

## Nanoleakage Evaluation of a Silorane Based, Nanohybrid and Giomer Composites – An In-Vitro Study

Dr.Lakshmi Swathi. Akkala, Dr.Sujeer. R, Dr.Toby Thomas, Dr.Veronica.

1, 2, 3&4 (Dept. Conservative Dentistry & Endodontics, Saveetha Dental College & University, Chennai, India)

**Abstract: Aim:** This study evaluates the Nano-leakage of 3 different composite restorations.

**Materials and Methods:** Group-A: Silorane Composite Resin (Filtek Silorane, 3m Espe) bonded with Silorane Adhesive; n=5. Group-B: Nano-Composite (Ceram X Nano) bonded with two Step Self-Etch Adhesive; n=5. Group-C: Giomer bonded with two Step Self-Etch Adhesive; n=5. 15 extracted premolars were taken class V cavity preparations were made on the buccal surfaces of the teeth. All the cavities in group A were restored with silorane composite. Group-B was restored with nano-composite, Group-C with giomer and bonding agent used were self etch primer. Nano-leakage patters were then viewed under SEM (Scanning Electron Microscope)

**Results:** Silorane shows lesser silver uptake than other two composite restorations. There was statistically significant difference between Nano-leakage of group- A, group- B and group- C.

**Discussion:** Silver nitrate solution 50% (w/v) (AgNO<sub>3</sub>) is the most used tracer for evaluation of the nanoleakage phenomenon. This solution can penetrate the dentin due to the small silver ion size. Silorane is Biocompatible, Hydrophobic and low – shrinking posterior restorative material. Silorane adhesive consists of self etch primer and a adhesive bonding. The silorane bonding agent is a self etch adhesive which is easy to use and has low technique sensitivity. The silorane resin is more hydrophobic than conventional methacrylate resins - results in reduced water uptake.

**Conclusion:** It is generally accepted that heavy silver uptake along the interfacial layer and in the adhesive layer can be due to imperfect resin infiltration, retained water or other solvent, poor polymerization, or phase separation.

**Key Words:** Nano-leakage, Silorane, Nano-composite, Giomer.

### I. Introduction

In the past 15yrs a dramatic improvement in adhesive technology and resin composite formulations has occurred<sup>[1]</sup>. The utmost goal of bonded restorations is to achieve a marginal and internal seal<sup>[4]</sup>.

The term nano leakage was introduced by Sano, et al in 1995<sup>[13]</sup> to describe a specific type of leakage, which exists even in the absence of marginal gaps. This leakage occurs laterally, through sub-microns porosities (estimated to be about 20 to 100nm in width) at the base of hybrid layer, which have not been left poorly polymerized<sup>[14, 15]</sup>. This de-mineralized but not fully hybridized dentin layer can be considered a weak point in the adhesion mechanism that could allow dentinal fluid to slowly permeate the interface, and this is believed to degrade the adhesive resin<sup>[13]</sup>.

Silver nitrate solution 50% (w/v) (AgNO<sub>3</sub>) is the most used tracer for evaluation of the nano-leakage phenomenon. This solution can penetrate the dentin due to the small silver ion size (0.059) nm in diameter<sup>[3]</sup>. Contrasting the size of this ion with the size of some bacteria (0.5-1.0µm)<sup>[16]</sup> yields considerable information about the results obtained in evaluating the Nano-leakage phenomenon.

Two major properties of dental composites that have still to be improved are their polymerization shrinkage and related polymerization stress. Both parameters contribute to different clinical challenges such as reduced marginal integrity and post-operative sensitivity. Imperfect margins result in marginal staining and eventually secondary caries, and represent the most important reason for the replacement of existing insufficient composite fillings. Polymerization shrinkage also leads to cuspal displacement and even up to cracks in healthy tooth structure.

Two main strategies to reduce polymerization shrinkage:

- Reduction of reactive sites per volume unit.
- Reduction of shrinkage using different types of resin.

The density of reactive sites per volume unit can be reduced principally in two ways:

- By increasing the molecular weight per reactive group.

- By increasing the filler load.

This aim of the study was to evaluate the Nano-leakage of 3 different composite restorations.

