

Microleakage in Open-Sandwich Class II Dental Restorations



ADA 2015 Emerging Techniques

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The integrity and durability of the marginal seal has always been of prime concern.....

to overcome the inherent composites disadvantages such as the polymerisation shrinkage.....

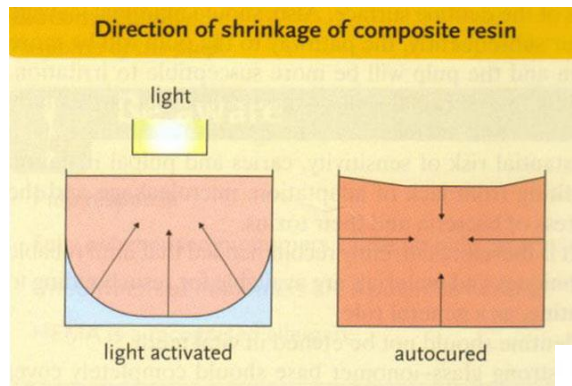
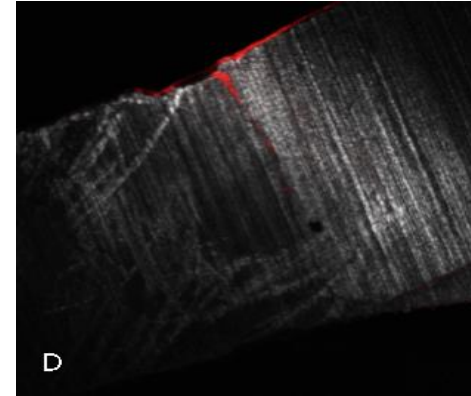
and the weaker adhesion at the composite-dentin interfaces

- The step-by-step incremental technique,
- transparent matrices,
- reflecting wedges and
- improved adhesive systems

..... solved only partially these problems.

CLSM images of dentin area in longitudinal section

Showing microleakage with Rhodamine B dye in interface with restoration.



C-Factor

Factors that influence stress formation include volumetric polymerization shrinkage; elastic modulus and flow of the resin composite; adherence of the resin composite to the cavity walls.

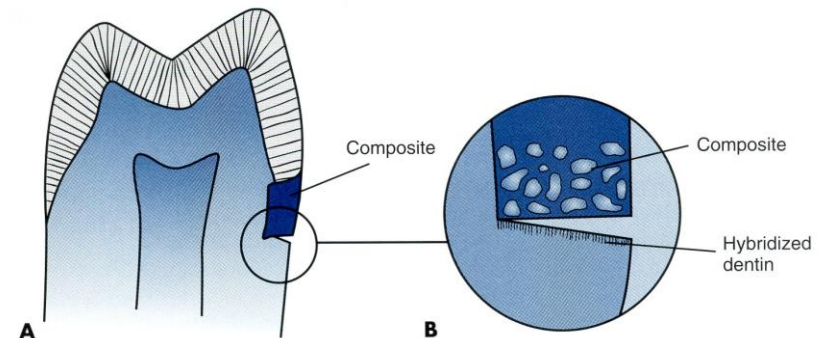




FIGURE 12-2 Contraction gap (exaggerated). **A**, V-shaped gap on root surface. **B**, Restoration-side vector is composite; root-side vector is hybridized dentin.

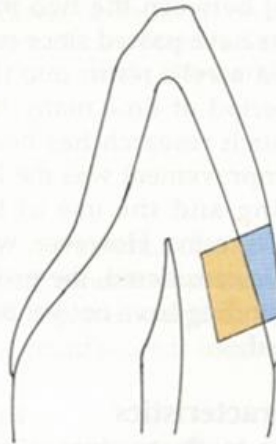
The technique, so-called “Sandwich” as an effective technique for both anterior and posterior resin based restorations.....

The open-sandwich technique was proposed


which consists in a gingival layer of another class of material (usually GIC) prior to resin composite insertion in class II cavities (Kirsten GA. *et al.*, 2013)

Evidence shows that fracture of restorations is one of the main causes of restoration replacement. Modern composites offer perfect features for enamel replacement: high wear resistance and aesthetics. However, they are not able to provide resistance to fracture .

