The effect of Dietary materials on shear punch strength and surface texture of a nanofill and a microhybrid composite A one year study

Dr. Hala Fares

Operative Dentistry Department, Faculty of Oral and Dental Medicine, Misr University for Science and Technology, Egypt.
fares_hala@yahoo.com

Abstract: Two types of composites (a nanofill composite: Filtek Z350XT; and a microhybrid composite: Filtek Z250); were evaluated regarding shear punch strength and surface texture relative to four different conditioning media (distilled water, heptane, 50% ethanol – water solution and buffered lactic acid) at one week, three, six and twelve months. Shear punch strength was measured by the aid of a custom made device holding the composite metal moulds and mounted on a universal testing machine. Regarding the effect of the different kinds of conditioning media, on the shear punch strengths of the tested restorative materials; it was found that, at the periods one week and three months, Filtek Z350 XT, and Filtek Z250 groups of specimens, demonstrated no statistically significant differences amongst each other regarding the mean shear punch strengths, relative to the four types of conditioning media. At six months, and for each one of the two types of composites; analysis of variance (ANOVA) test, showed that the results were statistically significantly different ($P< 0.05$). It was found that the mean shear punch strength of the specimens conditioned in heptane was statistically significantly higher than that of specimens conditioned in the other conditioning media, using Student – Newman – Keuls test and the least significant difference procedure (LSD). At twelve months, using the previous statistical tests, it was found that those specimens conditioned in heptane significantly demonstrated the highest mean shear punch strength compared to specimens conditioned in the other three conditioning media. Mean while those specimens conditioned in 50% ethanol – water solution significantly exhibited the lowest mean shear punch strength compared to specimens conditioned in the other conditioning media. Regarding the effect of the conditioning time, and for the two types of composites; conditioning for one week and three months resulted in no statistical significance ($p > 0.05$) regarding the mean shear punch strengths of different groups of specimens, relative to all conditioning media. However, conditioning for 6 months resulted in significant decrease in the mean shear punch strengths of the specimens conditioned in distilled water, 50% ethanol-water solution and buffered lactic acid, while the groups of specimens conditioned in heptane demonstrated no significant differences regarding mean shear punch strengths. Conditioning for twelve months resulted in significant decrease in the mean shear punch strengths of all specimens relative to all conditioning media. The specimens conditioned in 50% ethanol-water solution demonstrated significant decrease in mean shear punch strengths compared to other specimens conditioned in distilled water, heptane and buffered lactic acid. Conversely, the specimens conditioned in heptane demonstrated significantly higher mean shear punch strengths compared to the other groups**.** Concerning the comparison between the two types of composites, the results were found to be statistically significant, using analysis of variance and the Student – Newman - keuls tests. At all time periods and relative to all conditioning media; Filtek Z250 exhibited higher shear punch strength then Filtek Z350 XT. Regarding surface texture; it was observed that all samples demonstrated different degrees of surface defects including roughness and pitting by inspection and for the two types of composites; it was obvious that the samples stored in ethanol-water solution, demonstrated more surface defects compared to other groups of samples. Also samples conditioned for twelve months and six months showed marked surface changes compared to samples conditioned for one week and three months. There was no marked difference in surface defects when inspecting and comparing samples belonging to the two types of composites regarding the different conditioning media and at all time periods.

[Hala Fares. **The effect of Dietary materials on shear punch strength and surface texture of a nanofill and a microhybrid composite A one year study.** *Life Sci J* 2013; 10(4): 2070-2080]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 275

Keywords: Simulating the oral environment, shear punch strength: the test of clinical significance.

Introduction

Concepts in restorative dentistry have been continually changing during the last decades. The process was certainly heading towards providing maximum function and esthetics with minimal removal of sound tooth structure. So based on the possibilities of adhering the restorations to tooth structure, a new cavity preparation philosophy emerged: cavity size and shape being minimally invasive *(Roulet, 2000, Sturdevant, 2012)*.

The strength of the restorative material and the production of a perfect seal on the material tooth interface, in addition to, the restoration of appropriate esthetics, are the most important goals of restorative dentistry *(Van Meerbeek et al., 2000b)*.

As shear stresses are induced in teeth and restorations during mastication and parafunction, the shear punch test reflects qualities of clinical significance. *(International Organization for standardiz-ation [ISO] 2000, Nomoto et al.,2001*; *Yap et al., 2003, 2005 and Bagheri et al, 2007, 2010, 2012)*.

During the last decades, clinicians have been confronted with a continuous and rapid turnover in composite restorative materials. It started in the *mid-'60s* with the advent of the first commercialized restorative resin composites, followed in the *early'70s* by the introduction of the acid-etch technique in clinical practice. Since then, there has been ongoing progress in developing more refined and diversified restorative composites along with the production of steadily improved bonding agents *(Van Meerbeek et al., 2000b)*.