## II. Materials And Methods

Three commercially available composites were used in this study. 15 extracted premolars were taken, and randomly assigned into 3 different groups. Group-A: Silorane Composite Resin (Filtek Silorane, 3M Espe) bonded with Silorane Adhesive; Group-B: Nano-Composite (Ceram X nano) bonded with two Step Self-Etch Adhesive; Group-C: Giomer bonded with two Step Self-Etch Adhesive. Class V cavity preparations were made on the buccal surfaces of the teeth. Standardized saucer shaped cervical cavities (2.0mm high, 2.0mm wide were and 2.0mm deep) with cervical margins located in dentin were cut on buccal and lingual surfaces of teeth. Diamond burs were used for cavity preparation. Hand cutting instruments were used to provide adequate cavity finishing. Group-A: Application of silorane system adhesive self etch primer for 15secs with black micro-brush, followed by gentle air dispersion and 10secs of light curing, then adhesive bond applied by gentle air dispersion and 10secs of light curing. Placement of filtek silorane low shrink composite resin (3m Espe) and 20secs of light curing (Elipar free light) Group B and C were bonded by two step self etch adhesive followed by nano-composite and giomer restorations and light cured. Teeth were coated with nail varnish leaving 1mm around the restoration and placed in ammonical silver nitrate solution for 24hrs after removing from photo-developing solution, the specimens were rinsed under running water for 5mins<sup>[5]</sup>. Teeth were sectioned bucco-lingually through the center of restorations by using a low speed diamond saw. The specimens were dried mounted on aluminum stubs and sputter-coated with Au-Pd. The nano-leakage patterns were observed by scanning electron microscopy using the backscattered electron image mode.

## III. Results

Total no of teeth included and excluded were presented in table 1. The mean and standard deviations and statistical significance of percentage of silver penetration for three adhesive systems are presented in table 2. Anova presented in table 3. Regarding the nano-leakage depth at 24 hrs, there is statistically significant difference between group-A, group-B and group-C. Giomer showed higher penetration depth of silver ions than nano-composite and silorane ( $p \leq 0.05$ ). Nano-composite showed higher penetration depth of silver ions than silorane ( $p \leq 0.05$ ). No water trees were found in any of the restorations.

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
NANOLEAKAGE * GROUP	15	100.0%	0	.0%	15	100.0%

Table – 1 Total No of Cases

Group	Mean	N	Std. Deviation
Silorane	.40	5	.548
Nano composite	1.80	5	.837
Giomer	3.00	5	.707
Total	5.20	15	2.092

Table – 2 Mean and Standard Deviation

Silorane showed least nano-leakage when compared with Nano-Composite and Giomer.

Group	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.583	4	1.896	7.845	.004
Within Groups	2.417	10	.242		

Table – 3 Anova

#### IV. Discussion

Nano-leakage of composite restorations occurs because of stressed placed along the tooth / restoration interface from polymerization shrinkage, temperature fluctuations in oral environment and mechanical fatigue through repetitive masticatory loading<sup>[16]</sup>. Despite their different formulations, adhesive systems should be able to provide adequate cavity wall-resin interface sealing. The adhesive systems are composed of a distinct association of hydrophilic and hydrophobic monomers dissolved in an organic solvent such as water, ethanol or acetone. The adhesive mechanism includes dentin surface de-mineralization either by phosphoric acid solutions, or by self-etch primers. The nano-spaces created on the collagen mesh after etching filled with resin monomers that co-polymerize in situ, creating the so called hybrid layer.

The term nano-leakage was introduced by Sano, et al in 1995<sup>[13]</sup> to describe a specific type of leakage, which exists even in the absence of marginal gaps. This leakage occurs laterally, through sub-microns porosities (estimated to be about 20 to 100nm in width) at the base of hybrid layer, which have not been left poorly polymerized<sup>[14, 15]</sup>. This de-mineralized but not fully hybridized dentin layer can be considered a weak point in the adhesion mechanism that could allow dentinal fluid to slowly permeate the interface, and this is believed to degrade the adhesive resin<sup>[13]</sup>.

Silver nitrate solution 50% (w/v) ( $\text{AgNO}_3$ ) is the most used tracer for evaluation of the nano-leakage phenomenon. This solution can penetrate the dentin due to the small silver ion size (0.059 nm in diameter<sup>[3]</sup>). Contrasting the size of this ion with the size of some bacteria (0.5-1.0 $\mu\text{m}$ )<sup>[16]</sup> yields considerable information about the results obtained in evaluating the Nano-leakage phenomenon.

NaOCl is a well-known non-specific proteolytic agent and its collagen removal ability has been evaluated. Recent studies reported that collagen removal with 10% NaOCl prevented the nano-leakage phenomenon<sup>[17, 18]</sup>. According to previous studies this nano-leakage patterns represents discontinuous islands of silver deposits within the hybrid layer, and could be related to water removal from dentin-resin interface, instead of incomplete adhesive infiltration.

#### V. Conclusion

Long term further clinical evaluations are needed to further conclude the nano-leakage phenomenon.