-  Composite resin
-  Glass ionomer cement



Closed Sandwich Technique

 Resin Composite

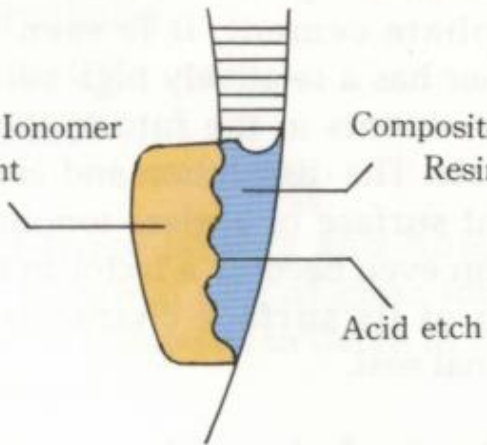
 Fuji IX GP



Glass Ionomer
Cement


Composite
Resin

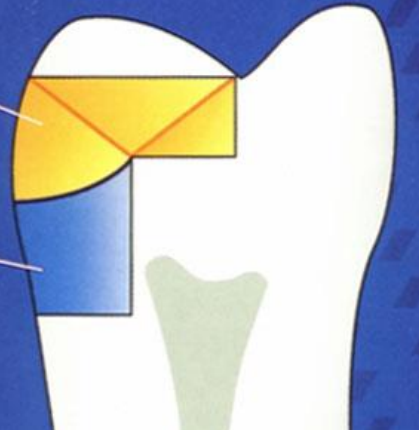
Acid etch



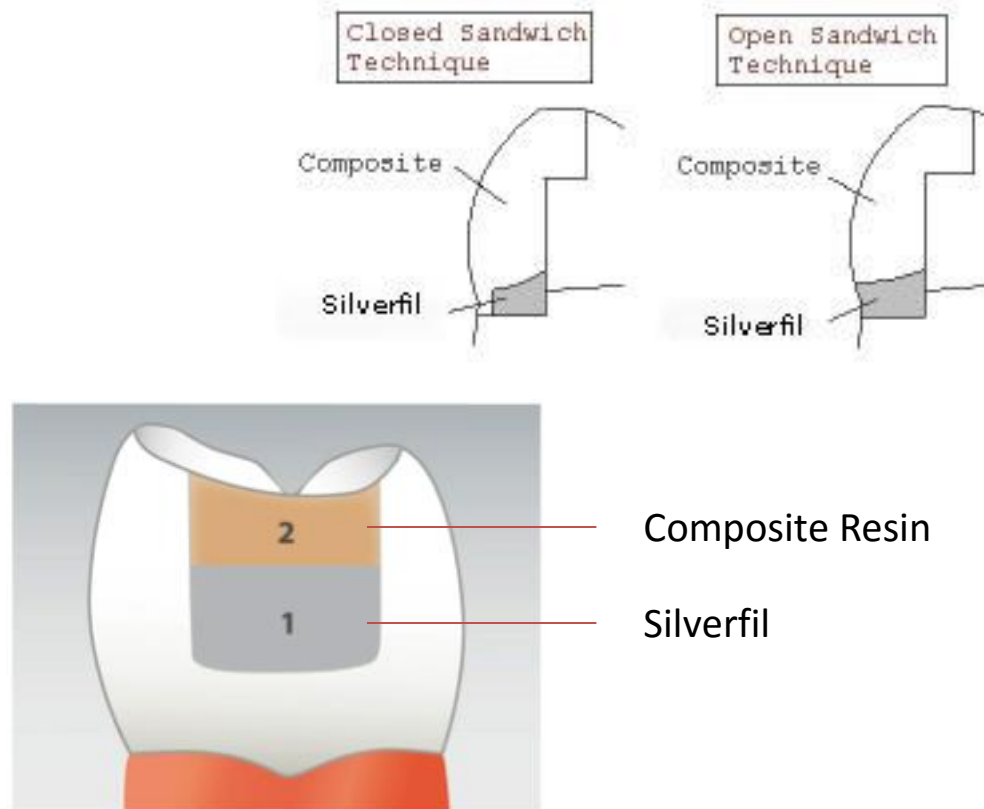
Open Sandwich Technique

 Resin Composite

 Fuji IX GP



The new SilverFil-CR open-sandwich technique was proposed



Silverfil Amalgam provides a fracture toughness almost double that of a conventional composite. This makes SilverFil Amalgam the strongest possible sub-structure to reinforce any composite restoration in large preparations.

Cavity
Preparation



Lining



Silverfil
Amalgam



Amalgam Bonding



Etching and CR



Why SilverFil Amalgam??

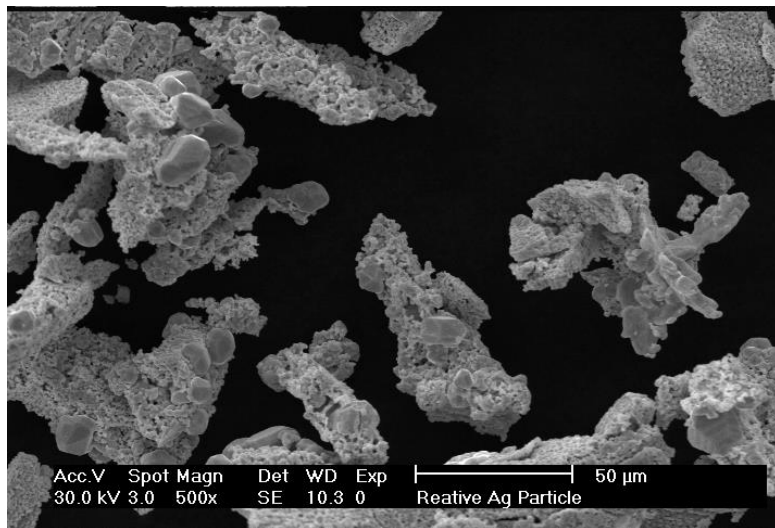
SILVERFIL ARGENTUM

Component 1:

