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Effect of Ultrasonic Scaling On Surface Roughness of Four Commercially Available Composite Resin Class V Restorations: An In-Vitro Study

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***Abstract**: This in-vitro study aimed at evaluating the surface roughness of four commercially available composite resins (Nano filled composite GC SOLARE X, Nano composite 3M ESPE Filtek™ Z350 XT, Nano filled composite Tokuyama ESTELITE® Alpha and Micro matrix restorative DENTSPLY Esthet.X® HD) used as restorative materials in simulated Class V cavity preparation of dimensions 4 mm width, 2mm length and 1.5mm depth pre and post ultrasonic scaling. Data obtained were statistically analysed using paired t-test, one-way ANOVA and Tukey's comparison test. Highest pre and post ultrasonic scaling mean surface roughness value was exhibited by Nano filled composite GC SOLARE X. The highest difference in surface roughness value was exhibited by in the Control group followed by Esthet X HD, Solare X, Estelite Alpha and the least by Filtek Z350XT. .*

1. Introduction

Ultrasonic scaling an effective part of dental prophylaxis is widely recommended by dental practitioners. [1] Ultrasonic tip vibrations are generated by ultrasonic scalers from electrical input. They can be categorized between magentorestrictive (18,000 – 45,000 Cps) and piezoelectric (25,000 – 50,000 Cps) units. [2, 3, 4]

Plaque and calculus deposits a common clinical finding occur predominantly in the gingival third of the teeth. These deposits may hinder the dental practitioner to differentiate between the tooth and tooth coloured restorations and the restoration-tooth interface leading to running the ultrasonic insert over the surface of the restorations. The ultrasonic scaling procedures are effective tools well suited for removal of plaque, calculus and bacterial endotoxins. However the mechanical stimulation may alter the surface integrity of the restoration and tooth thereby increasing the surface roughness which may influence staining, aesthetic appearance, bacterial colonization and accelerate the rate of plaque formation. [5,6] Bjornson et al and Teughels et al have demonstrated a correlation between tooth roughness and accelerated bacterial colonization. [6, 7] A study by Bollen et al exhibited that surface roughness beyond 0.2 um resulted in increase in plaque deposit and risk for caries. [8]

Class V lesions that may be carious or noncarious most usually are presented on the cervical third of the facial and lingual aspect of the teeth. [1, 9] The non-carious cervical lesion (NCCLs) lesions are referred to as abrasion, erosion or abfraction. [2] Numerous restorative materials are available for Class V lesions. Glass ionomer cements have been one of the recommended material of choice for the restoration of Class V lesions for many years with its own advantages and disadvantages. They exhibit capability of chemically bonding with the tooth surface and anticariogenic activity by releasing fluoride. [3, 5, 6] However aesthetic concerns and inexpedient setting characteristics, clinical acceptance has been limited. [7, 10] Availability of more recently developed and greatly progressing tooth coloured filling materials particularly resin composites have broadened treatment options due to their various favourable physico-mechanical properties. The purpose of this study was to examine and evaluate the effect of ultrasonic scaling on the surface roughness of four different types of composite restorations in Class V lesions using profilometer.

2. Materials and method

Freshly extracted 50 human premolars were collected for the study protocol. All the collected teeth were examined and evaluated. Teeth with cracks and caries were excluded from the study. The teeth were randomly selected and divided into five groups comprising of 6 teeth. Standardized outline of 4mm x 2mm was marked on the buccal surface of all the teeth to simulate Class V lesions. Excluding the control group in all the 4 experimental groups Class

V cavity preparation of dimensions 4 mm width, 2mm length and 1.5mm depth were made on the buccal surface using FG1 and FG 271 carbide bur (SS White, Fleet Street, London). All the prepared cavities were restored with the below mentioned composite resin materials as per manufacturer's instructions:

