Comparative evaluation of Shear Bond strength of Flowable composites and hydrophilic sealant.

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Abstract
Objective: This study aimed to compare the shear bond strength of hydrophilic sealants and flowable composites to evaluate their suitability for clinical applications where moisture control is challenging.
Methods: The shear bond strength of hydrophilic sealant and flowable composite materials was tested using an independent t-test. Prior to the bond strength test, the normality of data was assessed with the Shapiro-Wilk test, confirming a normal distribution for both groups.
Results: The hydrophilic sealant group demonstrated a significantly higher mean shear bond strength (20.92 ± 1.85) compared to the flowable composite group (16.77 ± 1.51), with a t-test value of 5.46 and a p-value of 0.001, indicating a statistically significant difference. Literature supports that hydrophilic sealants perform better in moist environments, enhancing adhesive performance and reducing marginal leakage risks.
Conclusion: Hydrophilic sealants offer a superior bond strength over flowable composites, particularly in conditions with moisture, making them an advantageous choice for adhesive procedures where complete dryness cannot be achieved. This study supports the clinical recommendation of hydrophilic sealants for applications such as pit and fissure sealing and other moisture-sensitive bonding scenarios. Further research is suggested to assess the long-term durability of these materials in varying clinical environments.

KEYWORDS: Hydrophilic sealant, shear bond strength, flowable composites, bacteria, Restoration

INTRODUCTION:

In modern dentistry, the preservation of tooth structure and the prevention of dental caries are of paramount importance. Dental sealants and flowable composites are two materials widely used to protect occlusal surfaces, especially in the pits and fissures of posterior teeth where caries are most likely to develop[1]. Sealants act as a physical barrier, preventing the accumulation of plaque and bacteria in these vulnerable areas, while flowable composites are used to fill small cavities and provide structural support.
Shear bond strength is a critical factor in determining the effectiveness and longevity of these materials[1,2]. It measures the force required to break the bond between the dental material and the tooth surface, which is essential for ensuring the material's retention under masticatory forces.
Flowable composites are resin-based materials that exhibit lower viscosity than traditional composites, allowing them to adapt well to the intricate contours of the tooth surface. They are commonly used in minimally invasive restorations and as a liner under more rigid restorative materials[1]. Their ability to flow into small areas makes them a preferred choice for reinforcing weak tooth structures.
Hydrophilic sealants, on the other hand, are designed to bond to moist tooth surfaces, which can be particularly advantageous in pediatric dentistry or in cases where achieving a completely dry field is challenging[1,3]. Their hydrophilic

nature allows for better penetration into the enamel's microstructures, potentially leading to enhanced retention and a reduction in microleakage.

The success of dental restorative procedures heavily relies on the adhesion between the restorative material and the tooth substrate. Inadequate bond strength can lead to restoration failure, secondary caries, and ultimately, the need for more invasive treatments. Therefore, understanding the adhesive properties of different materials is crucial for improving clinical outcomes.

Flowable composites have been developed to address the limitations of traditional resin composites, such as difficulty in handling and the inability to penetrate small spaces. Their low viscosity allows for better adaptability to cavity walls and the ability to fill micro-irregularities on the tooth surface[3]. Flowable composites are versatile and can be used in various applications, including as a base in cavity preparations, in Class V restorations, and in the repair of small defects[4]. However, their lower filler content compared to conventional composites can result in reduced mechanical properties, which raises concerns about their long-term performance, particularly in load-bearing areas.

Hydrophilic sealants are particularly advantageous in situations where moisture control is challenging. These sealants are formulated to bond effectively to enamel surfaces that may retain some moisture, thus enhancing their ability to penetrate deep into the pits and fissures of teeth[3,5]. This is particularly important in pediatric dentistry, where complete isolation of the tooth surface can be difficult. The hydrophilic nature of these sealants allows them to create a stronger bond in less-than-ideal conditions, potentially leading to better retention and longer-lasting protection against caries.

Shear bond strength is a critical measure of the adhesive performance of dental materials. It reflects the ability of the material to withstand forces that act parallel to the bonded interface, simulating the conditions experienced in the oral cavity during chewing[6]. High shear bond strength indicates a strong adhesive bond, which is necessary to prevent the dislodgement of the material and the subsequent failure of the restoration[7]. Factors that can influence shear bond strength include the type of adhesive system used, the surface preparation of the tooth, and the inherent properties of the restorative material itself.

This study's comparative evaluation of the shear bond strength between flowable composites and hydrophilic sealants is significant for several reasons. Firstly, it provides insight into which material offers superior adhesive properties, thereby guiding clinicians in their choice of material for specific clinical applications[3]. Secondly, by understanding the conditions under which each material performs best, clinicians can optimize treatment protocols to enhance the longevity of restorations. Finally, this study contributes to the broader body of research aimed at improving the quality of dental care and patient outcomes.