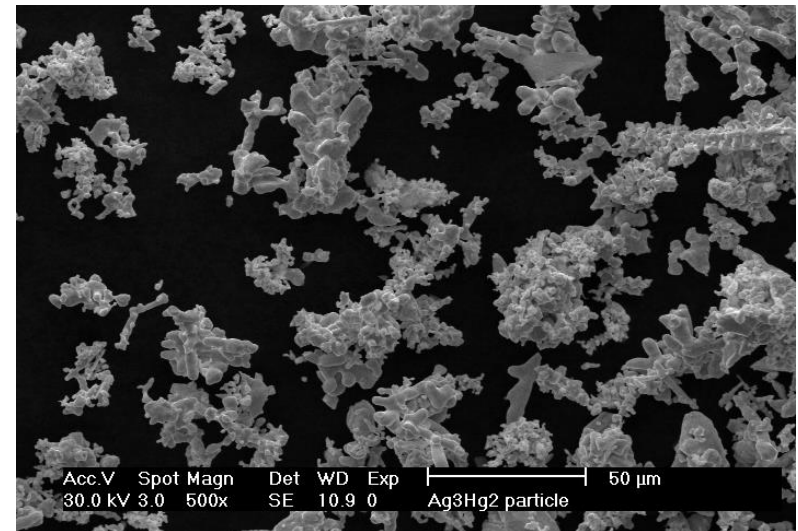
Chemically processed silver particles (Ag) that are highly reactive to mercury.

Component 2:

A partially amalgamated silver-mercury powder (Ag_3Hg_2)



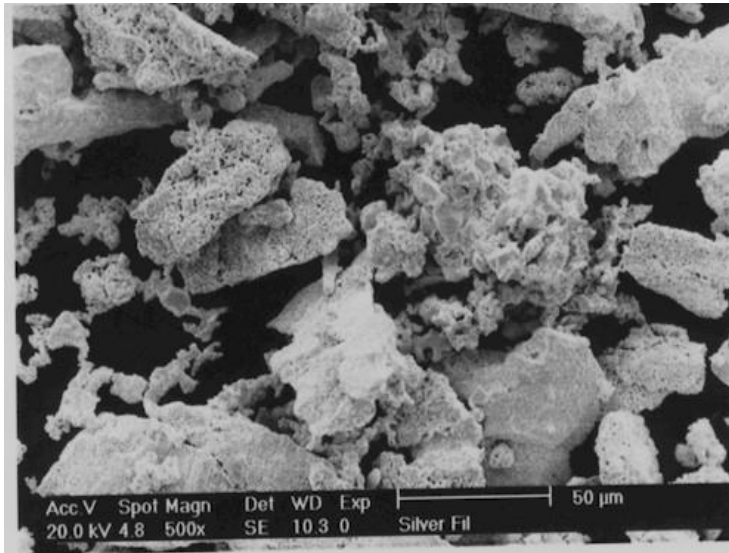
- Microscopic appearance of reactive silver particles.
- Porous appearance of the particles.



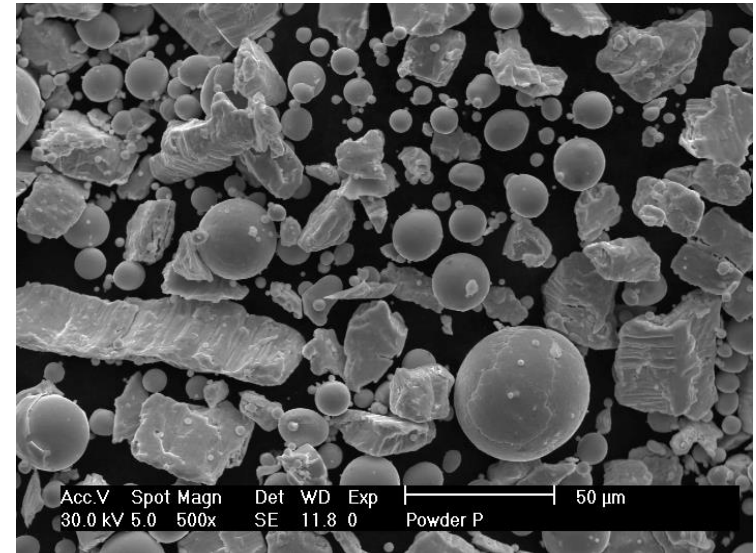
- Microscopic appearance of Ag_3Hg_2 particles.
- The material appears less porous.

What is the difference between SilverFil and Dental Amalgam?

