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COMPARATIVE EVALUATION OF THE FLEXURAL PROPERTIES OF VARIOUS BULK FILL COMPOSITES.

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ABSTRACT-

The aim of this study is to perform a comparative evaluation of the flexural properties of various bulk fill composites. Bulk fill composites play a significant role in the restorative field of dentistry. The modern bulk fill composites offer better strength and better performance. These materials reduce the cuspal deflection rate and also have reduced polymerisation shrinkage. This study focuses on comparative evaluation of four bulk filled composites , 3M Filtek Bulk Resin , Tetric N Flow Bulk Resin , EverX Flow Bulk Resin , SDR (Smart Dentin Replacement) Posterior Bulk Fill Flowable Base resin with most widely used Universal Restorative resin 3M Z350XT. The specimens were made with the standardisation technique and were subjected to be tested by the Instron (Universal Testing Machine). The results were analysed statistically and were subjected to One way analysis of variance(ANOVA) (a=0.05). The results revealed that the modern bulk fill composites had similar flexural strength compared to the conventional Universal restorative resin 3M Z350XT. The maximum flexural strength was seen in EverX Flow at a maximal value of 273.17 Mpa for the specimen. These modern materials have great flexural strength and great scope in future.

Keywords: Bulk Fill Composites, Flexural Strength , EverX Flow , Universal restorative resin 3M Z350XT

Introduction -

Bulk fill resins are modern resins which in future will replace the conventional composites.Bulk fill composites offer several advantages to the operator. A few of them are that they provide easy control over the flow of the material,adequate strength compared to conventional composites, reduced curing time , better flowability ,longer life , increased flexural strength and better adaptability to the cavity walls without inducing high polymerisation stress are few of them(Cidreira Boaro et al. 2019).Conventional composite materials offer high curing stress.Curing stress can be also responsible for cusp deflection in cases of high C - factor based direct composite restorations , such as in cases of large composite Class I restorations , and in cases of MOD Class II cavities(Strydom 2002).

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The modern bulk fill composite materials offer reduced polymerisation stress. The steps used with the conventional composites were majorly dependent on the pattern of incremental curing .The use of bulk fill composites omits this procedure of incremental curing and hence saves a lot of chair time.The recently marketed bulk fill composites claim to have a curing depth of 4 mm per application (Agarwal et al. 2015)as compared to 2 mm curing depth of the conventional composites.Polymerization shrinkage stress of resin-based composites can affect marginal integrity and lead to marginal leakage, debonding, secondary caries, post-operative sensitivity, development of perimarginal white lines. Curing stress can also be responsible for cusp deflection(Prager et al. 2018) . These modern materials reduce the polymerisation shrinkage stress and help in providing longevity to the restoration.

3M Filtek resin(Benalcázar Jalkh et al. 2019) is a kind of bulk fill resin . This form of resin is made from nanotechnology. The single layer of increment is 5mm. A single layer of increment is sufficient to cure the composite. And this doesn't need any additional layering. This procedure is fast and easy procedure.This kind of material shows excellent adaptation without additional expensive dispensing.Excellent handling of the material and the sculpability.The curing process involves curing for 10 seconds on buccal , lingual and occlusal aspect respectively(Ивашов et al. 2014).This material can be used as a liner as Class I and Class II restorations, as a fast bulk fill base up to 4 mm for Class I and Class II restorations and as a wear-resistant solution for small, non stress-bearing occlusal surfaces, Class III and Class V.

Tetric N Flow is available in dentine translucency shade and enamel translucency shade. The bulk fill can be cured for 4 mm at a single increment .Exposure time at energy >= 500mW/cm2 is for 20 seconds.The flexural strength of the material is 110mpa and the modulus of elasticity is 5300mpa with the compressive strength being at 230mpa.These materials have nano additives added in them for better clinical performance.(Mandava et al. 2018)

EverX Flow(Reis et al. 2017) is a short-fibre, reinforced flowable composite designed to replace dentine and reinforce even the largest restorations while simultaneously preventing them from cracking. Offering high wear resistance and superb aesthetics,this material has excellent fracture toughness, close to that of dentine, due to the high amount of short fibres strongly bonded to the resin matrix. Its thixotropic viscosity allows it to adapt perfectly to the cavity floor without slumping, even when placed in upper molars. EverX Flow's Bulk shade offers a depth cure of 5.5 mm, ideal for deep posterior cavities, while the Dentin shade has a depth cure of 2 mm for highly aesthetic results and core build-up(Garoushi et al. 2015).

