ASDJ
AINSHAMS DENTAL JOURNAL

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
Des. 2019 - Vol. XXII

Comparative Study Evaluating Micro-tensile Bond Strength of Bulk Fill and Nanohybrid Composite Resin to Dentin (An In-vitro Study)

*Dr. Ahmed Ata Abd El-ghany Abd Elaal**

Abstract: This study objective is comparing and evaluating shear bond strength of bulk fill and nanohybrid composites. A successful composite restoration requires adequate polymerization to improve mechanical properties, biocompatibility, and positive long term prognosis. It has been suggested that the increased translucency of these materials can actually enhance the depth of curing of bulk fill composites. A variety of bulk fill composites are available, differing in filler volume, resin matrix composition and type of photoinitiator which absorb a greater amount of light energy within the 400-450 nanometer range. Sixty human molars were used in the current study, teeth were randomly divided to three groups (n= 20) according to the tested composite resin materials, Filtek Z250 XT nanohhbrid composite, Filtek Evoceram bulk fill, and X-trafill bulk fill. Microtensile bond strength measured by universal testing machine after thermocycling, and the fracture type examined under SEM by two observers. One way ANOVA and Turhey's post Hoc tests were used for statistical analysis. Filtek Z250 XT recorded the highest mean value of microtensile bond strength (29.3518 ±3.42), followed by Tetric Evoceram Bulk fill registered (27.755 ±4.39), while X-tra fill bulk fill recorded the lowest mean values (24.589 ± 2.67) as shown in table (2). There was a significant difference between Filtek X-tra group and Fill Z250 XT group, while there was no significant difference between Filtek Z250 XT group, and Tertic Evoceram group.

Introduction:

Bulk-fill resin composites are old idea. The concept has been on the minds of practitioners, manufacturers and researchers over the past two decades [1]. According to the techniques of application, the resin composite classified into incrementally

* Lecturer of Operative Dentistry, Faculty of Dental Medicine, Al- Azhar University (Assiut Branch)

placed and bulk. Bulk fill composites have been produced to simplify placement of dental composite in deep cavities.

This category of resin composite allowing the practitioner to place each increment up to 4 mm thick to be cured in a single step [(2)], Even though incremental layering may be necessary to ensure adequate polymerization of the composite resin, there are also some disadvantages to this technique, air entrapment between the different layers May occur [(3,4)]. The researchers and practitioners are facing controversy with regard to the appropriate placement technique, namely, bulk placement that offers much greater depth of curing [(5)]. This Bulk fill composite is a light-cured composite material that can be packed and cured in bulk increments thickness of 4 – 5 mm [(6)]. Incremental layering technique has been accepted as a standard technique for resin composite placement in cavity preparations. This technique consists of placing each increments of resin composite material of 2 mm or less thickness followed by light curing from an occlusal direction and then placing another increment until the preparation is completely filled [(7)].

Incremental technique allowing adequate light penetration and subsequently adequate polymerization resulting in improved physical properties with enhanced marginal adaptation and decreased the cytotoxic effect of resin composite [(8)]. Secondly, incremental technique decreasing the polymerization shrinkage and its resulting stresses which may cause cuspal deflection, post operative sensitivity or micro cracks in the tooth structure. These stresses can also lead to failure of adhesive at the tooth/restoration interface causing marginal micro leakage, and secondary caries [(9)]. On the other hand the incremental technique has many disadvantages, such as; air voids incorporation or possibility of contamination between increments, failures of bond between increments, time consumption, required to place and cure each increment [(10)]. To overcome the problem from incremental techniques there are new categories of resin composites that have been produced which can be successfully packed in bulk and cured in thicknesses of four mm while the maximum recommended thickness for most commonly used composites is two mm [(11)].

A successful composite restoration requires adequate polymerization to improve mechanical properties, biocompatibility, and positive long term prognosis. It has been suggested that the increased translucency of these materials can actually enhance the curing depth of bulk-fill composites. A variety of bulk fill composites are available, differing in filler volume, resin matrix composition and type of photoinitiator which absorb a greater amount of light energy within the 400-450 nanometer range. This study objective is comparing and evaluating shear bond strength of bulk fill and nanohybrid composites [(12)].