- Studies have proven that SilverFil has a high coefficient of diffusion for mercury (Amalgamation within 3 seconds).
- No evidence of any excess mercury in SilverFil amalgams.



Microscopic view of Silverfil powder



- Microscopic appearance of a traditional Disperse Phase Alloy (Non gamma 2).
- A mixture of lathe-cut and spherical particles.

Microleakage Study.....

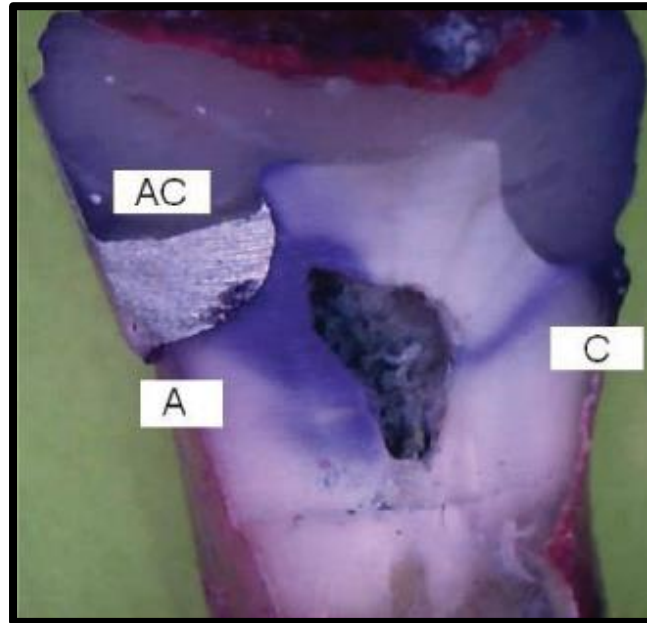
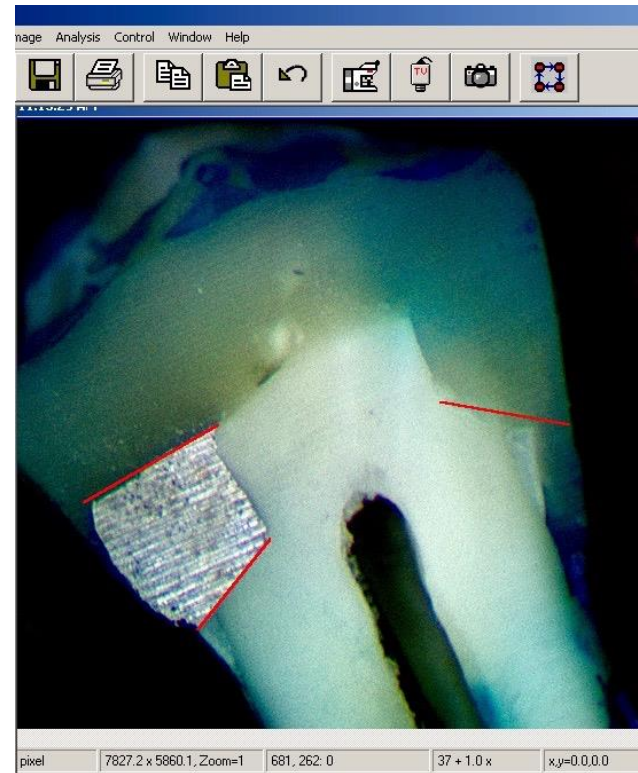


Figure shows the tooth-material interface at longitudinal view

- A : Amalgam-tooth Interface,
- AC : Amalgam-composite Interface,
- C : Composite-tooth Interface



mean gap widths and SD (μm) obtained from each experimental group between dentin and the materials tested

