ORIGINAL RESEARCH

# Comparison of the Effect of Different Bonding Agents on the Microleakage of Two Hydrophilic Pit and Fissure Sealants: An *Ex Vivo* Study

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## Abstract

**Aim:** To compare the impact of fifth- and seventh-generation bonding agents on the microleakage between Embrace WetBond sealants and Ionoseal.

**Materials and methods:** Forty extracted human premolar teeth were used for the study and grouped according to different sealants and bonding agents—group I: Embrace WetBond sealant with fifth-generation bonding agent; group II: Embrace WetBond sealant with seventh-generation bonding agent; group III: Ionoseal with fifth-generation bonding agent; group IV: Ionoseal with seventh-generation bonding agent. For microleakage evaluation, all the teeth were subjected to invasive sealant placement using the respective sealant materials in combination with bonding agents as specified. The treated teeth were stored at 37°C for 24 hours and then thermocycled for 100 cycles at temperatures of 5°C and 55°C with a dwell time of 30 seconds. In order to assess microleakage, the samples were immersed in 0.2% methylene blue dye for 24 hours, then sectioned in buccolingual direction, and evaluated under stereomicroscope.

**Results:** The mean microleakage scores in group III were highest at 0.90 ± 0.57, while the least was in group IV at 0.30 ± 0.68, indicating that Ionoseal with seventh-generation bonding agent was the most effective. However, when the mean microleakage scores of the four groups were compared using Kruskal–Wallis test, it indicated that the differences were not statistically significant.

**Keywords:** Embrace WetBond, Ionoseal, Microleakage, Pit and fissure sealants.

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## Introduction

Caries of pits and fissures accounts for 80–90% destruction affecting permanent dentition and 44% in primary dentition.[1] This inclination is largely owing to the anatomical structure located on these surfaces, particularly promoting plaque retention.[2] Sealants are utilized to prevent pit and fissure breakdown by creating an external barrier that cuts down the nutrition supply to the microbes in the immediate vicinity. Studies have shown that sealant application can reduce the incidence of decay by 76.3% in first permanent molars and 76% in primary molars.[2,3]

The majority of sealants are resin based and proven to be the most effective. As the materials are based on hydrophobic resin systems, they are very sensitive to moisture contamination which is a significant issue in young children and partially erupted teeth. In recent times, hydrophilic resin-based sealants which can be used in a moist environment have been studied. An advanced resin-based sealant was recently formed that includes di-, tri-, and versatile acidic acrylate monomers that have a pragmatic hydrophilic-hydrophobic equilibrium. The outcome is a resin sealer with hydrophilic characteristics that set in regardless of humidity.

Glass ionomer sealants, considered hydrophilic, are further advocated in instances where significant moisture management proves challenging to obtain. They have minimal abrasive strength and are highly soluble in oral fluids, resulting in reduced retention levels compared to resin-based sealants. Ionoseal, an extremely viscid resin-modified glass ionomer (RMGI) cement, was strategically designed for intended use in caries-prone pits that have decreased moist susceptibility, a lesser soluble nature, and greater retention ability in contrast to traditional glass ionomer sealants.[2]

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Bonding agents consist of different dimethacrylates like bisphenol glycidyl methacrylate (Bis-GMA) along with diluting monomers such as triethylene glycol dimethacrylate (TEGDMA) will maximize the micromechanical bonding of composite to the tooth structure including both enamel and dentin.[4] One of the main problems with sealants is microleakage, which leads to bacterial invasion and sealant failure. This may be due to salivary contamination during sealant application.[5] The present fifth-generation bonding agents require a two-step procedure of etching the tooth and administration of a combination of adhesive resin and primer. The seventh-generation bonding agent is a blend of etchant, primer, and bonding resin into one single solution resulting in a simplified one-step bonding procedure.

According to studies, bonding agents enhance the persistence of both hydrophobic pit and fissure sealants as well as Ionoseal,[6] because they need less effort to apply and require fewer steps in the manufacturing process; bonding agents like self-etching and self-adhering systems have become popular owing to ease of administration.[7] There is a paucity of studies that have compared Ionoseal with hydrophilic sealants and bonding agents. Therefore, this *ex vivo* study intends to compare the microleakage between Ionoseal and Embrace WetBond sealant when used in conjunction with fifth- and seventh-generation bonding agents, using dye penetration method.

## Materials and Methods

For conducting the study, 40 intact premolars extracted for orthodontic purposes with no evidence of caries were used after taking consent from the patients. The approval of the Institutional Review Board was obtained for the conduct of the study.

Samples were allocated into four distinct categories:

- Group I: Embrace WetBond sealant with fifth-generation bonding agent.
- Group II: Embrace WetBond sealant with seventh-generation bonding agent.
- Group III: Ionoseal with fifth-generation bonding agent.
- Group IV: Ionoseal with seventh-generation bonding agent.