The chemical environment is one aspect of the oral environment that could have an appreciable influence on the *in vivo* degradation of composite resins *(Yap et al., 2000a)*. The most common reasons for failure of composite restorations are bulk fracture and secondary caries *(Mjor & Jokstad, 1993; Mjor et al., 2000 and Sarrett et al., 2000)*. The fact that a composite material can perform well in one patient but may degrade, wear and fracture prematurely in another, is attributed to individual variations including the type of occlusion, diet, salivary and plaque compositions. *(Sarrett et al., 2000)*. Microdefect analysis of clinically worn composites revealed extensively damaged layers on both occlusal contact and contact-free areas**.**

Intraoral degradation of composites cannot be attributed to mechanical factors alone, but involves chemical degradation as well subsurface material damage was attributed to the softening and possible removal of portions of the polymer matrix by certain chemicals present in the oral environment. Among these chemicals, dietary solvents play a major role in this respect. This biodegradation may affect both cohesive strength of the resin composite as well as the interfacial attachment mechanism to tooth tissues *(Kao, 1989; Sarrett et al., 2000; Yap et al., 2000a, 2005 and Sturdevant, 2012)*.

Therefore this study was conducted to evaluate the effect of some food simulating materials on a microhybrid composite (Z250, 3M-ESPE), and a nanofill composite (Filtek Z350 XT, 3M-ESPE); as regard shear punch strength; and surface texture at different time periods.

2. Materials and Methods

A microhybrid composite (Filtek, Z250) and a nanofill composite (Filtek Z350 XT), were selected for this study. The material, its components manufacturer and the lot number are shown in table1.

I- Shear punch testing:

Specimens' preparation:

Shear punch specimens were prepared in metal washers (17-mm outer diameter, 8-mm inner diameter and 1-mm thick). The washers were placed on glass slides and the restorative materials were dispensed directly into the moulds. A second glass slide was placed on top of the washers and gentle pressure was applied to extrude excess materials. The top surface of composite specimens was light cured according to the manufacturers instructions. Light curring was performed using an Demetron LC polymerization unit (Kerr, France), with an intensity of 600 mW/Cm^2. The intensity of light was measured following every five specimens to assure even curing of the resin composite using an intensometer.

The four different conditioning media (three different food simulating materials):

1- Heptane (37°C), simulating butter, fatty meats & vegetable oils.
2- 50% Ethanol-water solution (37°C), simulating certain beverages, including alcohol, vegetables, fruits, candy and syrup.
3- Buffered lactic acid pH$_4$ (37°C), simulating acidic food.
4- Distilled water (37°C), simulating the wet oral environment.

Grouping of samples:

A total of 160 specimens were used for shear punch testing. They were divided into two main groups of 80 relative to the resin composite used. Each group was further subdivided into four main sub groups, 20 specimens each to represent the four different conditioning media. Each sup group was then sub-divided into four classes of five relative to the testing periods: one week, three, six and twelve months, (Tables 2 & 3).

Shear punch strength of the tested composite materials:

The nanofill composite (80 samples); 20 for each testing period with 5 specimens in each conditioning media.

The microhybrid composite (80 samples); 20 for each testing period with 5 specimens in each conditioning medium.

The mean shear punch strength of the samples belonging to each composite material was computed at the end of each testing period (to monitor the effect that the length of conditioning time had on shear punch strength); and relative to each conditioning medium (to assess the effect that the type of conditioning media had on shear punch strength). In the mean time, a comparison was set between the two types of restorative composites used, regarding the value of shear punch strengths at the different setup parameters of the test.

Method of shear punch testing:

The mean shear punch strength of each group of samples was computed at the end of each testing period (to monitor the effect that the length of conditioning time had on shear punch strength); and relative to each conditioning medium (to assess the effect that the type of conditioning media had on shear punch strength).

At the end of each conditioning period, the specimens were washed and blotted dry with filter paper. Shear punch strength testing was then conducted using a custom designed shear punch apparatus mounted on a computer controlled materials testing machine (Model LRX-plus; Lloyd Instruments Ltd., Fareham, UK) with a loadcell of 5 kN and data were recorded using computer software (Nexygen-4.1; Lloyd Instruments).

Table 1: The resin composites evaluated in this study

Material	Type	Components	Manufacturer	Batch #
3M Filtek[TM] Z350 XT	Nanofill Composite	A combination of zerconia and silica cluster nanofiller Matrix: BIS-GMA, UDMA, TEGDMA, BEGDMA and BIS- EMA resins	3M ESPE Dental Products St Paul, MN, USA	N313043 (shade A3.5)
3M Filtek[TM] Z 250	Microhybrid composite	In organic filler: Zirconia/Silica (60% by volume) Matrix: BIS-GMA, UDMA and BIS-EMA resins	3M ESPE Dental Products St Paul, MN, USA	N361548 (Shade A 3.5)

Table (2): Factors to be investigated for shear punch test.