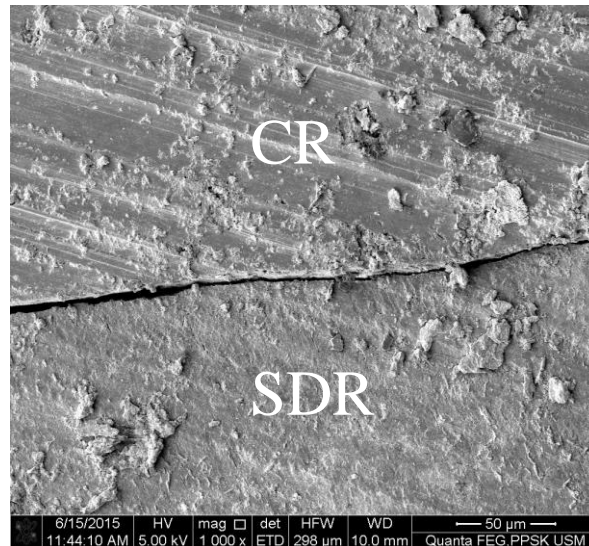
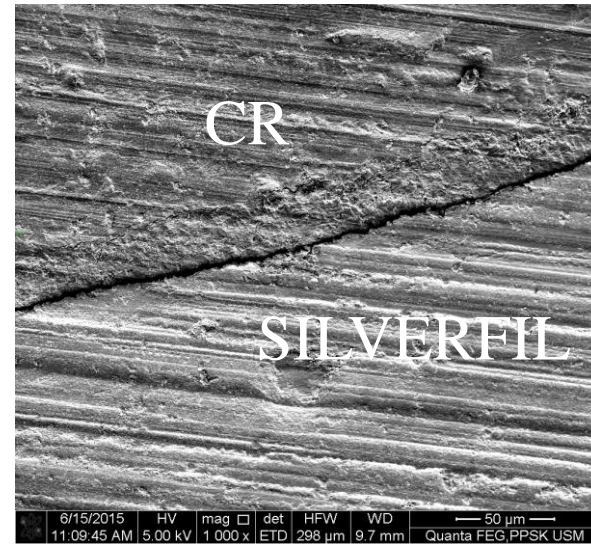
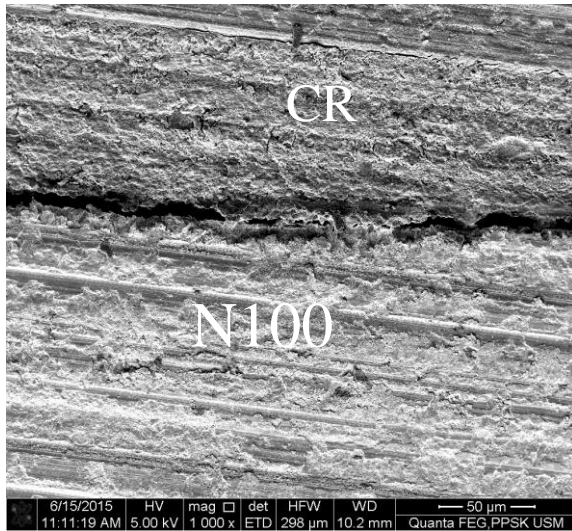
Group	Mean gap width (μm)
1. SilverFil [®] with Panavia F amalgam bonding + CR	$4.6 \pm 2.2^*$
2. Ketac N100 nanoionomer RMGI + CR	$5.2 \pm 2.7^*$
3. Conventional Fuji II [™] GIC+ CR	20.6 ± 6.9
4. Full CR Filtek Z350 XT	$3.8 \pm 2.1^*$

* Indicate no significant difference ($p>0.05$).

Mann-Whitney and Kruskal-Wallis Tests.

CR= Composite Resin; GIC= Glass Ionomer Cement;

RM GIC= Resin Modified Glass Ionomer

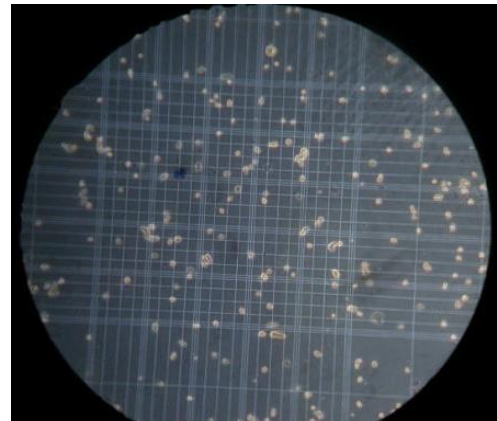
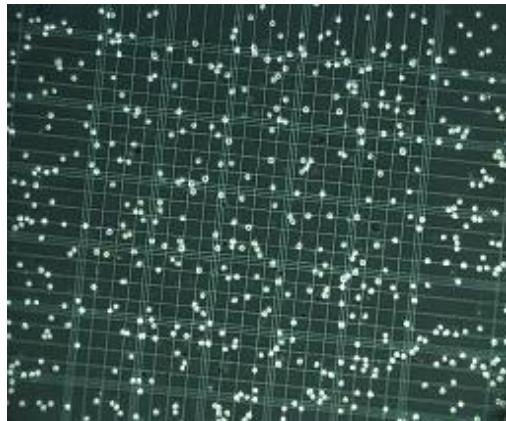