The teeth were disinfected using hydrogen peroxide after the tooth surfaces were cleaned to remove plaque and debris from the pit and fissures of tooth and polished using mixture of pumice and water using a polishing brush and cup. 0.5 mm depth enameloplasty was performed all along the occlusal fissure margins of the samples with 0.8 mm diameter fissure bur.[6]

In groups I and III, enamel was etched using 37% orthophosphoric acid applied directly to all the susceptible pits and fissures and extend up to cuspal inclines. The teeth were dried for 30 seconds, cleaned with air-water spray for 20 seconds, dried with oil-free compressed air, and evaluated for frosty-white appearance. Fifth-generation bonding agent (3M ESPE Adper Single Bond 2) was then administered on the fissures according to the manufacturer's recommendations and cured using light-emitting diode (LED) light curing unit. In groups II and IV, seventh-generation bonding agent (GC Solare Universal Bond) was directly applied on the fissures according to the manufacturer's directions, followed by light-cured with an LED curing unit.

### Administration of Pit and Fissure Sealant

After the placement of sealant, curing was done following the manufacturer's recommendation.[6] In distilled water, samples were placed at 37°C for 24 hours, and later underwent thermocycling for 100 cycles at 5°C and 55°C with a dwell duration of 30 seconds each. Before assessing microleakage, root apices were sealed with resin. Two layers of protective coating of nail varnish were applied to all the tooth surfaces, except for a 2 mm region surrounding the sealant borders. Then, the obtained samples were subsequently immersed in solution containing 0.2% methylene blue for 24 hours. A double-faced diamond disk was used for sectioning specimens longitudinally in a buccolingual. Obtained slices were then inspected using stereomicroscope at a magnification of 40× to assess microleakage.

Four criteria: A ranking scale was utilized to evaluate the microleakage score (Fig. 1) (dye penetration depth):[6]

0—no dye penetration.

1—dye penetration limited to the outer half of the sealant.

2—dye penetration extending to the inner half of the sealant.

3—dye penetration extending to the underlying fissure (Khodadadi et al., 2014).

## Results

The mean microleakage scores (Table 1) in group I was 0.70 ± 0.82, group II was 0.60 ± 0.84, group III was 0.90 ± 0.57, and group IV was 0.30 ± 0.68. However, this variance in the mean microleakage scores among four groups was not statistically significant ($p = 0.19$).

## Discussion

Pit and fissure sealants exhibited a pivotal role in the prevention of dental caries in these caries-susceptible regions since their introduction by Cueto and Buonocore. However, several studies have documented the progressive loss of sealants over a period. According to research, the total survival percentage ranges from 92% beyond 1 year to 28% after 15 years with a single application of sealant. This is particularly important in children where either the teeth may be partially erupted or the child may not be cooperative enough to enable good isolation of the teeth requiring sealant placement. Further, when sealants are used as a part of community/school oral health program, good isolation is always challenging. Occlusal fissures are eight times more prone to caries than the smooth surfaces. The likelihood of occlusal decay is higher in the initial 4 years post tooth eruption.[4,8]

Hitt and Feigal initially described the benefits of incorporating dentin bonding agent between the etched enamel and sealant. Resin monomers are components of adhesives solutions that permit resin to interact with substrates. Adhesive systems consist of monomers containing with both hydrophilic and hydrophobic groups. While the latter allows liaison and polymerization among the restorative material, the former increases wettability to hard tissues. Adhesives are composed of solvents, inorganic fillers, curing initiators, inhibitors, or stabilizers.[9,10]

The removal of the smear layer before bonding utilizing an etch-and-rinse procedure or the administration of the two major strategies to overcome poor bond strengths generated by the smear layer is to utilize bonding chemicals which may flow past the smear layer and integrate it by employing a self-etch process.[11] As an total-etch adhesive systems, phosphoric acid ($H_3PO_4$) efficiently breaks down the smear layer, which is subsequently eliminated *via* the flushing process. In self-etching systems, the smear layer is changed, disturbed, and/or solubilized with various acidic primers—in contrast to total-etch systems—the residues are not completely washed away, allowing adhesive contact against the dentin substrate. Micromechanical interlocking is the primary method of adhesion to enamel and dentin for both strategies.