A Refers to the type of resin composite	A1 A2	The nanofill composite restorative The microhybrid composite restorative
B Refers to the food simulating material	B_1 B_2 B_3 B_4	Distilled water Heptane 50% ethanol-water solution Buffered lactic acid pH_4
C Refers to the testing period	C_1	one week
	C_2	three months
	C_3	six months
	C_4	twelve months

Table (3): Interactions among variables regarding the shear punch test.

n=5		C_1	C_2	C_3	C_4	Total
A1	B_1	$A_1B_1C_1$	$A_1B_1C_2$	$A_1B_1C_3$	$A_1B_1C_4$	80
	B_2	$A_1B_2C_1$	$A_1B_2C_2$	$A_1B_2C_3$	$A_1B_2C_4$	
	B_3	$A_1B_3C_1$	$A_1B_3C_2$	$A_1B_3C_3$	$A_1B_3C_4$	
	B_4	$A_1B_4C_1$	$A_1B_4C_2$	$A_1B_4C_3$	$A_1B_4C_4$	
A2	B1	$A_2B_1C_1$	$A_2B_1C_2$	$A_2B_1C_3$	$A_2B_1C_4$	80
	B2	$A_2B_2C_1$	$A_2B_2C_2$	$A_2B_2C_3$	$A_2B_2C_4$	
	B3	$A_2B_3C_1$	$A_2B_3C_2$	$A_2B_3C_3$	$A_2B_3C_4$	
	B4	$A_2B_4C_1$	$A_2B_4C_2$	$A_2B_4C_3$	$A_2B_4C_4$	
		40	40	40	40	160

The shear punch apparatus used in this study:

A metal apparatus composed of two sections that upon closure precisely fitted together and were further tightened using two equally spaced tightening screws. Each section had in this middle a punch hole that went along the whole thickness of the section. The lower section possessed a self-locating recess onto which the washer holding the tested material was placed. This self-locating recess provided a snug fit with the washer holding the specimen. The upper section possessed a cylindrical projection that had a diameter similar to that of the washer. After inserting the washer in place, the upper section of the apparatus was placed on the lower section, with the projected cylinder lying on top of the washer thus preventing displacement of the washer, and minimizing torque when load was applied. When the two sections were fit together and the screws tightened, the punch hole of the two sections together with the punch hole of the washer all lied in one line. The whole apparatus was attached to the lower clamps of the universal testing machine. A tool steel punch with a flat end 2-mm in diameter was used to create shear force by sliding through a punch hole with a radial clearance of 0.01 mm. Testing was performed at a crosshead speed of 0.5 mm/min and the maximum applied load was recorded. Shear punch strength was then computed. **(Figs. 1,2 & 3)**

Fig. 1: The custom made apparatus used for shear punch testing.

II- Surface assessment:

At the end of each conditioning period, the groups assigned for surface assessment were inspected for surface defects.

Statistical analyses:

Statistical analyses were performed using SPSS for windows (Release 9) Software. Statistical significance is achieved when the *P*-values are ≤ 0.05.

Analysis of variance (ANOVA) test area performed to assess the presence of significant differences in mean shear punch strengths of different groups of the tested restorative composite related to the different conditioning media (i.e. whether the different conditioning media produced significant effect on the mean shear punch strengths of the different groups of the tested restorative composite. Student-Newman – keuls test and the least significant difference procedure, were used for pairwise comparison between means to find out which means were significantly different. These tests were separately performed for the groups of specimens that were investigated after one week, three, six and twelve months storage. And for each restorative composite used Paired t-test, was performed to study the effect of time on the shear punch strengths of all groups of specimens related to each conditioning medium through all time periods.

ANOVA and Student –Newman- Keuls tests were used to setup a comparison between the two types of restorative composites used, regarding the mean shear punch strengths.

Fig. 2: The apparatus opened showing the two sections: the upper one having the tool steel punch inserted through the punch hole.

Fig. 3: The custom made device mounted on the Lloyd machine.

3. Results

I- Shear Punch testing:

Regarding the effect of kind of food simulating materials on the shear punch strengths of the resin composites Filtek Z350 XT and Filtek Z 250; results showed that after one week conditioning (C_1), and three months conditioning (C_2); no statistical significant differences in mean shear punch strengths relative to the different conditioning media were evident, ($P > 0.05$) i.e. the different conditioning media Produced no significant differences among the mean shear punch strengths of the composites, (Filtek Z350 XT and Filtek Z250) groups of specimens, (Tables 4, 5, 8 & 9 and Fig. 4). Mean while, after six months conditioning (C3), and for each of the two composites the results showed statistical significant differences ($P < 0.05$).(Tables 6 & 10 and Fig.4).