Scanning Electron Microscopy Results

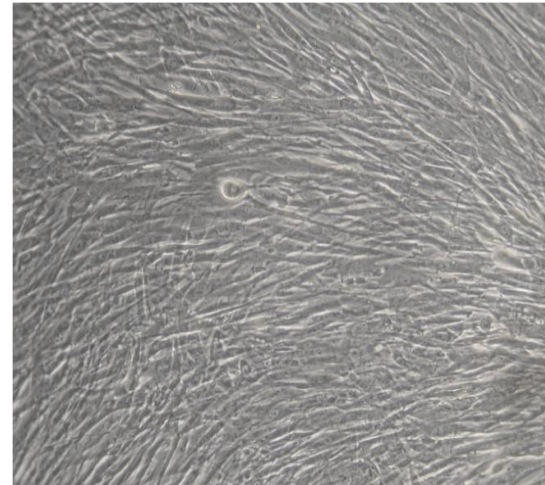
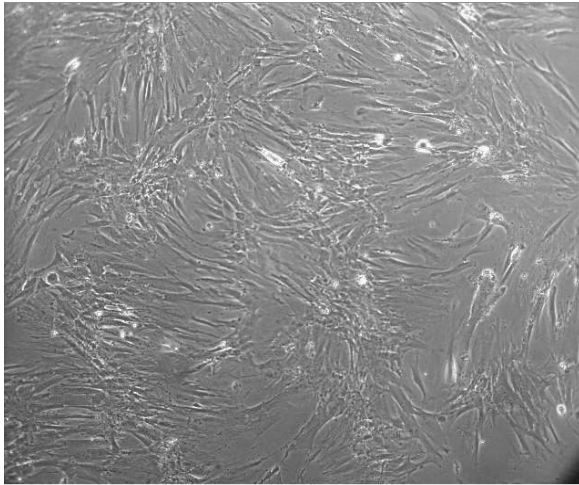
Cytotoxicity Study using SHEDs

Cells culture preparation

•In this study, stem cells of human exfoliated deciduous teeth [SHEDs] were cultured in Alpha Modification of Eagle's Medium supplemented with 20% Fetal Bovine Serum (FBS), 100 μ M L-ascorbic acid 2-phosphate, 2 mM L-glutamine, 100 U/ml penicillin and 100 μ g/ml streptomycin. The culture was incubated at 37°C in 5% CO₂. The SHEDs between 3rd and 5th passages was used in this study.



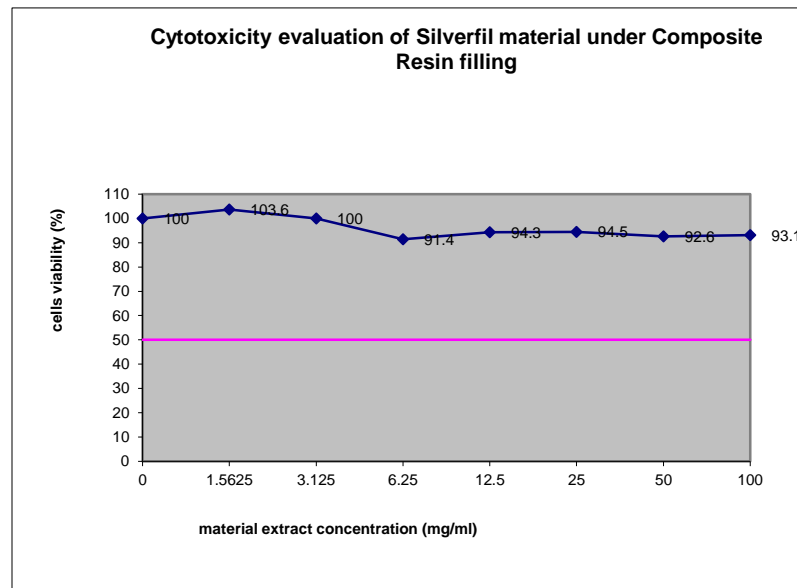
SHEDs under Light Microscope



The SHEDs between 3rd and 5th passages was used in this study

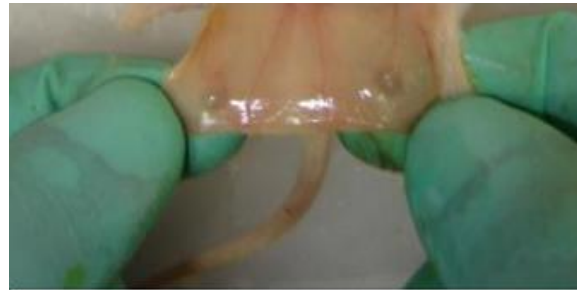
In this test, material was extracted in the complete culture medium (100mg/ml) and introduced to the stem cells of human exfoliated deciduous teeth [SHEDs]. Cells viability was measured by using 3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxy phenyl)-2-(4-sulphonyl)-2H tetrazolium (MTT) assay and ELIZA reader was used to measure metabolic activity of the cells.

This result ,similar to the cytotoxicity evaluation of Silverfil Amalgam material under Composite Resin filling showed that Silverfil was not toxic to the cells. The result showed that Silverfil material did not cause a significant decrease in MRC-5 cell viability (Graph). IC₅₀ was not observed even at the highest concentration (100 mg/ml).



The graph showed no 50% inhibition colony at the highest concentration of 100mg.

