

Comparative Analysis of Bond Strength and Microleakage of Nano composites to enamel and dentin



Medical Science

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ABSTRACT

Nanocomposites is a branch of science which is involved in the production of materials which ranges from particle size between 0.1-100nm. The present study was conducted to analyze the bond strength and micro leakage of newer nanocomposite on enamel and dentin . 40 extracted teeth were used in the study and divided into 2 groups – Group I-20 samples IPS Empress direct + tetricNBond Group II- 20 samples filtek Z350 + adaper single bond 10 samples from each group was used to analyses the bond strength using instron testing machine and 10 samples for analysis of microleakage using stereomicroscope . The results showed that group I IPS Empress direct showed higher bond strength and less microleakage value compared to group II filtek Z350

INTRODUCTION

Silver amalgam has been used as a standard restorative material since several years .The hazards of mercury toxicity and its effect on environment and health ,the increasing demand by the patient to esthetic tooth colored restorative material have reduced the application of these materials in dentistry for restoring the teeth .hence glass ionomer cement and composite resins have been used as an alternative for amalgam restoration .an ideal restorative material should be biologically compatible and reproduce the functional and esthetic properties of the tooth ¹ .

Nanotechnology also known as molecular engineering is the science of nanostructured materials exhibiting unique properties on the macroscale that have high potential technological benefits ,these benefits are attributed to the internal structure between 1 and 100nm .As the size of the particle decreases the physical properties ,the optical properties improves especially when the partical size nears the molecular scale ie <5nm. ² .Nanocomposites showed better mechanical properties ie improved compressive strength ,decreased polymerization shrinkage ,better wear resistance ,increased translucency ,and better esthetics ³ .

Filtek Z 350 XT and IPS Empress are nanocomposites used for anterior and posterior teeth

Therefore the aim of this study is to compare the bond strength and microleakage of newer nanocomposites Filtek Z350 and IPS Empress Direct to enamel and dentin

Materials

Composition

Tetric N-Bond (Ivoclar ,Vivadent)- Methacrylates 60 - 70 , Water, Ethanol 23 - 28 , Highly dispersed silicon dioxide 3 - 5 Initiators and Stabilisers 3 - 5

Adper™ Single Bond 2 (3M ,ESPE)- Dimethacrylate resins ,HEMA, Vitrebond™ Copolymer,Filler ,Ethanol,Water, Initiators.

Filtek z 350(3M ,ESPE)- Resin- BIS-GMA UDMA, TEGDMA ,filler

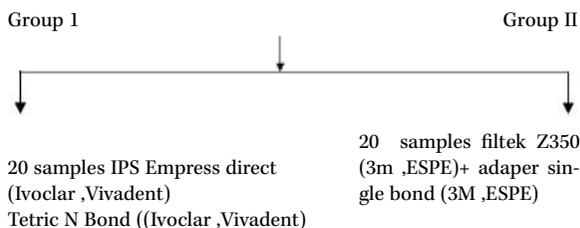
-20 nm silica , 4 to 11 nm zirconia

IPS IMPRESS DIRECT(Ivoclar ,Vivadent)- The monomer - dimethacrylates (20-21.5 wt%).

The fillers - barium glass, ytterbium trifluoride, mixed oxide, silicon dioxide and copolymer (77.5-79 wt%),

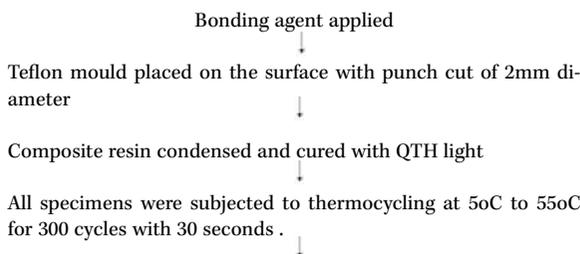
METHODOLOGY

40 freshly extracted teeth selected for the study and disinfected as per OSHA regulation



SUBGROUP A 10SAMPLES FOR BOND STRENGTH ANALYSIS
SUBGROUP B 10 SAMPLES FOR MICROLEAKAGE ANALYSIS

Tooth surface etched with 37% phosphoric acid for 20sec surface rinsed with water and dried with chip blower



Analysis for bond strength and microleakage were done

Preparation and grouping of sample for micro leakage testing - 10 samples from each group

The entire tooth were coated with nail polish except the interface of composite and tooth surface.

The teeth in experimental group were coated with nail polish leaving only the surface bonded. The specimens were placed in 50 % silver nitrate solution for 4 hrs and fixer solution for 4hrs

The teeth were washed in distilled water, the coating on the tooth surface was removed with scalpel

All teeth sectioned, bucolingually with the central line on the bonded surface using diamond discs at low speed.

The depth of dye penetration was measured using the scores as below .