Ionoseal RMGI, a light-curing radiopaque GI composite cement, was introduced by VOCO integration. The great wettability of Ionoseal enables more precise application into prepared cavities and hard-to-reach places. In dentistry, the usage of flowable restorative systems has increased largely due to its ease of administering, minimal modulus of elasticity, and decreased viscosity.[5] Similar to resin-based composites, the RMGIs also contains methacrylate component. RMGIs may adhere to enamel in an approach comparable to conventional glass ionomers, through a standard chemical bond to the tooth surface; a micromechanical bonding

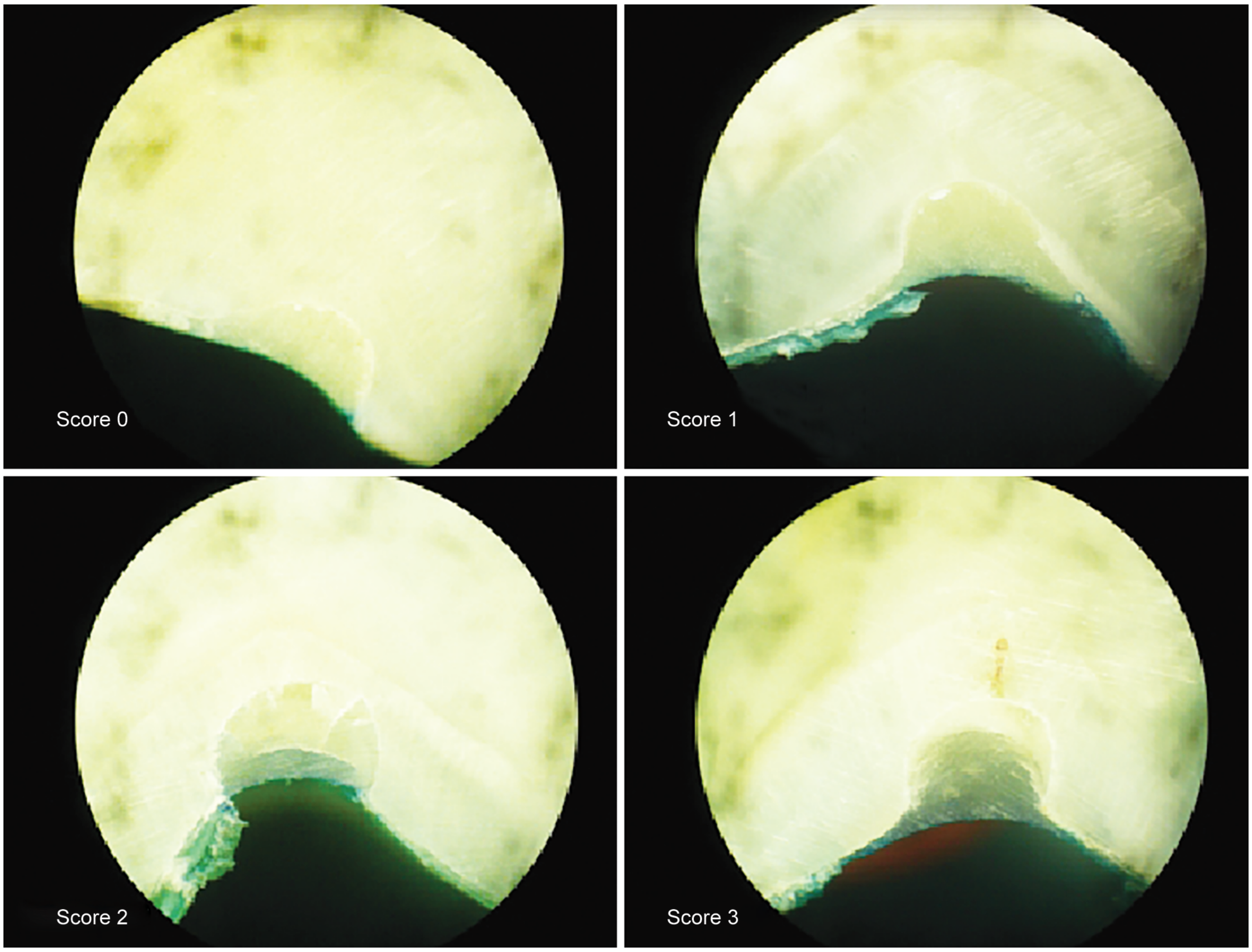


**Fig. 1:** Microleakage scores

**Table 1:** Comparison of mean microleakage scores between four groups using Kruskal–Wallis test

| *Comparison of mean microleakage scores between four groups using Kruskal–Wallis test* | | | | | | |
|---|---|---|---|---|---|---|
| *Groups* | *N* | *Mean* | *SD* | *Minimum* | *Maximum* | *p-value* |
| Group I | 10 | 0.70 | 0.82 | 0 | 2 | 0.19 |
| Group II | 10 | 0.60 | 0.84 | 0 | 2 | |
| Group III | 10 | 0.90 | 0.57 | 0 | 2 | |
| Group IV | 10 | 0.30 | 0.68 | 0 | 2 | |

system, such as one found in resin composites, is also present. The occurrence of micromechanical bonding makes it common to see improved sealing outcomes following the application of an etching agent and a bonding agent. Polymerization shrinkage of resin component materials may result in peripheral gaps, resulting in microleakage, sensitivity, and marginal discoloration. This shrinkage causes an accumulation of stress concentration which could undermine the adhesion junction.[12]