In Vivo Study using Male Swiss Webster Strain Mice



The specimens and control were implanted with pliers in the subcutaneous abdomen area of mice

After sacrifice of mice, laparotomy treatment were done at the area of implanted specimen



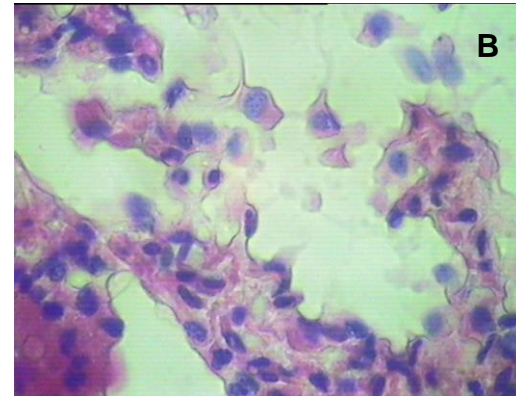
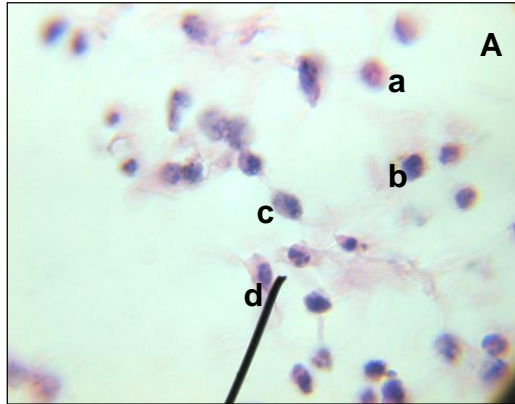
Properly identified tissue blocks were taken for histological specimens

Mean Percentage of Inflammatory Cells

Observation Time	Total Sample	Mean Percentage of Cells*						
		PMN			Lymphocyte	Macrophag	Mast Cell	Plasma Cell
		Neutrophil	Basophil	Eosinophil				
Control	4	17,65	9,15	6,25	53,44	11,21	1,04	1,25
1 st day	4	34,51	4,57	8,1	44,19	15,34	1,25	2,04
1 st week	4	11,52	4,03	6,05	54,68	15,76	6,2	1,76
2 nd week	4	16,68	9,28	7,84	55,48	7,89	2,83	0
3 rd week	4	14,93	8,08	8,24	52,67	8,13	1,36	0,78
4 th week	4	10,47	5,27	5,06	40,73	7,72	0,74	0,61
Mean		20,46 ± 12,87	7,90 ± 5,22	7,59 ± 6,55	50,20 ± 13,59	9,68 ± 6,67	2,80 ± 4,30	1,37 ± 1,99

Silverfil Argentum® versus Inflammatory Cells increase

In vivo Study using 24 Male Swiss Webster Strain Mice (Age: 8 weeks and Weight:18-28 grams)

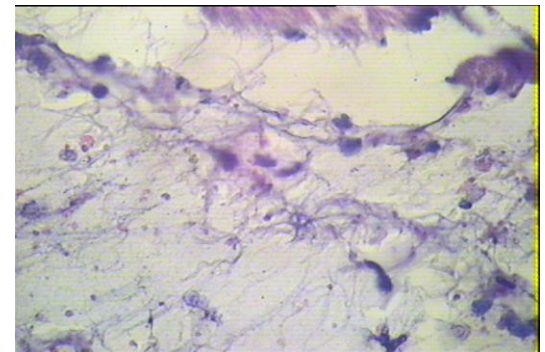


Inflammatory cells at subcutaneous area after Silverfil implantation
A. First day of evaluation at 1,000x magnification. Eosinophil (a); Basophil (b); Neutrophil (c) and Lymphocyte (d)
B. First week of evaluation at 400x of magnification showed increases of Lymphocytes and decreases of inflammatory cells



50x magnification HE

Subcutaneous area on second week of evaluation at 400x of magnification. No inflammatory cells detected at area of implantation (a)



400x magnification HE

Antibacterial Properties

Comparing zone of inhibition between five dental restorative materials against each type of bacteria;
Enterococcus faecalis and *Staphylococcus aureus*

Variable	Amalgam (n=10) median (IQR)	Silverfil (n=10) median (IQR)	Fuji IX (n=10) median (IQR)	Fuji II LC (n=10) median (IQR)	CR (n=10) median (IQR)	Control (n=10) median (IQR)	χ^2 Statistic (df) ²	P value ^a
<i>E. Faecalis</i>	7.24(1.95)	24.40(1.44)	5.85(0.92)	10.46(1.50)	0.00(0.00)	0.00(0.00)	41.50(4)	<0.001*
<i>S. Aureus</i>	6.95(0.93)	29.41(2.15)	8.97(0.29)	10.90(1.38)	0.00(0.00)	0.00(0.00)	46.05(4)	<0.001*
^a Kruskal-Wallis test.				*Significant				

Comparing zone of inhibition of each material between *Enterococcus faecalis* and *Staphylococcus aureus*

Variable	<i>E. Faecalis</i> (n=10) median (IQR)	<i>S. Aureus</i> (n=10) median (IQR)	Z statistic ^b	P value ^b
Amalgam	7.24(1.95)	6.95(0.93)	-0.56	0.571
Silverfil	24.40(1.44)	29.41(2.15)	-3.67	<0.001*
Fuji IX	5.85(0.92)	8.97(0.29)	-3.17	0.002 (<0.005)*
Fuji II LC	10.46(1.50)	10.90(1.38)	-0.98	0.326
CR	0.00(0.00)	0.00(0.00)	0.00	1.000
Control	0.00(0.00)	0.00(0.00)	0.00	1.000
^b Mann-Whitney test			*Significant	

Silverfil exhibited the most significant antibacterial activity, followed by Fuji II LC, Fuji IX and amalgam towards *S. aureus* and *E. faecalis*.