Materials and Methods:

Sixty sound extracted human molars were collected of six months duration till the beginning of the study, teeth been extracted for periodontal reasons. All the teeth were disinfected with 5% sodium hypochlorite for five minutes and cleaned with ultrasonic scaler to remove calculus, remnant of soft tissue and then washed with sterile water. Each tooth was mounted in blocks of acrylic resin and after resin setting, then stored in a normal saline solution.

Horizontal sectioning of the occlusal surface each molar was done to expose dentine. Sectioning under copious coolant of the tooth by low speed diamond saw (Hard tissue microtome, Germany). Teflon mould was used; its dimension was 4mm height and 4 mm internal diameter. The teeth were divided into three groups (n= 20) randomly according to the used type of resin composite to restore each group. Etching for 15 seconds using 37% of phosphoric acid (Scotchbond etchant, 3M ESPE Dental Products St. Paul Mn, USA), then rinsing for 10 seconds, the excess moisture was dried off leaving the dentine surface slightly wet.

The 5th generation bonding agent (Adper

single bond 2, 3 M ESPE Dental products st. Paul, MN, USA) was applied to the dentin surface of all specimens, light cured by LED curing device (Woodpecker, TMFreelight TM 2 St. Paul,MN,US), with an intensity of 800 mW/cm2 for 20 seconds.

Group I (Z250XT), incremental technique was used to horizontally fill the composite resin, two increments of 2mm thickness of each increment and cured for 20 seconds by LED curing device, while for Group II (Tetric Evo ceram) and Group III (X-tra fill bulk fill), the composite resin was placed of 4 mm thickness as one increment into the cavity and for 20 seconds curing with the same curing device. The restorations then finished with diamond burs (TR-24EF, MANI, Japan) with air water coolant spray to avoid heat generation and polished by Sof-lex XT (3M ESPE, St. MIN, USA)system. The used materials in the current study were presented in table (1).

All specimens were stored in incubator for one week of 100% humidity and thermocycling (Thermocycler Wileytec, Haake ek30, Germany) for 1500 cycle in the water bath between 5º C and 50º C with 30 seconds of dwell time for each bath and 10- 15 second of transfer time.

Table (1): The materials used in the study.

Material	Type	Composition	Manufacturer
Filtek Z250 XT Shade(A3)	Nanohybrid composite	Resin: Bis-phenol A glycol di-methacrylate (Bis -GMA), Urethane dimethacrylate (UDMA), Ethoxylated bisphenol A glycol dimethacrylate (BIS-EMA), Poly ethylene glycol di-methacrylate (PEGDMA) and Tri-ethylene glycol di-methacrylate (TEGDMA). Fillers: (82% by weight) Zirconia/silica, Non agglomerated/ non-aggregated 20 nanometer surface-modified silica particles.	3M ESPE Dental Product St. Paul, MN,USA
Tetric Evo Ceram	bulk-fill composite resin	Resin: (20–22% weight). Bis-phenol A glycol di-methacrylate (Bis-GMA), Ethoxylated bisphenol A glycol di-methacrylate (Bis-EMA) and Urethane dimethacrylate (UDMA). Fillers: (79–81% by weight): barium glass, ytterbium tri-fluoride, mixed oxide and prepolymer Additional contents: additives, catalysts, stabilizers and pigments	Ivoclar Vivadent AG, Schaan, Liechensten, Europe
X-tra fil	bulk-fill composite resin	Resin: Bis-phenol A glycol di-methacrylate (BisGMA), Urethane di-methacrylate (UDMA), Tri ethylene glycol di-methacrylate (TEGDMA). Fillers: 86% by weight inorganic fillers.	Voco GmbH methacrylate, Cuxhaven, Germany
Adper single bond 2	Primer and bond	BIS-GMA, HEMA, di-methacrylates, polyalchenoic acid, ethanol, co-polymer, water 3-8%, initiators	3M ESPE Dental Product St. Paul, MN,USA

All the groups were subjected to bond strength evaluation using universal testing machine (Autograph, AG- 15, Shimadzu inc, USA). a tensile load was applied at a cross head speed of 1 mm/min until fracture occurred. For failure mode assessment the specimens were examined by two separate observers under SEM (JOEL JSM 5600, MA, USA)at 100x magnification and the mode of failure (adhesive, cohesive or mixed) for each specimen was identified.

Statistical analysis was calculated by one way ANOVA for comparing the forces at which fracture occurred, and Tukey's Honest significant difference Post Hoc test was used for comparing the three tested groups ($p>0.05$).

