

**EFFECT OF BLOOD CONTAMINATION USING SELF-ETCHING SELF-ADHESIVE FLOWABLE COMPOSITE AND NANOHYBRID COMPOSITE ON THE SHEAR BOND STRENGTH TO DENTIN – AN IN-VITRO STUDY**

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**ABSTRACT**

**Background:** Shear bond strength (SBS) is a key factor in the success of restorative materials, reflecting their adhesion to dentin. Blood contamination can interfere with resin infiltration and compromise bonding. Self-etching self-adhesive flowable composites offer ease of application, while nanohybrid composites provide superior mechanical properties. Comparing their SBS under uncontaminated and contaminated conditions helps assess their clinical performance. **Aim:** To compare and evaluate the shear bond strength (SBS) of self-etching self-adhesive flowable composite and nanohybrid composite to dentin under uncontaminated conditions and after contamination with blood. **Materials and Methods:** Sixty extracted human premolars were prepared with standardized Class V cavities and divided into two groups: uncontaminated, and blood-contaminated. Each group was subdivided into two subgroups (n = 15): self-etching self-adhesive composite and nanohybrid composite. SBS was measured using a universal testing machine. Data were analysed using independent t-test, one-way ANOVA, two-way ANOVA, Tukey post-hoc test, and Levene's test. **Results:** Under uncontaminated conditions, nanohybrid composite showed significantly higher SBS than self-etch composite (p < 0.001). Blood contamination caused the greatest reduction in SBS, with self-etch composite performing significantly better than nanohybrid composite (p < 0.001). Significant differences were observed among subgroups and between factors (p < 0.001). **Conclusion:** Nanohybrid composite performs best under ideal conditions, while self-etch composite shows greater resistance to contamination. Blood contamination has the most detrimental effect on dentin bonding.

**KEYWORDS:** Shear bond strength, dentin, nanohybrid composite, self-etch composite, contamination, in-vitro study.

**INTRODUCTION**

Achieving a dry and well-isolated operative field is a fundamental prerequisite for successful endodontic and restorative dental procedures. Any contamination of the prepared surface by saliva, blood or gingival crevicular fluid should be avoided in order to achieve a successful and durable bond between the resin composite and the tooth.<sup>[1,2]</sup> Achieving good moisture control is a common

problem encountered in restorative dentistry, especially when rubber dam isolation is not feasible.<sup>[3,4]</sup> Many carious lesions are found in areas where it is difficult to obtain appropriate isolation for the use of dentin bonding agents, especially when the site is near or at the gingival margin.<sup>[3]</sup>

Among various contaminants, blood presents a significant challenge due to its high protein and macromolecule content, including fibrinogen. When blood contaminates the bonding surface, fibrinogen forms a film that interferes with resin infiltration into enamel and dentin, resulting in a marked reduction in shear bond strength—reported to be as high as 70%. This disruption compromises the formation of a durable resin-tooth bond and negatively affects restoration performance.<sup>[5]</sup>

Contamination can adversely affect adhesive performance, leading to increased postoperative sensitivity, marginal discoloration, secondary caries, and restoration dislodgement. Hence, maintaining a contamination-free field is especially crucial when using composite resin restorations, which are highly technique-sensitive.

This study aimed to evaluate the effect of blood on SBS of self-etching self-adhesive and nanohybrid composites to dentin.

## MATERIALS AND METHODS

### Sample preparation

Sixty freshly extracted human premolars were selected. The exclusion criteria for the present study comprised teeth with developmental defects such as hypoplasia, fluorosed teeth, previously endodontically treated teeth, teeth with existing restorations, fractured teeth, teeth exhibiting calcified canals or canal obstruction, teeth with internal resorption, and those presenting with periapical pathology or any other structural or pathological abnormalities. Teeth were cleaned, marked, and embedded in acrylic blocks up to 1 mm apical to the

cemento-enamel junction, maintaining the long axis of the tooth parallel to the block. Standardized Class V cavities were prepared using diamond points to expose dentin. Surfaces were polished with silicon carbide paper to simulate the smear layer. Specimens were stored in distilled water until testing.

### Experimental groups

- **Group A (Uncontaminated):**
  - Sub-group A1: Constic® self-etching self-adhesive composite (n = 15)
  - Sub-group A2: 3M™ Filtek™ Supreme Flowable Restorative nanohybrid composite (n = 15)
- **Group B (Blood contamination):**
  - Sub-group B1: Constic® self-etching self-adhesive composite (n = 15)
  - Sub-group B2: 3M™ Filtek™ Supreme Flowable Restorative Nanohybrid composite (n = 15)

Fresh human capillary blood was obtained from the clinician fingertip using a sterile disposable lancet under aseptic conditions (the investigation was approved by the ethical clearance committee of the institute and the informed consent was obtained). The prepared tooth surface was contaminated with blood for 15 seconds using a microbrush to simulate clinical conditions, followed by rinsing with water for 10 seconds and gentle air-drying for 10 seconds to obtain a standardized dry surface prior to further procedures.