In summary, the comparative evaluation of the shear bond strength of flowable composites and hydrophilic sealants is essential for advancing restorative dentistry. By determining the strengths and weaknesses of these materials in terms of adhesion, this research will help clinicians make more informed decisions, ultimately leading to more effective and durable dental treatments.

Given the clinical significance of both flowable composites and hydrophilic sealants, it is essential to evaluate and compare their shear bond strengths to determine their effectiveness in clinical practice. This study aims to provide a comparative evaluation of the shear bond strength of flowable composites and hydrophilic sealants, thereby guiding clinicians in selecting the most appropriate material for different clinical scenarios.

MATERIALS AND METHOD:

Study design and sample size derivation:

The present research followed experimental, randomized type of study design. The sample size was derived using G*Power software Version 3.1.9.6 based on the previous study mean values and adopted apriori power analysis with 95% power and 0.05 alpha error. Based on the t test family and difference between two independent groups, sample size derived was 10 tooth per group with a total of 20 samples.

Ethical clearance:

Before the commensal of the experiment, ethical approval was obtained from the Saveetha Institutional research review board.

Tooth samples A total of 10 extracted molars were utilized for the study. A thorough cleaning of the sample followed by meticulous visual examination was done. Tooth samples with sound buccal surfaces were used for the intervention.

Randomization:

Using computer generated random numbers, the samples were randomly distributed to the two groups. Group I was Ultraseal XT Hydrophilic sealant and Group II was flowable composite(Ivoclar).

Sealant placement

The experimental phase of the study was conducted in white research lab, saveetha dental college. Acid etching technique was followed for both the groups using 37% orthophosphoric acid. With respect to hydrophilic sealant, tooth samples should be slowly dried and left marginally moist to achieve a shiny appearance as shown in figure 2 . On the other hand, a white glacial appearance of tooth enamel has to be attained for flowable composite application.

FIGURE 1: Template used of size 1.5mm

FIGURE 2: Sealant placement

Shear Bond Strength Testing:
Mounting: Secure each tooth sample in a mounting resin or acrylic block to ensure stability during testing.

FIGURE 3: Machine setup

Testing Machine Setup: Place the mounted sample in a universal testing machine, aligning the bonded area perpendicular to the applied force as depicted in figure 3.
Force Application: A chisel or knife-edge probe applies a shear force directly at the bond interface at a crosshead speed of around 0.5 to 1 mm/min until failure.
Statistical analysis

Shear bond strength of all the samples were imported to SPSS software version 20.0(IBM Corp, Armonk, NY,USA). Data was analyzed using SPSS software version 27. Shapiro-wilks test was used to determine the normality of the data. Independent t test was used to find the difference in mean shear bond strength between the groups.

RESULTS:

Normality of the data was analyzed using Shapiro-wilks test and a non-significant value was obtained for both the intervention groups, hence parametric test was employed.

The following tables provide the obtained statistic data

Table 1: Normality test using Shapiro-wilks test

Outcome	Groups	Shapiro-Wilk		
		Statistic	df	Sig.
Shear bond strength	Hydrophilic Sealant	0.887	10	0.16
	Flowable composite	0.871	10	0.06

- Hydrophilic Sealant: The Shapiro-Wilk statistic is 0.887 with a significance (Sig.) value of 0.16, which is greater than the commonly used threshold of 0.05. This suggests that the data for the hydrophilic sealant group are normally distributed.
- Flowable Composite: The Shapiro-Wilk statistic is 0.871 with a Sig. value of 0.06, which is also greater than 0.05. This indicates that the data for the flowable composite group are normally distributed as well.

Table 2: Comparison of mean shear bond strength between the groups using independent t test

Outcome	Groups	Independent t test			
		Mean	SD	Test value	P value
Shear bond strength	Hydrophilic Sealant	20.92	1.85	5.46	0.001*
	Flowable composite	16.77	1.51		

- Hydrophilic Sealant: The mean shear bond strength is 20.92 with a standard deviation (SD) of 1.85.
- Flowable Composite: The mean shear bond strength is 16.77 with an SD of 1.51.

Based on the data provided:

1. **Normality of Data**: The Shapiro-Wilk test results (Table 1) indicate that both the hydrophilic sealant and flowable composite groups have normally distributed data ($p > 0.05$), which validates the use of the independent t-test for comparing their means.
2. **Comparison of Shear Bond Strength**: The independent t-test (Table 2) shows a statistically significant difference in the mean shear bond strength between the hydrophilic sealant and flowable composite groups ($p = 0.001$). The hydrophilic sealant group has a higher mean shear bond strength (20.92) compared to the flowable composite group (16.77).

DISCUSSION:

The results of this study demonstrate that the hydrophilic sealant has a significantly higher shear bond strength compared to the flowable composite. This finding is crucial for clinical applications where strong adhesion to dental surfaces is necessary to ensure long-lasting restorations.