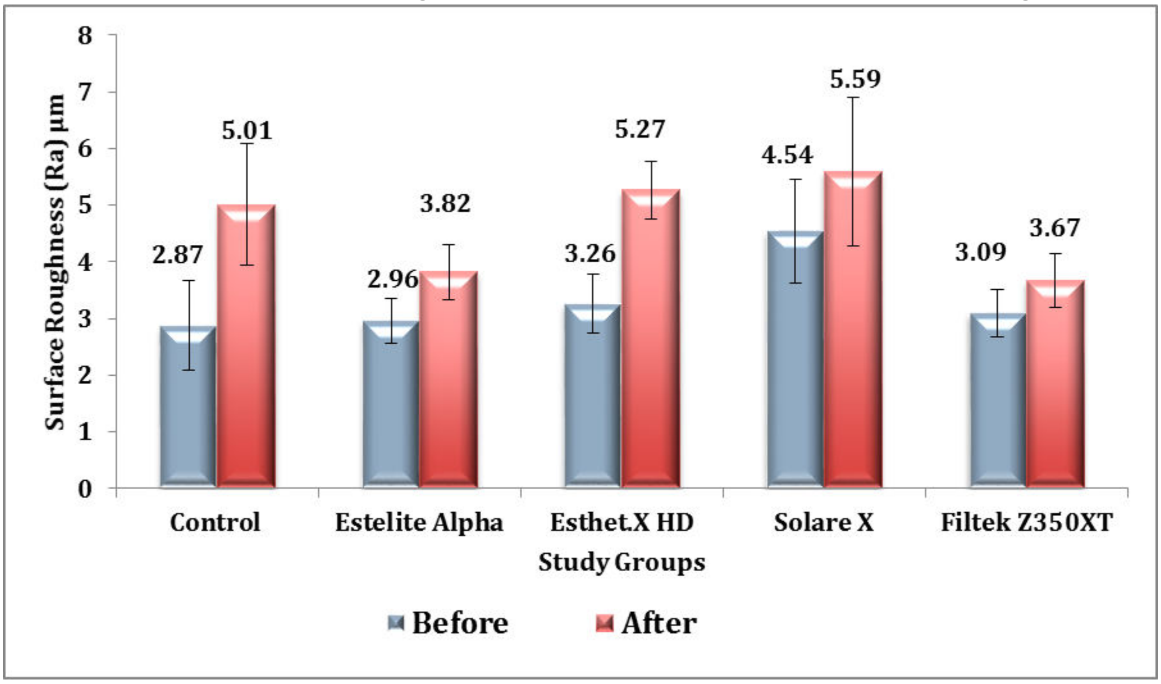
Group 2: Nano filled composite
Tokuyama ESTELITE® Alpha
Group 3: Micro matrix restorative
DENTSPLY Esthet.X® HD
Group 4: Nano filled composite
GC SOLARE X
Group 5: Nano composite
3M ESPE Filtek™ Z350 XT

Table 1: Comparison of surface roughness (Ra) values before and after scaling in each study group

Group		N	Mean	Standard Deviation	Mean difference (95% CI)	t	df	p-value
Group 1 Control	Before	6	2.87	0.79	-2.14 (-2.52, -1.76)	-14.43	5	<0.001*
	After	6	5.01	1.08				
Group 2 Estelite Alpha	Before	6	2.96	0.40	-0.86 (-1.21, -0.50)	-6.20	5	0.002*
	After	6	3.82	0.49				
Group 3 Esthet X HD	Before	6	3.26	0.52	-2.01 (-2.34, -1.67)	-15.52	5	<0.001*
	After	6	5.27	0.51				
Group 4 Solare X	Before	6	4.54	0.91	-1.05 (-2.37, 0.28)	-2.03	5	0.09
	After	6	5.59	1.32				
Group5 Filtek Z350XT	Before	6	3.09	0.41	-0.58 (-0.81, -0.35)	-6.46	5	0.001*
	After	6	3.67	0.47				

Paired t test *p<0.05 statistically significant

Graph 1: Surface roughness (Ra) values before and after ultrasonic scaling



Control and experimental group specimens were stored in the formulated artificial saliva (Composition: sodium chloride – 0.4 g/l, potassium chloride – 0.4 g/l, calcium chloride–H_2O – 0.795 g/l, sodium sulphur–H_2O – 0.005 g/l, sodium dihydrogen phosphate–H_2O – 0.69g/l, distilled water – 1000ml) at 37°C for 2 weeks prior to scaling. The specimens were rinsed for 30 seconds under running tap water and cleaned in an ultrasonic cleaner for 5 minutes. Specimens were air dried and finished using polishing discs (Sof-Lex, 3M ESPE). The intitial surface roughness (Ra) was assessed using the profilometer (Surtronic 3+, Taylor Hobson Precision, U.K.) with stylus moving at 0.8 mm/s. Ultrasonic scaling was performed on all specimens with ultrasonic scaler (Satellacc, Cedex, France) for 60 seconds with copious water flow at level 5 power setting. The scaling tip was angled approximately 15°

to the surface of the restoration and the direction of scaling was perpendicular to the long axis of the tooth. The specimens were rinsed under running tap water for 30 seconds and further cleansed in an ultrasonic bath for 5 minutes. All specimens were subsequently air dried, and post-ultrasonic instrumentation roughness was analysed using the profilometer. Data obtained were evaluated with paired t-test, one-way ANOVA, Tukey's comparison test.