### Bonding and Testing

Composites were applied according to manufacturer instructions. Shear bond strength was tested using a universal testing machine.



Fig. 1: DMG constic®



Fig. 2: 3M™ Filtek™ supreme flowable restorative composite



Fig. 3: Futurabond DC bonding agent



Fig. 4: Class V cavity preparation



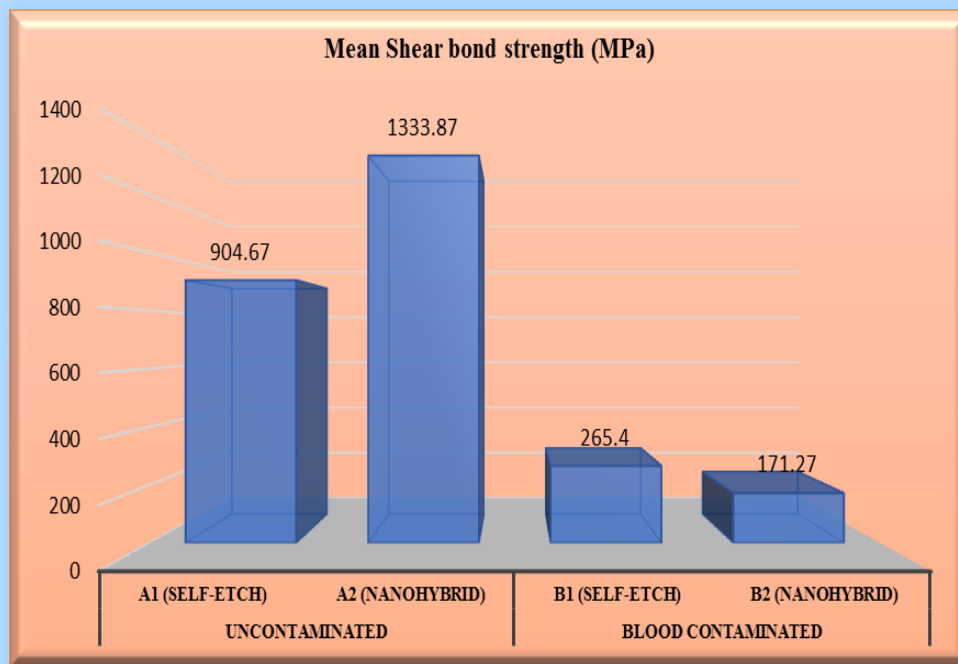
Fig. 5: Testing under universal testing machine(UTM)

**RESULT**

**Table 1: Comparison of Mean shear bond strength (MPa) between composite types within each contamination condition (A1 vs A2, B1 vs B2) (n=60).**

Group	Subgroup	N	Mean (MPa)	SD	Mean difference	95% CI of difference	t value	p value
Uncontaminated	A1 (Self-etch)	15	904.67	44.49	-429.2	-482.4 to -375.9	-16.5	0.001*
	A2(Nanohybrid)	15	1333.87	90.30				
Blood contaminated	B1 (Self-etch)	15	265.40	26.63	94.13	76.73 to 111.5	11.0	0.001*
	B2 (Nanohybrid)	15	171.27	19.33				
F-value			1085.72					
p-value			0.001*					

\*Statistically significant



**Fig. 6: Comparison of Mean shear bond strength (MPa) between composite types within each contamination condition (A1 vs A2, B1 vs B2) (n=60).**

**Table 2: Two-way ANOVA showing the effect of composite type and contamination condition on shear bond strength (MPa).**

Composite	Condition	n	Mean (MPa)	SD
Self-etch	Uncontaminated	15	904.67	44.49
	Blood	15	265.40	26.63
Self-etch (overall)		30	585.04	320.00
Nanohybrid	Uncontaminated	15	1333.87	90.30
	Blood	15	171.27	19.33
Nanohybrid (overall)		30	752.57	581.00

**Table 3: Levene's test and two-way ANOVA (between-subjects effects) for shear bond strength (mpa) (n = 60).**

Source	Levene Statistic	df1	df2	Type III Sum of Squares	df	Mean Square	F-value	p-value	Partial Eta Squared
Levene's Test	7.82	3	56	—	—	—	—	0.001*	—
Composite	—	—	—	185,000.00	1	185,000.0	52.10	0.001*	0.482
Condition	—	—	—	10,250,000.00	1	10,250,000.0	2885.30	0.001*	0.981
Composite × Condition	—	—	—	1,150,000.00	1	1,150,000.0	323.70	0.001*	0.852
Error	—	—	—	199,000.00	56	3,553.57	—	—	—
Total	—	—	—	12,000,000.00	59	—	—	—	—

