of microleakage [30].

The low pH of one-step self-etch resin cements (1.5 to 2.5) due to the presence of methacrylate-based components makes them hydrolytically unstable [30].

Due to the partial penetration of these cements (compared to two-step liquid-based systems), nanometer scale porosities are also seen in the hybrid layer (nano-leakage)[30]. Although tiny, these porosities can act as a path for penetration of water, plasticization of resin matrix and elimination of naked monomers. This issue is another explanation for increased microleakage after thermocycling. On the other hand, Panavia F2 primers contain HEMA; which is a basically hydrophilic molecule with an affinity to hydrophobic molecules. Thus, it can serve as a good mediator between the hydrophilic and hydrophobic components in an adhesive system. Absence of HEMA in Maxcem and Biscem can somehow explain our obtained results. Presence of MDP (having a potential to chemically bond to HA) is another reason for the significant difference in microleakage between Panavia F2 and the two other resin cements in our study.

## CONCLUSION

Within the limitations of this study, occlusalmicroleakage was the lowest in Panavia F2, followed by Biscem and Maxcem, respectively ($P<0.001$). Gingival microleakage of Panavia F2 was significantly less than that of Maxcem ($P<0.001$) but was not significantly different from the gingival microleakage of Biscem. Occlusalmicroleakage of Panavia F2 was significantly less than its gingival microleakage ($P<0.05$). But, no significant difference was found betweenocclusal and gingival microleakage in Maxcem and Biscem. Panavia F2 resin cement is superior to Maxcem and Biscem for cementation of alumina ceramic inlays.

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