Bulk fill resins are mostly available in two types . The first one being the low viscosity type which is flowable , and the second one being the high viscosity types which is sculptable in nature.SDR (Smart Dentin Replacement) Posterior Bulk Fill Flowable Base (Hickey et al. 2016)is a single component, fluoride containing, and visibly light cured radiopaque resin composite restorative material. The composition of highly popular SDR is as follows:the major

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component being barium aluminofluoroborosilicate glass, followed by strontium aluminofluorosilicate glass, with modified urethane dimethacrylate resin and thoxylated bisphenol A dimethacrylate (EBPADMA), also dilutent like triethylene glycol dimethacrylate (TEGDMA)is added in it , with presence of camphorquinone as a photoinitiator, other additives are butylated hydroxytoluene (BHT), UV stabilizer, titanium dioxide, and iron oxide pigments. The handling characteristic of SDR is like that of typically of a flowable composite .This material offers minimal polymerisation stress and can be added in the increments of upto 4mm. SDR has a self-leveling feature (Pfefferkorn, n.d.)that allows intimate adaptation to the prepared cavity walls. This material is available in universal shade , after the application of this bulk fill composite a layer of universal type material is used for missing occlusal/facial/enamel.

The control group in the study was chosen as Universal composite restorative material 3M Z350XT. In these materials fillers are a combination of non-agglomerated/non-aggregated 20 nm silica filler, non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, and aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles).They offer great polishability and are widely used composite material for all kinds of restorative needs.(D'Alpino et al. 2015)

Our team has done previous studies in this field and also wants to do study in future as this is a challenging field.(Rao and Kumar 2018; Felicita 2017; A. R. Jain 2017; Patturaja 2016; Mp 2017; Sivamurthy and Sundari 2016; Kumar et al. 2006; Azeem and Sureshbabu 2018; Krishnan and Lakshmi 2013; Sekar et al. 2019; Felicita, Chandrasekar, and Shanthasundari 2012)(Neelakantan et al. 2011; R. K. Jain, Kumar, and Manjula 2014; Johnson et al. 2019; Keerthana and Thenmozhi 2016; Lakshmi et al. 2015)

Materials and Methods

Specimen Preparation -

To assess the flexural strength of these materials it was imperative to make specimens which were exactly of the same dimensions . The specimens were prepared by the use of additional silicone moulds and were cured for the same duration for each specimen . The specimens were prepared by a single operator. For each restorative material 4 samples were prepared . The dimension of the specimen was 2 x 2 x 10mm thickness. While preparing the specimens to check the accuracy exactly and confirm it , a digital vernier calliper was used to measure the dimensions. The samples were made by compressing the composite material between two glass plates with intermediate polyacetate sheets, separated by a steel mold having an internal dimension of 2 x 2 x 10mm.

Irradiation occurred on the top and bottom of the specimens, as specified in ISO 4049:2009 standards; the time of the light exposures was 20 seconds, with three light exposures, overlapping one irradiated section no more than 1 mm of the diameter of the light guide (1241 mW/cm2, Elipar Freelight 2, 3M ESPE, Seefeld, Germany) (Flury et al. 2013)to prevent

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multiple polymerizations. After removal from the mold, the specimens were ground with silicon carbide paper (grit size P 1200/4000 [Leco]) to remove protruding edges or bulges, and then stored for 24 hours in distilled water at 37^0C(Garcia et al. 2014).

Testing of Specimen -

The samples were loaded until failure in a Instron universal testing machine (Z 2.5, Zwick/Roell, Ulm, Germany) in a three-point bending test device, which was constructed according to the guidelines of NIST 4877 with a 12-mm distance between the supports.During testing, the specimens were immersed in distilled water at room temperature. The crosshead speed was 0.5 mm/min. The universal testing machine measured the force during bending as a function of deflection of the beam. The bending modulus was calculated from the slope of the linear part of the force-deflection diagram(Pradeep et al. 2016).