Nurul Ain bt Jaafar *et al.*,
**Antibacterial Properties of
 Dental Restorative
 Material:**

*Intern Medical J.I Vol. 20,
 No. 4, pp. 490 - 492 , August
 2013*

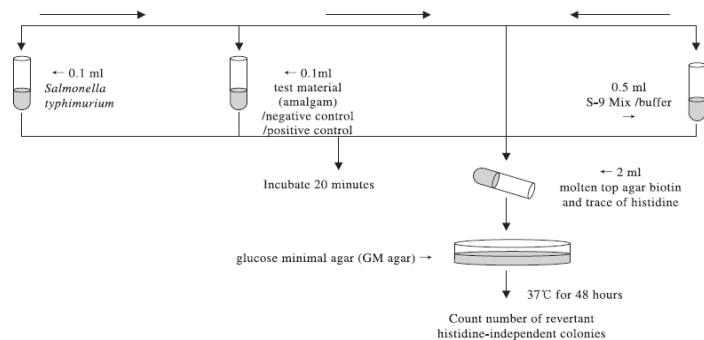


Figure 1. Overview of bacterial reverse mutation test (Ames Test) process

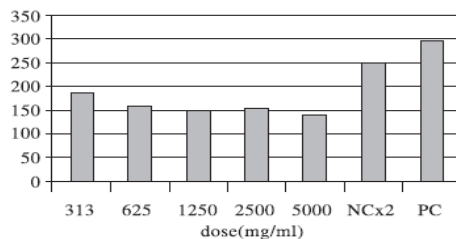
Table 1. Positive Controls

Strain	Positive control chemical (-S9)	Molar concentration (mg/plate) ^a	Positive control chemical (+S9)	Molar concentration (mg/plate) ^a
TA98	4-Nitro-o-phenylenediamine	2.5	2-Animoantracene	2.5
TA100	Sodium Azide	5.0	2-Animoantracene	2.5

a - Concentration based on 100 x 15 mm petri plate containing 20 to 25 ml of GM agar (Mortelmans and Zeiger, 2000).

TA98

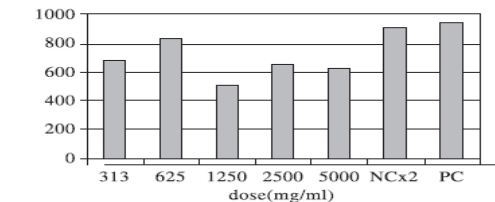
number of colonies



Tests in two strains without metabolic activation (-S9 Mix)

TA98

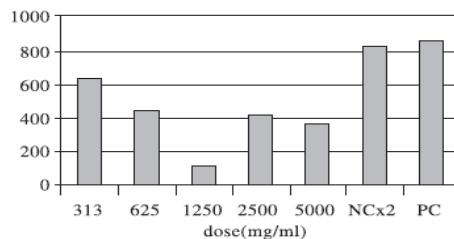
number of colonies



Tests in two strains with metabolic activation (+S9 Mix)

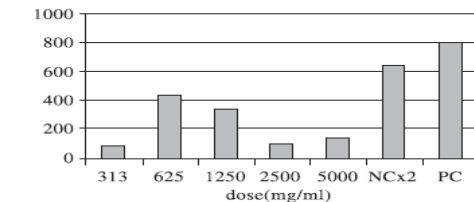
TA100

number of colonies



TA100

number of colonies



Genotoxicity Study:

This study demonstrated that the test material did not exhibit any mutagenic activity under the chosen conditions. Thus, silverfil could be considered to have no genotoxicity effect.

Hassan A. et al. **An *in vitro* Study of Genotoxicity of Silverfil Amalgam:**

Intern Medical J.I Vol. 20,
No. 4, pp. 409 - 412 , August
2013

Conclusions :

SilverFil Amalgam:

- could be used as material of choice for sandwich technique under composite resin fillings
- can protect the tooth and the fillings from fracture in large composite fillings in Class I and Class II restorations
- benefits as a sandwich material in cases of deep gingival floor of cavity where it is difficult to get good moisture controls
- showed no BPA leaching from Composite resin, thus preventing harm to pulpal tissue
- safe & non toxic to the pulpal cells as well as no inflammatory reaction to the tissues