Results:

Filtek Z250 XT recorded the highest mean value of microtensile bond strength (29.3518 ±3.42), followed by Tetric Evoceram Bulk fill registered (27.755 ±4.39), while X-tra fill bulk fill recorded the lowest mean values (24.589 ± 2.67) as shown in table (2). The difference between Filtek Z250 XT group, and Tertic Evoceram group was not significant, while the difference between Filtek Z250 XT group and X-tra Fill group was significant. Also the difference between Tetric Evoceram group and X-tra fill group was significant (p value > 0.05) as shown in table (3).

Table (2): Mean value (Mpa) of the tested bulk fill composites.

Composite resin	Microtensile bond strength Mean value (Mpa)	S.D*
Filtek Z250XT	29.3518	± 3.42
Tetric Evo ceram Bulk fill	27.755456	± 4.39
X-tra fill Bulk fill	24.589553	± 2.67

* S.D refers to Standard Deviation.

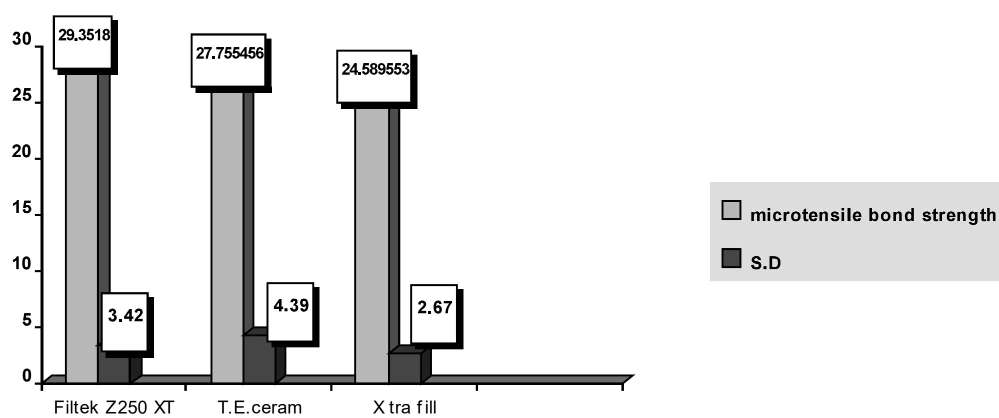

Figure (1): Chart graph showing the microtensile bond strength of the tested composite resin restorations.

Table (3): Turkeys post Hoc test for comparisons between the tested groups.

Groups		Mean difference	P value
Filtek Z250 XT	Tetric Eco ceram bulk fill	1.596344	0.218
Filtek Z250 XT	X-tra fill Bulk fill	4.762247	0.001*
Tetric Evo ceram bulk fill	X-tra fill Bulk fill	3.165903	0.001*

* Significant Difference (P value > 0.05).

Table (4): Failure mode:

Fracture type	Z250 XT	Tetric Evoceram	X-tra fill
Adhesive	13	15	16
Cohesive	2	0	0
Mixed	5	5	4

Adhesive fracture was most frequent of all the tested groups (73.3 %), only two specimens have cohesive fracture in Z250 XT group, Mixed fracture was observed in (23.3 %) in all the tested groups.

Disscusion:

In the recently introduced bulk fill composites there was a need to evaluate the bond strength to suspect their longevity. The null hypothesis was rejected because the values of the microtensile strength of the tested composite restorations exhibited significant differences. In the current study, thermocycling was performed to simulate the in vivo conditions of thermal changes intraorally [(13)].

Filtek Tetric Evoceram has shown microtensile bond strength comparable to that of nanohybrid composite , that may due to presence of the modifications of the matrix of resin which lowered the shrinkage stresses, that also was described by manufacturer. Presence of aromatic dimethacrylate (AUDMA) in the matrix of Filtek Tetric Evoceram giving a property to the resin network to rearrange, that improving adaptation of the restoration during and post the process of polymerization and accommodate the resulting shrinkage without creating high stresses [(14,15)].

Filtek Z 250 XT is a nanohybrid resin composite has a high microtensile bond strength increasing its longevity as it was recorded by Mehl A, Hickel R, Kunzelmann KH[(18)]. Also the increase in filler content with decreasing their size and inerparticle spacing improving the fatigue limit because that increases the obstacle for the growth of crack as recorded by Oberholzer TG et al. [(17)]. Filtek Tetric Evoceram has different shapes of fillers approaching round shape which improves translucency to improve curing depth than that of Filtek Z25XT, but nanoclusters of Filtek z25XT giving better mechanical properties[(18)].