#### References

- [1]. B Simi and BS Suprabha. Evaluation of micro leakage in posterior nanocomposite restorations with adhesive liners. J Conservative Dentistry-2011. April-JUN 14(2), 178-181.
- [2]. Silmara Aparecida Milori Corona, Maria Cristina Borsatto, Renata Andrea Salvitti de sa Rocha, Regina Guenka Palma-Dibb. Micro-leakage on class v glass ionomer restorations after cavity preparation with aluminiu, oxide air abrasion. Braz.Dent J vol 15 no.1 april 2005.
- [3]. Van Meerbeek B, De Munck J, Yoshida Y, Inoue, Vargas M, Van Landuyt K et al. Adhesion to enamel and dentin: current status and future challenges. Oper Dent. 2003;28:215-35.
- [4]. E. H Mobarak, LE Daifalla. Long term nano-leakage depth and pattern of cervical restorations bonded with different adhesives. Operative Dentistry 2012, 37-1, 45-53.
- [5]. Patricia de Brito Pereira Garcia DUARTE, Eduardo Moreira da SILVA. Nano leakage phenomenon on deproteinized human dentin. J Appl Oral Sci 2 007; 15 (4): 285-91.
- [6]. 3M ESPE Filtek Silorane – low shrink posterior restorative, silorane system adhesive – self-etch primer & bond.
- [7]. L Shi, X Wang, Q Zhao, Y Zhang, L Zhang, Y Ren, Z Chen. Evaluation of packable and conventional hybrid composites in class-I restorations: three-year results of a randomized, double-blind and controlled clinical trial. Operative Dentistry, 2010, 35-1, 11-19.
- [8]. VV Gordan, IA Mjor. Short and long term clinical evaluation of post-operative sensitivity of a new resin based restorative material and self-etching primer. Operative Dentistry, 2002, 27, 543-548.
- [9]. Wolfgang Weinmann, Christoph Thalacker, Rainer Guggenberger. Siloranes in dental composites. Dental materials, 2005, 21, 68-74.
- [10]. Fahad Umer, Farah Naz and Farhan Raza Khan. An in vitro evaluation of microleakage in class-v preparations restored with hybrid versus silorane composites. J Conserv Dent 2011 April-Jun; 14 (2) 103-107.
- [11]. Roula Al-Boni and Ola M Raja. Microleakage evaluation of silorane based composites versus methacrylate based composites. J Conserv Dent. 2010 Jul-Sep 13(3) 152-155.
- [12]. VS Agarwal, VV Parekh, NC Shah. Comparative Evaluation of microleakage of silorane based composites and nano-hybrid composite with or without polyethylene fiber inserts in class II restorations: an in vitro study. Operative Dentistry, 2012, 37-4. 000-000.
- [13]. Sano H, Takatsu T, Ciucchi B, Horner JA, Matthews WG, Pashley DH nanoleakage: leakage within hybrid layer. Oper dent-1995;20:18-35.
- [14]. Sano H, Yoshida Y, Ebisu S, Burrow MF, Takatsu T, Ciucchi B, ET AL. Comparative TEM and SEM observations of nanoleakage within the hybrid layer. Oper Dent, 1995;20:160-7.
- [15]. Varela SG, Rabade SB, Lombardero PR, Sixto JML, Bahillo JDG, Park SA, in vitro study of endodontic post cementation protocols that use resin cements. J Prosthet Dent. 2003;89:16-53.
- [16]. Kubo S, Yokota H, Sata Y, & Hayashi Y (2001) the effect of flexural load cycling on micro-leakage of cervical resin composites. Operative dentistry 26(5) 451-459.
- [17]. Goes MF, Montes MAJR. Evaluation of silver methenamine method for nano-leakage. J Dent. 2004;32:291-8.
- [18]. PIOCCH t, kobaslija S, Huseinbegovic A, MULLER K, Dorfer CE, the effect of NaOCl dentin treatment on nano-leakage formation. J Biomed Mater Res 2001; 56:578-83.
- [19]. M. Hashimoto, J. De Munck, S. Itoc, H. Sanod, M. Kagaa, H. Oguchia, B. Van Meerbeek, D.H. Pashley. In vitro effect of nanoleakage expression on resin-dentin bond Strengths analyzed by microtensile bond test, SEM/EDX and TEM. Biomaterials 25 (2004) 5565–5574.
- [20]. Mario Fernando de Goesa, Marcos Antonio Japiassu Resende Montesb, Evaluation of silver methenamine method for nanoleakage. Journal of Dentistry (2004) 32, 391–398