The different conditioning media produced significant differences among the mean shear punch strengths of the groups of specimens of both types of composites. (Tables 6 & 10 and Fig. 4). Those specimens conditioned in heptane (B_2) significantly demonstrated the highest mean shear punch strength compared to specimens conditioned in the other three conditioning media, meanwhile comparison among the means of shear punch strengths of specimens conditioned in the other three conditioning media/(distilled water, 50% ethanol – water solution and buffered lactic acid), showed no statistical significant difference. After twelve months conditioning (C_4), also the results showed statistical significance ($P < 0.05$), the different conditioning media produced significant differences among the mean shear punch strengths of both types of composites' groups of specimens (Tables 7 & 11, Fig. 4). Those specimens conditioned in heptane (B_2) demonstrated the highest mean shear punch strength compared to specimens conditioned in the other three conditioning media. While those specimens conditioned in 50% ethanol – water solution significantly exhibited the lowest mean shear punch strength compared to specimens conditioned in the other three conditioning media. Comparison between specimens conditioned in distilled water and those conditioned in buffered lactic; regarding mean shear punch strengths resulted in no statistical significance.

Concerning the comparison between the two types of composites, the results were found to be statistically significant using analysis of variance and the Student –Newman – Keuls tests. At all time periods and relative to all conditioning media; Filtek Z250 exhibited higher shear punch strength in comparison Filtek Z350 XT.

Regarding the effect of conditioning time on the mean shear punch strength of the restorative composite used in this study; it was found that conditioning for one week and three months resulted in no statistical significance ($P > 0.05$) regarding the mean shear punch strengths of different groups of specimens, relative to all conditioning media and through the time periods (C_1 - C_2), However, conditioning for six months and twelve months (C_3 & C_4) showed statistical significance ($p < 0.05$) regarding the mean shear punch strengths of different groups of specimens, relative to all conditioning media (B_1, B_2, B_3, B_4) and through the time periods (C_3 & C_4). Conditioning for six months resulted in significant decrease in the mean shear punch strengths of the groups of specimens conditioned in distilled water, 50% ethanol-water solution and buffered lactic acid (B_1, B_3 & B_4), however the groups of specimens conditioned in heptane demonstrated no significant differences regarding mean shear punch strengths. Conditioning for 12 months resulted in significant decrease in the mean shear punch strengths of all groups of specimens relative to all conditioning media. The groups of specimens conditioned in 50% ethanol-water solution demonstrated significant decrease in mean shear punch strengths compared to other groups of specimens conditioned in distilled water, heptane and buffered lactic acid. Conversely, the groups of specimens conditioned in heptane demonstrated significantly higher mean shear punch strengths compared to the other groups.(table, 12).

Table (4): **Mean shear punch strengths of the composite (Filtek Z350XT) relative to different conditioning media, at C_1.**

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
0.275	130.4 ± 11.6	B_1 (control)
0.275	126.4 ± 16.2	B_2 (Heptane)
0.275	140.4 ± 16	B_3 (50% ethanol-water solution)
0.275	125.7 ± 8.6	B_4 (Buffered lactic acid pH_4

- Significance is achieved at $p \leq 0.05$.

Table (5): Mean shear punch strengths of the composite (Filtek Z350XT) relative to different conditioning media, at C_2.

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
0.364	130 ± 11.5	B_1 (control)
0.364	126.3 ± 16.2	B_2 (Heptane)
0.364	134.3 ± 15.3	B_3 (50% ethanol-water solution)
0.364	122.5 ± 8.4	B_4 (Buffered lactic acid pH_4

Significance is achieved at $p \leq 0.05$.

Table (6): Mean shear punch strengths of the composite (Filtek Z350XT) relative to different conditioning media, at C_3.

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
0.036*	110^b ± 9.8	B_1 (control)
0.036*	126.2^a ± 16.2	B_2 (Heptane)
0.036*	113.5^b ± 12.9	B_3 (50% ethanol-water solution)
0.036*	101.3^b ± 6.9	B_4 (Buffered lactic acid pH_4

Significance is achieved at $p \leq 0.05$.

Table (7): Mean shear punch strengths of the composite (Filtek Z350XT) relative to different conditioning media, at C_4.

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
< 0.001*	86^b ± 7.6	B_1 (control)
< 0.001*	106.1^a ± 13.6	B_2 (Heptane)
< 0.001*	60.4^c ± 6.9	B_3 (50% ethanol-water solution)
< 0.001*	80.2^b ± 5.5	B_4 (Buffered lactic acid pH_4

Significance is achieved at $p \leq 0.05$.

Table (8): Mean shear punch strengths of the composite (Filtek Z250) relative to different conditioning media, at C_1.

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
0.181	159 ± 7.3	B_1 (control)
0.181	156 ± 6.7	B_2 (Heptane)
0.181	162.7 ± 6.5	B_3 (50% ethanol-water solution)
0.181	145.9 ± 19.5	B_4 (Buffered lactic acid pH_4

- Significance is achieved at $p \leq 0.05$.