The test procedure was carried out with controlled force, and the test load increased and decreased with a constant speed between 0.4 mN and 500 mN. The load and the penetration depth of the indenter were continuously measured during the load-unload-hysteresis. The universal hardness is defined as the test force divided by the apparent area of the indentation under the applied test force.(Lindemuth and Hagge 2000)
The results were compared using one-way and multiple-way analysis of variance (ANOVA) and Tukey post hoc test (a=0.05).

Results and Discussion -

The results are generated by the Universal Testing Machine after testing the specimen under the controlled factors.The Group 1 (3M FilTek) samples revealed flexural strength of four samples as 156.09 ,131.85, 161.15 , 152.23 respectively. The Group 2 (Tetric N Flow) samples revealed flexural strength of four samples as 135.03 , 144.76 , 96.26 , 155.52 respectively.The Group 3 (EverX Flow) samples revealed flexural strength of four samples as 273.17 , 161.72 , 170.07 , 122.24 respectively . The Group 4 (SDR Plus Bulk Fill Composite) samples revealed flexural strength of four samples as 168.72 , 160.94 , 92.31 , 108.85 respectively. The control Group 5 (3M FilTek 350Z XT) revealed the flexural strength of 94.97 , 139.60 , 115.46 , 129.59. The results revealed the statistical significance which was similar to the control group . The statistical analysis was done with ANOVA tests and the tests between the two groups revealed a value of 0.203.

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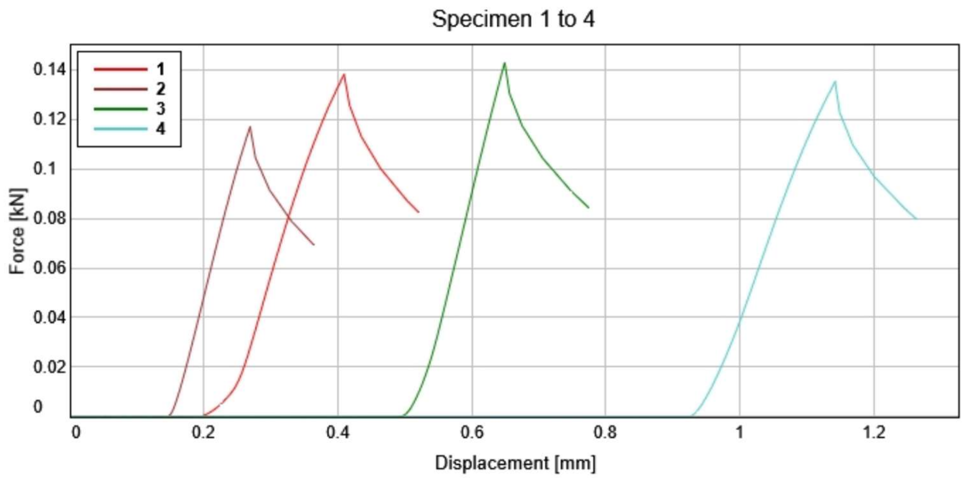

Figure 1 : Depicting the result of triple bending test performed on sample prepared from 3M FilTek Bulk Fill Composite