Results

Table 1: Mean Bond strength level of Nano composites

	Mean	Std. Deviation	Mean Difference	95% Confidence Interval of the Difference		Std. Error Difference	T value	P value
Impress	14.77	1.94	2.55	0.39	4.52	0.983	2.499	0.022
Filtek	12.31	2.43						

Table 1 :The mean Bond strength level among IPS Impress Direct and Filtek Z 350 materials was 14.77 + 1.94 and 12.31+2.43 respectively. Independent Sample ‘t’ test was used to compare the difference in the mean (2.55) between the materials. It was observed that the ‘p’ value is 0.022 and it is less than 0.05 hence there is a difference in mean bond strength among the materials at 5% level of significance.

Table 2: FILTEKZ350 /IPS IMPRESS DIRECT * FILTE Z350/IPS IMPRESS DIRECT Cross tabulation showing microleakage of two nanocomposites

Count	FILTEKZ 350/ IPS IMPRESS DIRECT		Total
	IPS IMPRESS DIRECT	FILTEK	
FILTEK/ IMPRESS	NO PENETRATION	5	5
	CORONAL 1/3	5	8
	MIDDLE 1/3	0	2
Total	10	10	20

Table 3:non parametric fisher’s T test for analysis of level of significance between the two samples

	Impress	Filtek	Fishers Exact Test value	P value
No penetration	5	0	7.158	0.017
Coronal1/3	5	8		
Middle 1/3	0	2		
Deep penetration	--	--		

Discussion

Nanocomposites have shown to have better physical and mechanical properties which has lead to greater demand in dentistry .Good adaptation between the restorative material and tooth is essential to reduce microleakage ,discolouration between the composite tooth interface ,pulpal irritation ,and recurrent caries .A strong bond between the restorative material and tooth is important from biological and esthetic perspectives ⁵.

The basic mechanism of adhesion of composite resin to the tooth surface is by exchange of inorganic component of the tooth with synthetic resin .there are 2 steps involved

Step I- involves creating micro porosities in enamel and dentin area of tooth by removing calcium phosphate .Step II -hybrid-

The scoring criteria

- 0 - No dye penetration
- 1 - dye penetration till the coronal third
- 2 - dye penetration till the middle third
- 3 - dye penetration till the apical third

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Shear Bond strength analysis using universal testing machine –Instron

10 samples of each group were mounted in acrylic block 2.5mm in height and 1.5mm thickness and transferred to the universal instron testing machine at a cross head speed of 1mm/min to check the bond strength.

Statistical analysis for bond strength was done using independent sample T test and microleakage using fishers test

zation which involves infiltration and polymerization of resin within the microporosities leading to micromechanical bonding ⁶.

Both the test material showed a good bond strength as seen in table 1 and ,however the mean bond strength value was higher with group I compared to group II and the P values were significant among the groups . This property of group I to show higher bond strength value may be due to reason that the bonding agent used Tetric N-Bond has an acidic monomer with a ph of 2.5-3 .it I sthe combination of hydrophilic monomer (HEMA) and hydrophobic group (dicandiol dimethacrylate)and intermediate (BIS –GMA) GROUP.THIS property of tetric n bond will help to form a bridge between hydrophilic tooth substrate and hydrophobic resin material .

The nanocomposite IPS Empress direct used in group I showed better results probably might be due to the altered structure of the nanocomposite with nanomeric filler particles. Incorporation of these nanomeric filler particles increases the filler loading and thereby improving the mechanical and physical properties of the material. The filler particles in nanocomposites are more compactly placed and also thus allow more amount of resin to be incorporated . thus the nanocomposite and nanobonding agent showed better results in group I⁷.

Microleakage is defined as the clinically detectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative materials applied to it and is the major problem in clinical dentistry. Achieving a micromechanical and biomechanical bond between the restoration and tooth is considered effective and a standard procedure in clinical practice. Microleakage studies have mostly done using dyes in the present study silver nitrate was used as a dye for detection of microleakage because the size of silver ion are extremely small ie 0.059 nm when compared to a typical bacterium which is 0.5-1.0 µm or internal diameter of dentinal tubules (1-4 µm), as done by Mathew et al. (2001) ⁸.

According to table 2 and 3 IPS Empress direct showed less microleakage with 5 samples showing no leakage ie score 0 whereas 5 samples showed leakage till the coronal 1/3 ie score 1 compared to filtek z350 which showed 8 samples with leakage up till coronal 1/3 ie score 1 and 2 samples showing leakage uptill mid-

the third ie score 2 .Non parametric fisher's test was performed and the value was found to be significant .

This decrease in microleakage with IPS Empress direct and tetric N Bond is related to the factors that this composite has high filler load, the nano filler technologies decrease the percentage of organic monomers which is responsible for increasing the hygroscopic expansion of composite which is the main cause of increasing of leakage ⁹.

Conclusion

Within the limitation of this study both the nanocomposites showed good bond strength and minimal microleakage however IPS empress showed higher bond strength and less micro leakage compared to filtek Z350 .

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