The ability of the hydrophilic sealant to efficiently interact with moisture on the tooth surface, improving adhesion, may be the reason for its higher bond strength. The ability of hydrophilic materials to withstand or even flourish in damp environments is beneficial in the oral cavity, where total dryness is difficult to attain. Conversely, in such an environment, the flowable composite, which is often more hydrophobic, would have a lower affinity for bonding.

The benefits of hydrophilic sealants over conventional composites in terms of bond strength have also been noted in earlier research, particularly in situations where moisture cannot be completely controlled. This is consistent with recent research, bolstering the idea that hydrophilic sealants could provide better results in difficult clinical situations. But it's important to remember that, although bond strength is important, other qualities like wear resistance and aesthetics also need to be taken into account.

According to research on restoration lifespan, hydrophilic sealants—especially those used on pit and fissure sealants for kids and teenagers—may lessen marginal leakage and enhance seal retention in high-stress regions[8]. In comparison to flowable composites, hydrophilic sealants performed better in preventing recurrent caries over a 12-month follow-up period, suggesting a stronger, more dependable bond, according to a study by[89] . The researchers pointed out that hydrophilic sealants might produce longer-lasting outcomes in clinical settings with less control over moisture.

A previous study conducted stated that the self-adhering flowable resin composite had the lowest shear bond strength values while Group II; showed the highest shear bond strength among the materials tested, substantiating to our provided results[9,10].

In vitro shear bond strength tests are crucial for assessing the effectiveness and clinical applicability of adhesive systems[11]. Furthermore, it has been suggested that this approach may be more effective in examining the complex interactions between composite materials and the substrate, even if shear bond strength testing is straightforward.

A reserach conducted also included and discussed on the contributions of bonding and etching generations, which stated that the self-etch (SE-1 step) seventh generation bonding agent (G-Bond), the self-adhesive flowable composite (Constic),[11,12] and the etch and rinse (ER-2 steps) fifth generation (Adper Single Bond) all had statistically significant differences in microleakage[9,10,13]. When comparing self-etch (G-Bond) with etch and rinse (Adper Single Bond 2), greater microleakage was seen in the G-Bond than in the Adper Single Bond 2, however the difference was not statistically significant.

Another research conducted by, stated that the microleakage could not be stopped by any of the restorative materials. Compared to Vertise flow, Filtek flowable bulk fill composite displayed greater microleakage but a stronger shear bond[14].

Research has also compared the adhesion of hydrophilic sealants and flowable composites to enamel and dentin[15]. Dentin, being a more moist and permeable tissue, often benefits from the use of hydrophilic bonding agents and materials. Studies show that hydrophilic sealants have superior bonding performance on dentin surfaces compared to flowable composites, which can fail more readily under moisture due to the lack of compatibility with hydrophilic substrates[16]. These findings further emphasize the importance of material selection based on the substrate and environmental conditions.

One concern with hydrophilic sealants is the potential for water sorption, which could lead to dimensional changes or compromise the material's integrity over time[17]. However, recent formulations of hydrophilic sealants have improved in terms of water resistance while retaining their adhesive strength in moist conditions[18]. A comparative study by[18], highlighted that, while flowable composites generally experience less water sorption, they fail to achieve the same adhesive stability in moist environments as hydrophilic sealants. Thus, while both materials have their pros and cons, hydrophilic sealants may offer a better balance in clinical situations where moisture control is limited.

Bond strength is not the only factor influencing clinical outcomes; fracture resistance and overall durability also play a significant role[19]. Studies show that although flowable composites have relatively good mechanical properties, they may be prone to bond failure under shear forces in moist conditions, while hydrophilic sealants, despite being slightly softer, often maintain their bond better in these conditions[20]. This suggests that hydrophilic sealants may be a more suitable option for certain applications, such as sealing occlusal surfaces in posterior teeth, where moisture control is harder to achieve.

This growing body of research aligns with the findings of this study, suggesting that hydrophilic sealants could be more advantageous for adhesive procedures in challenging clinical scenarios. However, future research should continue to refine these comparisons and explore new formulations that address both bond strength and dimensional stability under varying environmental conditions.

CONCLUSION:

This study demonstrates that hydrophilic sealants exhibit significantly higher shear bond strength compared to flowable composites, particularly in conditions where moisture control may be compromised. The results suggest that the hydrophilic properties of these sealants allow them to bond more effectively to dental surfaces, making them a superior choice in clinical situations that require strong adhesion under moist conditions.

The findings are supported by existing literature, which highlights the enhanced bond strength, durability, and moisture compatibility of hydrophilic materials. Consequently, hydrophilic sealants may be recommended over flowable composites in situations where complete moisture control is difficult to achieve, such as in sealing pits and fissures or bonding to dentin.

Future studies could further validate these results by examining the long-term performance of hydrophilic sealants and comparing them with other materials under different clinical conditions. Overall, this research underscores the importance of selecting appropriate materials based on clinical needs and environmental factors to achieve optimal outcomes in restorative dentistry.

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