Embrace WetBond is a newer generation sealant that forms micromechanical and chemical interactions with slightly barely wet tooth surfaces. Enamel must be well conditioned before resin sealant may adhere successfully to it. In the current investigation, 37% phosphoric acid gel was utilized with an acid etching period of 30 seconds in groups I and III. Etching allows sealant to penetrate deeply into the enamel by creating micropores and demonstrating a strong micromechanical interaction. In this investigation, following etching, the bonding agent 3M ESPE Adper Single Bond 2 was applied to the tooth surface prior to sealant deployment in groups I and III.

Its hydrophilic resin chemistry differs significantly among the normal hydrophobic bis-GMA resins utilized in standard sealants. Embrace WetBond combines di-, tri-, and multifunctional acrylate monomers with an innovative acid-integrating chemistry that can be induced by moistness. When a sealant comes into contact with moisture, it spreads throughout the enamel surface, because of its hydrophobic properties, conventional sealants do not spread across wet tooth surfaces. Due to its unique chemistry, Embrace WetBond is miscible with water, flowing into moisture-containing etched enamel and combining with it since they inherently contain water.

According to research, using a bonding agent underneath sealant on an etched enamel surface enhances bond strength, reduces microleakage, and increases resin transit into fissures. The present study was done to compare the microleakage between Embrace WetBond sealant and Ionoseal when used along with fifth- and seventh-generation bonding agent.

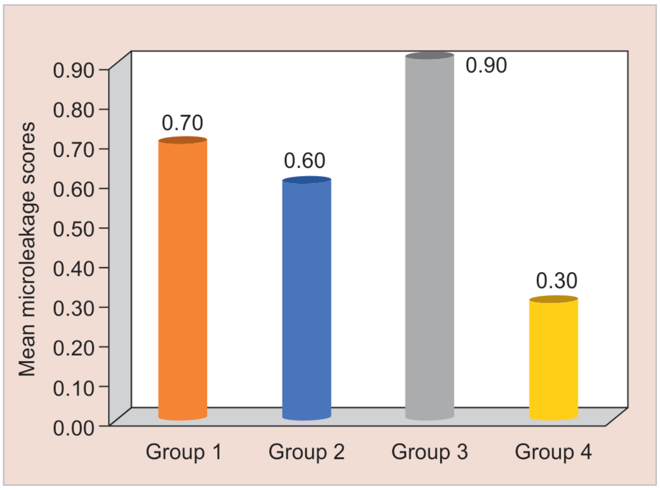


**Fig. 2:** Mean microleakage scores between four groups

Our study seems to indicate that seventh-generation bonding agent showed reduced microleakage of both Embrace WetBond and Ionoseal. Ionoseal when used with fifth-generation bonding agent showed maximum microleakage. Microleakage was evaluated using a four-ranked scale; the mean microleakage score in group I was 0.70 ± 0.82, and in group IV, it was 0.30 ± 0.68. Compared to Embrace WetBond sealant along with the use of a fifth-generation bonding agent, the microleakage was comparatively less in the case of Ionoseal (Fig. 2) when used along with a seventh-generation bonding agent. When compared to group II, where the mean microleakage score was 0.60 ± 0.84, group IV had less microleakage of 0.30 ± 0.68. The mean microleakage score in group III was 0.90 ± 0.57 which was higher than group I. However, this variance in the mean microleakage scores across four groups was not statistically significant ($p = 0.19$). Studies show that Ionoseal application without etching and bonding agent administration resulted significant larger microleakage when it was used in conjunction with etchant and bonding agent.[6]

The scarcity of empirical evidence utilizing the same methods and materials investigated in the current study limits the ability to make a valid comparison with the findings of prior research. This is the first research to evaluate the microleakage of Embrace WetBond sealant with Ionoseal; additional *in vitro* and clinical investigations must validate the findings and suggest it in the therapeutic setting.

## Conclusion

- There is no statistically significant difference in the microleakage between fifth- and seventh-generation bonding agents used along with hydrophilic sealants.
- Use of self-etch bonding agents along with the sealants decreases the clinical working time in case of uncooperative patients when the moisture control is inadequate and during the community oral health programs for sealant placement.
- Ionoseal along with seventh-generation bonding agent is comparatively cost effective when compared to embrace WetBond sealant along with fifth-generation bonding agents.

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