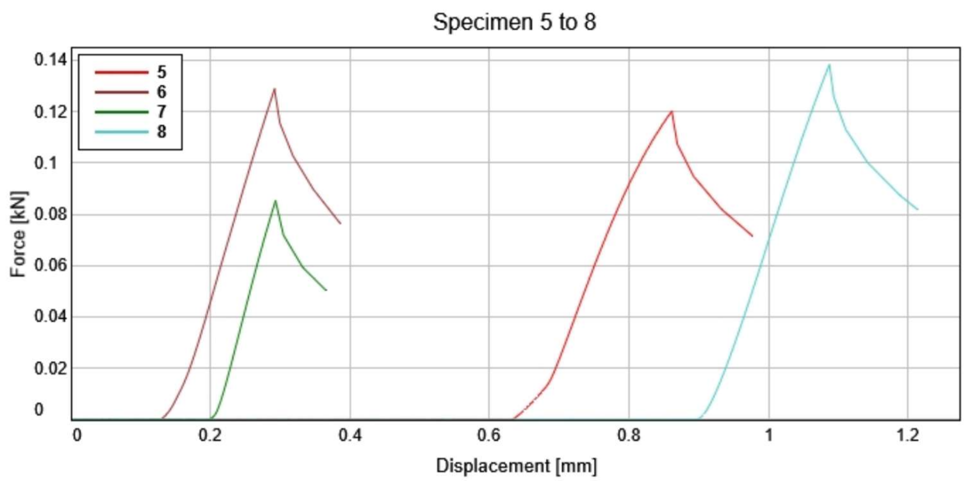

Figure 2 : Depicting the result of triple bending test performed on sample prepared from Tetric N Flow Bulk Fill Composite

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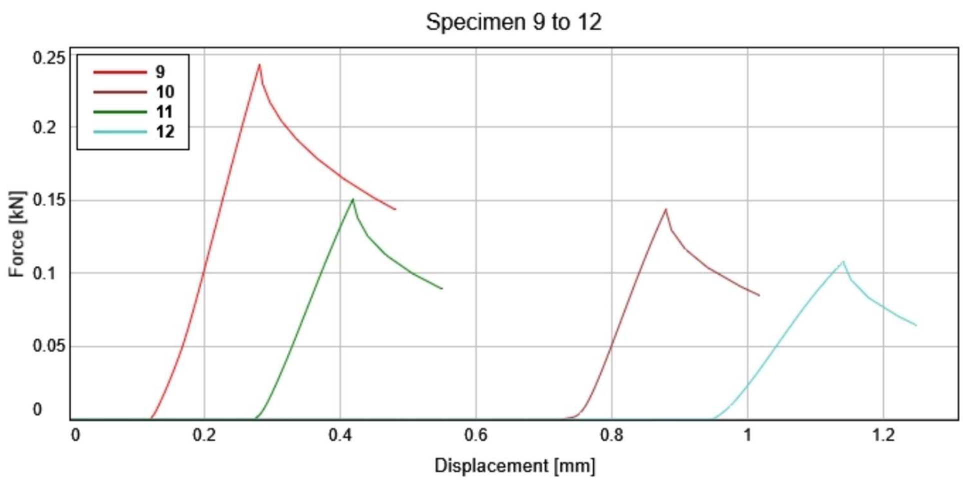

Figure 3 : Depicting the result of triple bending test performed on sample prepared from Ever X Flow Bulk Fill Composite

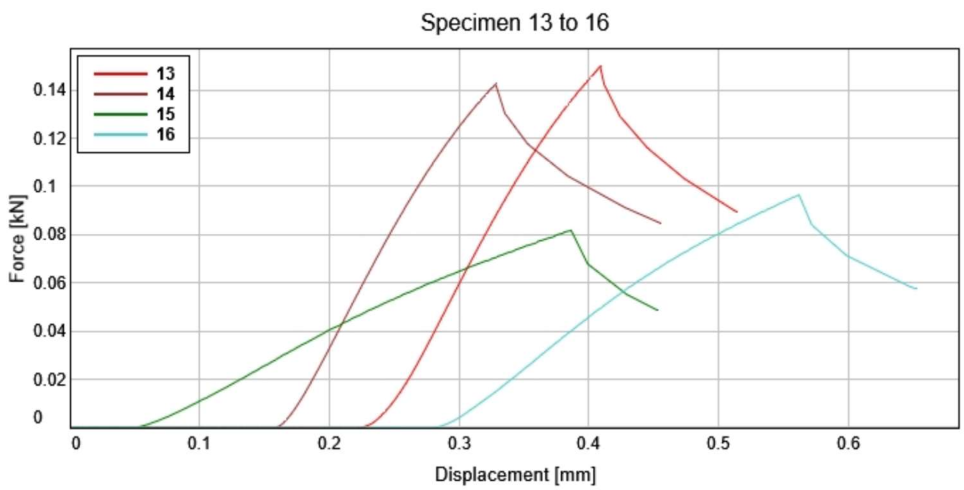

Figure 4 : Depicting the result of triple bending test performed on sample prepared from SDR Plus Bulk Fill Composite