Table (9): Mean shear punch strengths of the composite (Filtek Z 250) relative to different conditioning media, at C_2.

P value	*Shear punch strength (Mpa) (Mean ± Standard Deviation)*	*Type of conditioning medium*
0.126	158.6 ± 7.2	B_1 (control)
0.126	155.9 ± 6.7	B_2 (Heptane)
0.126	155 ± 6.2	B_3 (50% ethanol-water solution)
0.126	144.6 ± 19.3	B_4 (Buffered lactic acid pH_4

* Significance is achieved at $p \leq 0.05$.

Table (10): Mean shear punch strengths of the composite (Filtek Z 250) relative to different conditioning media, at C_3.

P value	***Shear punch strength (Mpa) (Mean ± Standard Deviation)***	***Type of conditioning medium***
0.025*	$137^b \pm 6.2$	B_1 (control)
0.025*	$155.7^a \pm 6.6$	B_2 (Heptane)
0.025*	$133.5^b \pm 5.4$	B_3 (50% ethanol-water solution)
0.025*	$123^b \pm 16.4$	B_4 (Buffered lactic acid pH_4

Significance is achieved at $p \leq 0.05$, Means with different letters are statistically significantly different according to S-N-K test.

Table (11): Mean shear punch strengths of the composite (Filtek Z 250) relative to different conditioning media, at C4.

P value	***Shear punch strength (Mpa) (Mean ± Standard Deviation)***	***Type of conditioning medium***
<0.001*	$115.1^b \pm 5.2$	B_1 (control)
<0.001*	$134.7^a \pm 5.7$	B_2 (Heptane)
<0.001*	$89^c \pm 3.6$	B_3 (50% ethanol-water solution)
<0.001*	$101.6^b \pm 13.5$	B_4 (Buffered lactic acid pH_4

- Significance is achieved at $p \leq 0.05$, Means with different letters are statistically significantly different according to S-N-K test.

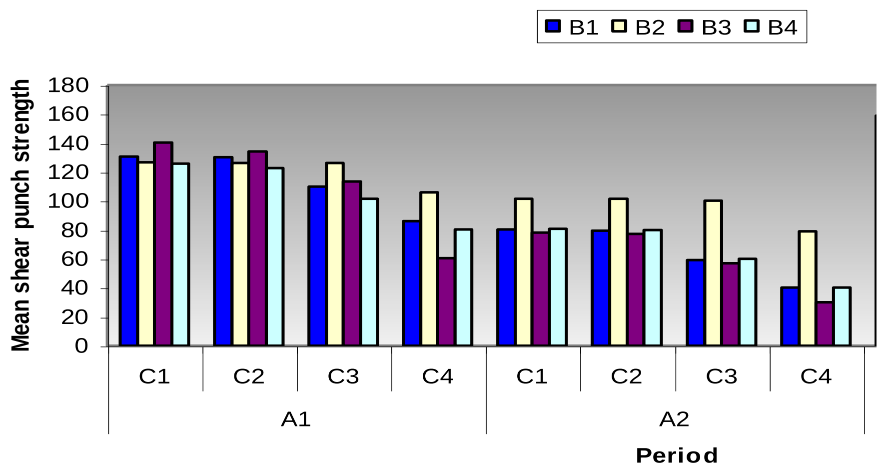

Fig. 4: Effect of the kind of food simulating materials on the shear punch strengths of the two restorative composites.

Table (12): The means, standard deviation values and results of paired t-test.

B_4	**B_3**	**B_2**	**B_1**	**Medium**	
***P*-value**	***P*-value**	***P*-value**	***P*-value**	**Period**	**Composite**
0.522	**0.163**	**0.967**	**0.889**	**C_1 - C_2**	**A_1**
<0.001*	**<0.001***	**0.931**	**<0.001***	**$C_1 – C_3$**	
<0.001*	**<0.001***	**<0.001***	**<0.001***	**$C_1 – C_4$**	
0.388	**0.112**	**0.979**	**0.775**	**C_1 - C_2**	**A_2**
<0.001*	**<0.001***	**0.802**	**<0.001***	**$C_1 – C_3$**	
<0.001*	**<0.001***	**<0.001***	**<0.001***	**$C_1 – C_4$**	

**: Significant at $P \leq 0.05$*

II- Results of surface assessment:

Regarding surface texture; it was observed that all samples demonstrated different degrees of surface defects including roughness and pitting by inspection and for the two types of composites; it was obvious that the samples stored in ethanol-water solution, demonstrated more surface defects compared to other groups of samples. Also samples conditioned for twelve months and six months showed marked surface changes compared to samples conditioned for one week and three months. There was no marked difference in surface defects when inspecting and comparing samples belonging to the two types of composites regarding the different conditioning media and at all time periods.

4.Discussion

The strength of the restorative material and the production of a perfect seal on the material tooth interface are the most important goals of restorative dentistry.