\*Statistically significant

The present study compared the shear bond strength between self-etch and nanohybrid composites under uncontaminated and blood-contaminated conditions. In the uncontaminated condition, the nanohybrid composite showed significantly higher shear bond strength compared to the self-etch composite ( $p = 0.001$ ). However, under blood contamination, the self-etch composite demonstrated significantly higher bond strength than the nanohybrid composite ( $p = 0.001$ ). (Table 1, Figure 6)

Two-way ANOVA revealed that both the type of composite material and the contamination condition had a highly significant effect on shear bond strength ( $p = 0.001$ ). Additionally, a significant interaction between composite type and contamination condition was observed, indicating that the performance of the composites varied depending on the presence or absence of contamination. (Table 2)

Levene's test showed a significant difference in variances among the groups ( $p = 0.001$ ), suggesting heterogeneity of variance. Overall, the results indicate that while nanohybrid composites perform better in ideal (uncontaminated) conditions, self-etch composites exhibit superior performance under contaminated conditions, highlighting their clinical advantage in situations where moisture control is compromised. (Table 3)

## DISCUSSION

The aim of the study was to compare and evaluate the shear bond strength to dentin before and after contamination with blood using self-etching self-adhesive composite and nanohybrid composite.

In this study, 60 human premolars (maxillary and mandibular premolar teeth) were used. Premolars are more prone to contamination due to their complex anatomy, including deep pits, fissures, and occasional multiple canals, along with their position in the arch which makes isolation difficult. During dental procedures, contamination by saliva, blood, or gingival fluids can compromise bonding, reduce restoration success, and introduce microorganisms into the root canal system, ultimately increasing the risk of microleakage and treatment failure.

According to research by Hegde and colleagues,<sup>[6]</sup> minimum bond strength of 17-20 Mpa is needed to resist contraction forces of resin composite materials, for enamel and dentin. Clinical experiences confirm that this bond strength is sufficient for successful retention of resin restoration. Kiremitci et al.<sup>[7]</sup> concluded that self etching adhesive systems produced higher bond strength than conventional total etch systems, especially the all-in-one system, which produced the highest bond strength.

These findings are consistent with the study conducted by Sattabanasuk V and colleagues,<sup>[8]</sup> which reported that residual blood proteins interfere with proper adhesion and inhibit the copolymerization between the adhesive system and the resin composite.

A study by Fritz et al.<sup>[9]</sup> also concluded that there was a decrease in the bond strength of the one-step bonding system because of the contamination after curing.

Bhatia et al.<sup>[10]</sup> in their study, reported that reapplication of the bonding agent significantly improved bond strength. This improvement can be attributed to the ability of the second application to re-establish proper

resin infiltration into the dentinal tubules and hybrid layer, especially in cases where initial contamination (such as blood or saliva) may have compromised adhesion. The reapplication helps to displace residual contaminants, enhance wettability of the dentin surface, and ensure better polymerization, thereby resulting in a more stable and durable resin–dentin bond.

The study confirmed that contamination markedly reduces SBS to dentin. The fibrin and protein layers present in blood act as a physical barrier, preventing adequate resin infiltration.

Nanohybrid composites, with smaller filler particles and higher filler loading, perform optimally in uncontaminated environments. Self-etching self-adhesive composites, by contrast, exhibit greater tolerance to contamination due to their chemical bonding mechanism and simplified application protocol. The significant interaction effect observed between material type and contamination underscores the need for careful material selection in clinical situations where contamination is unavoidable.

## CONCLUSION

The nanohybrid composite exhibited significantly higher shear bond strength under uncontaminated conditions, reflecting its superior mechanical properties and enhanced filler technology, which promote better resin infiltration and formation of a strong hybrid layer with dentin. This indicates that in an ideal, contamination-free environment, nanohybrid composites are capable of establishing more durable and reliable adhesion compared to other materials.

The presence of blood contamination led to a marked and statistically significant reduction in bond strength for both composite types. However, the reduction was more pronounced in the nanohybrid composite, suggesting that it is more sensitive to contamination. This can be attributed to the formation of a protein-rich film on the dentin surface, which obstructs resin penetration, compromises hybrid layer formation, and interferes with proper polymerization, thereby weakening the adhesive interface.

Additionally, the study findings demonstrated that the type of composite material, the contamination condition, and the interaction between these two variables had a highly significant effect on shear bond strength to dentin. This indicates that the performance of restorative materials is not solely dependent on their inherent properties but is also greatly influenced by the clinical environment. Hence, achieving optimal isolation and selecting appropriate materials are critical factors in ensuring successful and long-lasting dentin bonding.

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