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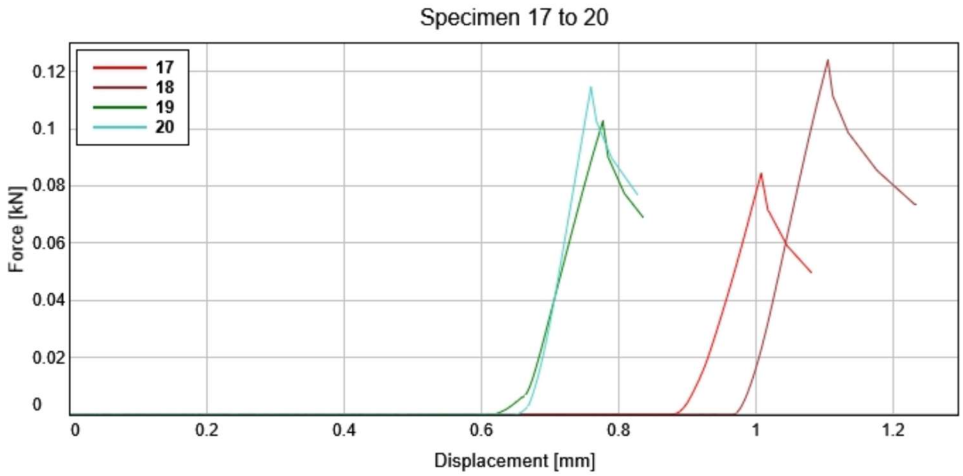

Figure 5 : Depicting the result of triple bending test performed on sample prepared from 3M FilTeK 350Z XT universal Bulk Fill Composite

Specimen Count	Maximum Force [N]	Flexure stress at Maximum Force [MPa]
1	138.75	156.09
2	117.20	131.85
3	143.25	161.15
4	135.31	152.23
5	120.03	135.03
6	128.67	144.76
7	85.57	96.26
8	138.24	155.52
9	242.81	273.17
10	143.75	161.72
11	151.18	170.07
12	108.66	122.24
13	149.97	168.72
14	143.05	160.94
15	82.05	92.31
16	96.75	108.85
17	84.42	94.97
18	124.09	139.60
19	102.63	115.46
20	115.19	129.59

Table 1 - Depicting the Flexural Stress at Maximal Force for all the Bulk fill composites.

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		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
maximumforce	Group 1	4	133.6275	11.42404	5.71202	115.4493	151.8057
	Group 2	4	118.1275	22.94390	11.47195	81.6186	154.6364
	Group 3	4	161.6000	57.22734	28.61367	70.5385	252.6615
	Group 4	4	117.9550	33.63302	16.81651	64.4374	171.4726
	control	4	106.5825	17.19884	8.59942	79.2153	133.9497
	Total	20	127.5785	35.05178	7.83782	111.1738	143.9832
flexuralstrength	Group 1	4	150.3300	12.85004	6.42502	129.8827	170.7773
	Group 2	4	132.8925	25.81569	12.90785	91.8140	173.9710
	Group 3	4	181.8000	64.38600	32.19300	79.3475	284.2525
	Group 4	4	132.7050	37.83787	18.91893	72.4965	192.9135

	control	4	119.9050	19.34946	9.67473	89.1157	150.6943
	Total	20	143.5265	39.43479	8.81789	125.0705	161.9825

Table -2 Depicting the basic statistical analysis of specimens involved in the study individually.

ANOVA						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
maximumforce	**Between Groups**	7267.272	4	1816.818	1.695	.203
	Within Groups	16076.641	15	1071.776		
	Total	23343.913	19			
flexuralstrength	**Between Groups**	9197.242	4	2299.310	1.695	.203
	Within Groups	20349.707	15	1356.647		
	Total	29546.949	19			

Table - 3 Depicting the ANOVA statistical analysis for the comparisons of the Groups. The statistical analysis

CONCLUSION- The study revealed that these modern bulk fill composites have a similar value of flexural strength as seen in the control group.The maximum flexural strength was seen in EverX Flow at a maximal value of 273.17 for the specimen. These modern materials have a

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great flexural strength and great scope in future.

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CONFLICT OF INTEREST - Nil

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