Shear stresses are induced in teeth and restorations during mastication and para function. As composites are evaluated in flexion, the strength of these materials cannot be directly compared despite some similarities in clinical applications *(International Organization for Standardization [ISO] 2000; Yap et al., 2003 and 2005).*

The shear punch test reflects qualities of clinical significance *(Leirskar et al., 2001; Yap et al., 2003, 2005, American Institute of physics, 2005; Guduru et al., 2006; Bagheri et al., 2007 and Betsy et al., 2007)*. The shear punch test used in this study was proposed by *(Nomoto et al., 2001)*, who used the ISO flexural test (ISO, 2000) for the assessment of surface and strength properties; as a standardized strength testing of all direct restorative materials. This approach was further supported by some recent studies; *(Leirskar et al., 2001; Yap et al., 2003, 2005, American Institute of physics, 2005; Guduru et al., 2006; Bagheri et al., 2007 and Betsy et al., 2007)*.

The chemical environment is one aspect of the oral environment that could have an appreciable influence on the *in vivo* degradation of composite resins *(Yap et al., 2000a)*. The most common reasons for failure of composite restorations are bulk fracture and secondary caries *(Mjor & Jokstad, 1993; Mjor et al., 2000 and Sarrett et al., 2000)*. The fact that a composite material can perform well in one patient but may degrade, wear and fracture prematurely in another, is attributed to individual variations including the type of occlusion, diet and salivary and plaque compositions. *(Sarrett et al., 2000)*. Microdefect analysis of clinically worn composites revealed extensively damaged layers on both occlusal contact and contact-free areas. The result stipulates that the intraoral degradation of composite cannot be attributed to mechanical factors alone, but involves chemical degradation as well. Sub surface material damage was attributed to the softening and possible removal of portions of the polymer matrix by certain chemicals present in the oral environment *(Kao, 1989 and Yap et al., 2000a, 2003& 2005)*. In this study, to types of composites (a nanofill composite: Filtek Z350XT and a microhybrid composite: Z 250); were being evaluated regarding shear punch strength, relative to four different conditioning media (distilled water, heptane, 50% ethanol – water solution and buffered lactic acid) and through the time periods, one week, three, six and twelve months. For each one of the two composites and at each one of the four time periods; analysis of variance (ANOVA) test was performed to assess the presence of significant differences in the mean shear punch strengths, relative to the different conditioning media. At the time periods one week and three months, Filtek Z350XT and Filtek Z250 groups of specimens, demonstrated no statistically significant differences amongst each other regarding the mean shear punch strengths, relative to the four types of conditioning media. Those results are consistent with those of *(Yap et al., 2000b and 2005)* who used the same conditioning media. However, they appear to contradict previous work that reported chemical degradation of direct esthetic restoratives by food simulating materials, especially ethanol solutions. *(Mckinney & Wu, 1985; Kao, 1989, Ferracane & Marker, 1992; Lee et al., 1998 and Yap et al., 2003)*. This disparity may be explained by differences in materials, the mechanical properties evaluated, testing methods and conditioning media and time.

At the time period six months, and for each of the two composites; analysis of variance (ANOVA) test, showed that the results were statistically significantly different ($P<0.05$), meaning that the different conditioning media produced significant differences among the mean shear punch strengths of the tested groups of specimens. Using Student – Newman – Keuls test and the least significant difference procedure (LSD), for pairwise comparison between means; it was found that the mean shear punch strength of the specimens conditioned in heptane was statistically significantly higher than that of specimens conditioned in the other conditioning media. the higher strength values may be attributed to the fact that heptane eliminates the leaching out of silica and combined metals in fillers, which occurs from conditioning in aqueous solutions, including dietary solvents or food simulating materials. *(Söderholm, 1983 and Yap et al., 2000b & 2005)*. Comparison among the means of shear punch strengths of specimens conditioned in the other three conditioning media (distilled water, 50% ethanol water solution and buffered lactic acid), showed no statistical significant difference. At the time period twelve months, and for each of the two composites; using the previous statistical tests (ANOVA, Student – Newman – Keuls test & the least significant difference procedure); it was found that those specimens conditioned in heptane significantly demonstrated the highest mean shear punch strength compared to specimens conditioned in the other three conditioning media. Mean while those specimens conditioned in 50% ethanol – water solution significantly exhibited the lowest mean shear punch strength compared to specimens conditioned in the other conditioning media. Those results are consistent with previous work that reported chemical degradation of direct esthetic restoratives by food simulating materials especially ethanol solutions ***(****Mckinney & Wu, 1985; Kao, 1989, Ferracane & Marker, 1992; Lee et al***.,** *1998 and Yap et al., 2003),* despite the presence of differences in materials, mechanical properties evaluated, testing methods, conditioning media and time. Regarding the effect of conditioning time on the mean shear punch strength of the restorative composite used in this study; it was found that for each of the two composites used; conditioning for one week and three months resulted in no statistical significance ($P > 0.05$) regarding the mean shear punch strengths of different groups of specimens, relative to all conditioning media and through the time periods (C_1 - C_2), However, conditioning for six months and twelve months (C_3 & C_4) showed statistical significance ($p < 0.05$) regarding the mean shear punch strengths of different groups of specimens, relative to all conditioning media (B_1, B_2, B_3, B_4) and through the time periods (C_3 & C_4). Conditioning for six months resulted in significant decrease in the mean shear punch strengths of the groups of specimens conditioned in distilled water, 50% ethanol-water solution and buffered lactic acid (B_1, B_3 & B_4), however the groups of specimens conditioned in heptane demonstrated no significant differences regarding mean shear punch strengths. Conditioning for 12 months resulted in significant decrease in the mean shear punch strengths of all groups of specimens relative to all conditioning media. The groups of specimens conditioned in 50% ethanol-water solution demonstrated significant decrease in mean shear punch strengths compared to other groups of specimens conditioned in distilled water, heptane and buffered lactic acid. Conversely, the groups of specimens conditioned in heptane demonstrated significantly higher mean shear punch strengths compared to the other groups. The fact that the ethanol solution had the worst effect on the tested restorative composite regarding shear punch strength, can be explained as follows, ethanol diffuses into the composite, which results in micro-cracking.