The lowest mean microtensile bond strength was recorded for X X-tra fil bulk-fill groups that in agreement with a study conducted by Damanhoury H et al. [(19)]. The polymerization stress has resulted from modulus of elasticity and volume of shrinkage as Ferracane JL mentioned [(20)]. The lowest values of microtensile bond strength was registered with X-tra fil bulk –fill that in accordance with the highest adhesive failure of that group, the other failure modes, mixed and cohesive was recorded for the other composite types which due to improved depth of curing.

Conclusion:

The tested bulk fill composites exhibited adequate bond strength values

References:

1 - Gordon's j .Christensen. Challenges of Bulk-Fill Resins January 2012, 1.

2- Demarco FF, Correa MB, Cenci MS, Moraes RR, Opdam NJM. Longevityof posterior composite restorations: not only a matter of materials. Dent mater. 2012; 28:87-101. j. Dentistry.2011.09.003.

3. Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR™ technology. Dent Mater 2011; 27: 348-55

4. Sakaguchi RL, Douglas WH, Peters MC. Curing light performance and polymerization of composite restorative materials. J. Dentistry 1992;20:183 88.

5. Abbas G, Fleming GJP, Harrington E, Shortall ACC, Burke FJT. Cuspal movement and micro leakage in premolar teeth restored with a packable composite cured in bulk or in increments. J. Dentistry 2003; 31:437-44.

6. Lazarchik DA, Hammond BD, Sikes CL, Looney SW, Rueggeberg FA. Hardness comparison of bulk filled Trans-tooth and incremental filled occlusal irradiated composite resins. J. Prosthet Dent. 2007; 98:129- 140.

7. Giachetti L, Scaminaci Russo D, Bambi C, Grandini R. A review of polymerization shrinkage stress: current techniques for posterior direct resin restorations. J Contemp Dent Pract. 2006;7(4):79-88.

8. Podshadley A, Gullett C, Crim G. Interface seal of incremental placement of visible light-cured composite resins. J Prosthet Dent.1985;53(5):625-6.

9- Goracci C, Cadenaro M, Fontanive L, Giangrosso G, Juloski J, Vichi A, Ferrari M. Polymerization efficiency and flexural strength of low stress restorative composites. Dent Mater. 2014; 30:688–94.

10. Rueggeberg FA, Caughman WF, Curtis JW Jr, Davis HC. Factors affecting cure at depths within light-activated resin composites. Am, J. Dent 1993; 6:91-5.

11. Baharav H, Brosh T, Pilo R, Cardash H. Effect of irradiation time on tensile properties of stiffness and strength of composites. J, Prosthet Dent 1997; 77:471-4.

12. Flury S, Hayoz S, Peutzfeldt A, Husler J, Lussi A. Depth of cure of resin composites: is the ISO 4049 method suitable for bulk fill material 2012; 28:521-28.

13. Giachetti L, Scaminaci Russo D, Bambi C, Grandini R. A review of polymerization shrinkage stress: current techniques for posterior direct resin restorations. J Contemp Dent Pract. 2006;7:79-88.

14. Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR™ technology. Dent Mate. 2011;27:348-55.

15. Mills RW. Blue light emitting diodes another method of light curing; Brit Dent J; 1995; 178:169.

16. Mehl A, Hickel R, Kunzelmann KH. Physical properties and gap formation of light-cured composites with and without 'soft-startpolymerization'. J, Dent 1997; 25: 321-330.

17. Oberholzer TG, Du Preez IC, Kidd M. Effect of LED curing on the micro leakage, shear bond strength and surface hardness of a resin based composite restoration. Bio,mater; 2005; 26,3981-86.

18. Nasim, P. Neelakantan, R. Sujeer, and C. V. Subbarao. Color stability of micro filled, micro hybrid and nano composite resins an in vitro study. J, Dentistry, 2010.38, 137 – 142.

19. N. Gon ¨ ulol and F. Yılmaz, The effect of finishing and polishing techniques on surface roughness and color stability of nano composites, J. Dentistry; 2012;40,64–70.

20. Ferracane JL. Placing Dental Composites - A Stressful Experience. Oper Dent. 2008;33:247-5