3. Results

Highest surface roughness (Ra) value before ultrasonic scaling was exhibited by Solare X followed by Esthet X HD, Filtek Z350 XT, Estelite Alpha and Control. Subsequent to ultrasonic scaling the surface roughness values were in the descending order of Solare X, Esthet X HD, Control, Estelite Alpha and Filtek Z350XT. Significant statistical differences were observed between all groups except Group 4. Mean difference in the surface roughness values pre and post ultrasonic scaling was highest in the Control group followed by Esthet X HD, Solare X, Estelite Alpha and Filtek Z350XT. (Table 1 and 2, Graph 1)

Tukey's post hoc paired comparison test exhibited statistically significant difference in the surface roughness values between Control and Solare X, Estelite Alpha and Solare X, Esthet X HD and Solare X, Filtek Z350XT and Solare X prior to ultrasonic scaling. Subsequent to ultrasonic scaling significant statistical difference was observed between Estelite Alpha and Solare X, Esthet X HD and Filtek Z350XT, Solare X and Filtek Z350XT. The following pairs showed statistically significant difference in the difference in the surface roughness values:
Control and Estelite Alpha, Control and Solare X, Control and Filtek Z350XT, Estelite Alpha and Esthet X HD, Esthet X HD and Filtek Z350XT. (Table 3)

Table 2: Comparison of surface roughness (Ra) values between the study groups

		N	Mean	Standard Deviation	Min	Max	ANOVA	
							F	p-value
Before	Control	6	2.87	0.79	1.97	4.03	6.87	0.001*
	Estelite Alpha	6	2.96	0.40	2.18	3.29		
	Esthet X HD	6	3.26	0.52	2.44	3.87		
	Solare X	6	4.54	0.91	3.01	5.58		
	Filtek Z350XT	6	3.09	0.41	2.74	3.76		
After	Control	6	5.01	1.08	3.77	6.86	6.27	0.001*
	Estelite Alpha	6	3.82	0.49	3.10	4.26		
	Esthet X HD	6	5.27	0.51	4.54	5.89		
	Solare X	6	5.59	1.32	3.40	6.94		
	Filtek Z350XT	6	3.67	0.47	3.09	4.20		
Change	Control	6	2.14	0.36	1.80	2.83	7.50	<0.001*
	Estelite Alpha	6	0.86	0.34	0.22	1.20		
	Esthet X HD	6	2.01	0.32	1.50	2.40		
	Solare X	6	1.05	1.26	1.51	1.79		
	Filtek Z350XT	6	0.58	0.22	0.35	0.98		

*p<0.05 statistically significant

4. DISCUSSION

Table 3: Pairwise comparison of surface roughness (Ra) values between the study groups

	(I) Group	(J) Group	Mean Difference (I-J)	Standard Error	p-value	95% Confidence Interval	
						Lower Bound	Upper Bound
Before	Control	Estelite Alpha	-0.09	0.37	0.99	-1.18	0.99
		Esthet X HD	-0.39	0.37	0.83	-1.48	0.69
		Solare X	-1.67	0.37	0.001*	-2.76	-0.59
		Filtek Z350XT	-0.22	0.37	0.98	-1.30	0.87
	Estelite	Esthet X HD	-0.30	0.37	0.93	-1.39	0.79