As ethanol has solubility characteristics similar to that of BIS-GMA, this may further promote the infusion of ethanol into the composite leading to greater damage. *(Lee et al., 1994, 1995 and Hobson et al., 2000)*.

At all time periods and relative to all conditioning media; Filtek Z250 exhibited higher shear punch strength compared to Filtek Z350 XT. Strength ranking was consistent with the clinical performance of different material types.

Regarding the polymer and filler content (approximately 60% volume) the microhybrid composite Filtek Z250 and the nanofil composite Filtek Z350XT were similar. The significant difference in strength could be attributed to the differentiation in filler size. For Filtek Z250, the presence of different filler particle size and the incorporation of small filler particles in to large porous ones provided islands of better strength *(Yap et. al., 2005, and Sturdevant, 2012)*

It was reported that the nano particles of Filtek Z350XT were added both individually and in clusters, termed nano clusters and that under wear conditions, individual nano particles could break off the lightly sintered nano clusters. However the interface between the loosely bound nano cluster fillers in the nanofill composite may also serve as possible pathways for crack propagation during shear strength testing. *(Yap et al., 2005).*

Regarding surface assessment at the end of each incubation period, it was observed that all samples demonstrated different degrees of surface defects including roughness and pitting by inspection and for the two types of composites; it was obvious that the samples stored in ethanol-water solution, demonstrated more surface defects compared to other groups of samples. Also samples conditioned for twelve months and six months showed marked surface changes compared to samples conditioned for one week and three months. There was no marked difference in surface defects when inspecting and comparing samples belonging to the two types of composites regarding the different conditioning media and at all time periods. Storage in different conditioning media may accelerate hydrolysis of surface components with subsequent softening and possible breakdown of products of the poorly polymerized resin oligomers. This may cause degradation of surface components as well as some staining.

The relatively long conditioning time in this study gave a chance for a more precise analysis of the response of biomaterials to a chemical environment. Analytical and numerical approaches are nowadays employed to investigate the properties and mechanical behavior of composite cylindrical models. Using the axially applied load and the effective mechanical properties, an almost exact analysis for the effective longitudinal young's modulus and the stresses distribution within the domain of each constituent could be performed *(Askari & Chasemi-Nejhad, 2007)*. The way fluids flow into and fill nano pores is of interest to physicists & chemists. Nano scale flow is dominated by surface properties, and dynamical properties of solutions as well as flow through nano channels *(Quirke, 2007)*. These include, buoyancy, surface area, charge accumulation, viscosity and steric factors. The prediction of mass transport and stability of a material is dominated by the competitive probability kinetics and the probability of reaction within the projected rates of interaction *(Mackay et al., 2007)*. The evaluation time in this study lasted for twelve months, which is supposed to provide more reliable, evidenced and consistent results in comparison to the previous studies

The fact that the strength was significantly impaired through the time periods six months and twelve months; in this study; suggests that the time period is critical. Again the critical effect of time has to be high lightened which provides solid evidence to this study as the conditioning time periods lasted for twelve months.

Recommendations

- The strength of resin composite restorative materials is, continuously, in need for further research work.
- Assessment of the strength of resin composite restorative materials should, preferably, be carried out at, comparatively, longer evaluation time periods.

References

1. Jean François Roulet: Adhesive Dentistry in the 21st century. *J Oper Dent 25: 355-366, 2000.*
2. Sturdevant's Art and Science of Operative Dentistry; 6th edition, 2012.
3. Van Meerbeek B, Perdigào J, Lambrechts P, and Vanherle G: Enamel and dentin adhesion in; Schwartz RS, Summitt JB, and Robbins JW (eds) Fundamentals of Operative Dentistry – A contemporary approach. *Chicago Quintessence Publishing 2nd edition, 2000 (b).*
4. International Organization for Standardization Specification for dentistry – polymer- based filling restorative and luting materials *ISO4049: 2000.*
5. Nomoto R, Carrick TE and Mccabe JF: Suitability of a shear punch test for dental restorative materials. *J Dent Mater 17 (5): 415-421, 2001*.
6. Yap AU, Lee MK, Chung SM, Tsai KT and Lin CT: Effect of food- simulating liquids on the shear punch strength of composite and polyacid-modified composite restoratives. *J Oper Dent 28 (5): 529-534, 2003a*.
7. Yap AU, Lin LY, Yang TY, Ali A and Chung SM: Influence of dietary solvents on strength of nanofill and ormocer composites. *J Oper Dent 30 (1): 129-133, 2005.*
8. Bagheri, Tyas and Burrow: Comparison of the effect of storage media on hardness and shear punch strength of materials. *Am J Dent 20 (5): 329-334, 2007.*
9. Bagheri, R; Mese A, Burrow F and Tyas J: Comparison of the effect of storage media on shear punch strength of resin luting cements. *J Dent 38(10): 820-7, 2010.*
10. Bagheri R: Effect of G-coat plus on the properties of esthetic restoratives. *IADR, General Session, June 2012*.
11. Yap AU, Low JS and Ong LF: Effect of food simulating liquids on the surface characteristics of composite and polyacid – modified composite restoratives. *J Oper Dent 25 (3): 170 -176, 2000a*.
12. Mjor IA and Jokstad A: Five year study of class II restorations in permanent teeth using amalgam, glass poly alkenoate (ionomer) cement and resin-based composite materials. *J Dent 21 (6): 338-343, 1993.*
13. Major JA, Moorhead JE and Dahl JE: Reasons for replacement of restoration in permanent teeth in general dental practice. *Int Dent J 50 (6): 361-366, 2000*.
14. Sarrett DC, Coletti DP and Peluso AR: The effects of alcoholic beverages on composite wear. *J Dent Mater 16 (1): 62-67, 2000.*
15. Kao EC: Influence of food – simulating solvents on resin composites and glass ionomer restorative cement. *J Dent Mater 5 (3): 201-208, 1989*.
16. Leirskar, Nordbo and Mount: Influence of resin coating on shear punch strength of Fuji IX. *Technical program of the 79th general*

session of the International Association for Dental Research. June 27-30, 2001.

17. Guduru, Ramesh and Kumar: Mechanical Behavior of Nanocrystalline materials and application of shear punch test. *NCSU libraries, 2006. http://www.lib.ncsu.edu/theses/available/etd-03212006-183021/*
18. Betsy, Cristina, Leila, Eduardo, Wanderlay, Luiz, Jose and Alfredo: Effect of drinks on the surface properties of dental resin composites. *J Polymer testing 26 (7): 855-861, 2007.*
19. Mckinney JE and WuW: Chemical softening and wear of dental composites. *J Dent Res 64 (11): 1326-1331, 1985.*
20. Ferracane JL and Marker VA: Solvent degradation and reduced fracture toughness in aged composites. *J Dent Res 71 (1): 13-19, 1992.*
21. Lee SY, Huang HM, Lin CY and Shib YH: Leached components from dental composites in oral simulating fluids and resultant composite strengths. *J Oral Rehabilitation, 25 (8): 575-588, 1998.*
22. Söderholm KJ: Leaking of fillers in dental composites. *J Dent Res 62 (2): 126-130, 1983.*
23. Lee SY, Greener EH, Mueller HJ and Chiu CH: Effect of food and oral simulating fluids on dentin bond and composite strength. *J Dent 22 (6): 352-359, 1994.*
24. Lee SY, Greener EH and Mueller HJ: Effect of food and oral simulating fluids on structure of adhesive composite systems. *J Dent 23: 27-35, 1995.*
25. Hobson RS, Macabe JF and Hgg SD: The effect of food simulants an enamel – composite bond strength. *British J of Orthodontics 27 (1): 55-59, 2000.*
26. Askari D and Ghasemi N: Closed form exact analytical solutions for mechanical properties and responses for reinforced nanocomposites. *Nano technology conference and trade show, 2007. http://www.nsti.org/bionano, 2007.*
27. Quirke N: The interaction of fluids with surfaces and nanoparticles. *Nano technology conference and trade show, 2007. http://www.nsti.org/bionano2007.*
28. Mackay CE, Gray MN, Reinert K and Sellers K: Methods for the Prediction of nanoparticle transport and receptor exposure in an aqueous environment. *Nano technology conference and trade show, 2007. http://www.nsti.org/bionano2007.*

11/10/2013