	Alpha	Solare X	-1.58	0.37	0.002*	-2.67	-0.49
		Filtek Z350XT	-0.13	0.37	0.99	-1.21	0.96
	Esthet X HD	Solare X	-1.28	0.37	0.02*	-2.37	-0.19
		Filtek Z350XT	0.17	0.37	0.99	-0.91	1.26
	Solare X	Filtek Z350XT	1.45	0.37	0.005*	0.37	2.54
After	Control	Estelite Alpha	1.19	0.49	0.14	-0.25	2.64
		Esthet X HD	-0.26	0.49	0.99	-1.70	1.19
		Solare X	-0.58	0.49	0.77	-2.02	0.87
		Filtek Z350XT	1.34	0.49	0.08	-0.10	2.79
	Estelite Alpha	Esthet X HD	-1.45	0.49	0.05	-2.89	0.00
		Solare X	-1.77	0.49	0.01*	-3.21	-0.32
		Filtek Z350XT	0.15	0.49	0.99	-1.30	1.60
	Esthet X HD	Solare X	-0.32	0.49	0.97	-1.77	1.13
		Filtek Z350XT	1.60	0.49	0.03*	0.15	3.04
	Solare X	Filtek Z350XT	1.92	0.49	0.005*	0.47	3.36
Change	Control	Estelite Alpha	1.28	0.36	0.01*	0.22	2.35
		Esthet X HD	0.14	0.36	0.99	-0.93	1.20
		Solare X	1.10	0.36	0.04*	0.03	2.16
		Filtek Z350XT	1.56	0.36	0.002*	0.49	2.63
	Estelite Alpha	Esthet X HD	-1.15	0.36	0.03*	-2.22	-0.08
		Solare X	-0.19	0.36	0.99	-1.26	0.88
		Filtek Z350XT	0.28	0.36	0.94	-0.79	1.34
	Esthet X HD	Solare X	0.96	0.36	0.09	-0.11	2.03
		Filtek Z350XT	1.42	0.36	0.005*	0.36	2.49
	Solare X	Filtek Z350XT	0.46	0.36	0.71	-0.60	1.53

Tukey post hoc test *p<0.05 statistically significant

4. Discussion

Studies corroborating the relationship between the restorative materials, periodontal health and external factors have been assiduously explored since decades. Removal of plaque, calculus and bacterial toxins can be achieved by various procedures and tools. Oral prophylaxis procedures may lead to an increase in the surface roughness of the tooth, restoration and the tooth restoration interface. Various studies have shown that increase in surface roughness of the tooth and restorative material promotes plaque formation, thereby increasing the risk of caries. Numerous aesthetic restorative materials are marketed and present varying options to the clinical practitioner. The surface roughness of restorative materials contribute to the longevity and success of the restoration. This study which evaluated the surface roughness of four commercially available composite restorative materials pre and post ultrasonic scaling demonstrated that ultrasonic scaling lead to an increase in surface roughness in varying degrees. The composite restorative materials differ based on particle size, quantity of the inorganic fillers, shape of fillers and volume. These variations contribute to different pysico-mechanical property presentations. [11] The least difference between pre and post ultrasonic scaling procedure was exhibited by simulated cavities restored with nano composite Filtek Z350XT followed by Estelite Alpha, Solare X, Esthet X HD and control groups.

Filtek Z350XT manufacturing involves a patented process which creates unique clusters of nanometer sized filler particles. The fillers are a combinations of non-agglomerated/non-aggregated 20 nm silica, 4 to 11 nm zirconia and aggregated zirconia/silica cluster fillers. The filler loading is approximately 72 to 78.5% weight and 55.6 to 63.3% by volume. Estelite Alpha comprise of supra nano spherical filler particles of size 200nm which are uniformly distributed in the resin matrix produced by sol gel method. The fillers are silica and zirconia with weight of 82% and 71% volume. Solare X is a traditional nanohybrid with addition of pre-polymerized fillers containing lanthanoid fluoride nano particles along with silica nanoparticles and 30

– 40% fluoroaluminosilicate glass fibres. Esthet X HD is a high definition micro matrix restorative with 77 wt% and 60 volume % of fillers comprising of Ba-F-Al-B-Si-Glass particles of size <1µm and nanofiller silica of size 0.04 µm.

The material exhibiting least difference in surface roughness value is the one with the smallest particle filler size of 20 nm silica and 4 to 11 nm zirconia. Various studies corroborate that nanohybrid composites with smaller average particle size exhibit superior physical properties. The increase in difference of surface roughness values by Solare X may be due to the presence of pre-polymerized fillers. The highest difference in surface roughness value was seen in material with the largest filler particle size. [11 - 14]

This in vitro study showed that the use of ultrasonic scalers affect the surface roughness of the composite restorative materials. However the surface of the restorative materials in the oral environment are subjected to various deleterious factors such as abrasion, attrition and erosion [15-19]. Hence it is suggested that the performance of the materials when subjected to ultrasonic scaling in clinical conditions should be assessed.

5. Conclusion

Ultrasonic scalers affect the surface roughness of composite restorative materials. Based on the study it can be concluded that composite restorative material Filtek Z350 XT with smallest filler particle size was found to be least susceptible to modification by ultrasonic scaling.

6. References

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