Section A-Research paper

To measure and compare the microleakage in three different newer direct composite resins using adhesive bonding system in Class V cavities – In Vitro study

Dr.AnkitNatani[1] ,Dr.Ananya Bhargava[2], Dr.Apoorva Bhargava[3] ,

Dr.AjayPrakashPandey[4] ,Dr .Siddhi Yadav[5], Dr .Priyanka Dubey[6]

[1]MDS, Pedodontics and Preventive dentistry,Reader ,Jaipur dental college,Jaipur (Raj) India

[2]MDS ,Orthodontics and DentofacialOrthopedics ,Assistant Professor (Department of Dentistry), RuxmanibenDeepchandGardi Medical College,Ujjain (M.P), India

[3]MDS,Conservative Dentistry and Endodontics,ConsultantEndodontist,Delhi , India

[4]MDS ,Prosthodontics ,Crown and bridge ,Senior Resident ,Anugrah Narayan Magadh Medical College,Gaya (Bihar) ,India

[5,6] MDS ,Conservative Dentistry and Endodontics , Reader , People's College of Dental Sciences and Research center,Bhopal(Madhya Pradesh)India

Corresponding Author:

Dr.AnanyaBhargava

MDS ,Orthodontics and DentofacialOrthopedics ,Assistant Professor (Department of Dentistry), RuxmanibenDeepchandGardi Medical College,Ujjain (M.P), India

Email id:drananyaortho@gmail.com

ABSTRACT-

Background-

When a light cure composite resin is used to restore a class V lesion, certain stresses are generated at the tooth-restoration interface. If these stresses exceed the bond strength of the restorative material, microscopic gaps are formed which eventually cause micro-leakage at the tooth-restoration interface. The objective of the present study was to measure and compare the micro-leakage values at of SDR *(*Dentsply)Nanoceramiccomposite material, Filtek Z 350 (3M ESPE) Nanocompositematerial andTetricEvoCeram (Ivoclar) Nanohybridcomposite material using adhesive bonding system in class V cavities – In Vitro study.

Material and method-

45 extracted premolar teeth were collected and stored.Class V cavities were prepared andrestored with restorative materials by dividing them into 3 equal groups, Group I(SDR),Group II (Filtek Z 350), Group III (TetricEvoceram.) Each containing a total of 15 samples.Once restored, each tooth was thermo cycled and were immersed in silver nitrate dye and observed under a stereomicroscope to visualize the extent of microleakage. Furthermore, each tooth was thereby graded to standardized criteria and analyzed.

Result-

There was a significant difference between the Groups($P<0.05$). The highest mean value was found among Group III(1.20±0.41) followed by Group II 350 (1.00±0.00) and Group I (0.00±0.00) respectively.

Conclusion-

None of the newer direct composite resins tested were free from microleakage We found thatGroup I(SDR)proved itself to be a superior restorative material, less microleakage ability, whereas Group II (Filtek-Z 350) and Group III(TetricEvo Cream)showed poor sealing capability.

Keywords-

Microleakage, Class V cavities, SDR™ (Dentsply) ,Filtek z350 (3M ESPE) ,TetricEvoCeram (Ivoclar)

INTRODUCTION

In the current age of adhesive dentistry or microdentistry, conservation of tooth structure is paramount.[1]. The boom in the aesthetic dentistry came with the advent of dentine adhesives.[2]One of the most important problems today of the restorative dentistry is the failure of restorative material to obtain a complete bond with the enamel and dentine, formation of micro-fissures, penetration of ions, molecules, bacteria and fluids into these fissures and the occurrence of post-operative pain, discoloration at the cavity edges, secondary decay and pulpal inflammations. It has been reported that this phenomenon, referred to as microleakage is due to the inadequacy of marginal adaptation between the restorative material and cavity wall.[3]

Composite resin materials have progressed from macrofills and from hybrids to microhybrids, and new materials such as packable and nanofilled composites have been introduced to the dental market.[4]. A new brand of composite resins called Nanofilled composites has been introduced to the dental market, which has been produced with nanofiller technology and formulated with nanomer and nanocluster filler particles.

Nanomers are discrete nanoagglomerated particles of 20-75 nm in size, and nanoclusters are loosely bound agglomerates of nano-sized particles. The combination of nanomer-sized particles and nanocluster formulations reduces the interstitial spacing of the filler particles and, therefore, provides increased filler loading, better physical properties, and improved polish retention.[5]

The various nanofilled composites that were used in this study have higher filler loading compared to conventional resin composites. SDR™—Smart Dentin Replacement (DENTSPLY DeTrey, Konstanz, Germany), indicated as a bulk-fill material and as a liner in Class I and Class II , Class V restorations. The ability to place it in 4 mm bulks instead of smaller increments withoutnegatively affecting the polymerization shrinkage, cavity adaptation, or the degree of conversion is considered a significant advantage of SDR.

Filtek Z350 (3M ESPE) Universal Restorative is a nanocomposite that contains a combination of a nonagglomerated/nonaggregated, 20 nm nanosilica fillers, and loosely bound agglomerated zirconia/silica nanocluster, consisting of agglomerates of primary zirconia/silica particles with 5-20 nm fillers.
Tetricevo cream comprises organically modified ceramic nanoparticles and nanofillers combined with conventional glass fillers of approximately 1 μm. The size of the nanoceramic particles was found to be approximately 2.3 nm.
The dentine bonding agent used in this study is G-Bond (GC Japan), which is a one-step, self-etch dentine bonding agent that forms a nonconventional interface with the dentin – a "Nano Interaction Zone" (NIZ) with minimal decalcification and almost no exposure to collagen fibers.

The class V lesion presents special problems with any restorative material because the selected material is required to bond to enamel and dentin/cementum. Dentin is a less favorable substrate than enamel for resin bonding. It was difficult to obtain good adhesion to dentine or cementum. Mostly due to these reasons, bonded composites are the common choice for aesthetic restoration of class V lesions.[6]
The amount of micro-leakage around the tooth-restoration interface when measured in millimetres will provide accurate results that can help the clinician to choose the best restorative material and the etching protocol for restoring class V lesions.
Therefore this study was conducted to evaluate and compare microleakage at the margins of a Class V restoration of SDR™ (Dentsply) ,Filtek z350 (3M ESPE) nanocomposite, / nanoceramic composite and TetricEvoCeram (Ivoclar) nanohybrid composite .

MATERIAL AND METHODS

Study design:- comparative study design.
Study duration:-2 years (January 2014-December 2015)
Study done-Department of Pedodontics , Jaipur Dental College,Jaipur (Rajasthan) India

Sampling-The extracted teeth collected were divided into three equal groups, containing 15 premolars in each groups. (n=15)

Group I - Restored with SDR(Dentsply) nanoceramic composite material.(figure 1)

Group II –Restored with Filtek Z 350 (3M ESPE) nanocomposite material (Figure 2)

Group III –Restored with TetricEvoCeram (Ivoclar) nanohybrid composite material (Figure 3)

Figure 1: SDR

Figure 2: Nano Composite

Figure 3: Tertic Evo Cream

Inclusion criteria

1.Patients aged 13-19 years.

2. Sound premolars (maxillary or mandibular) were considered for this study which were extracted due to orthodontic reasons.

Exclusion criteria

1. Any carious and hypoplastic teeth were excluded.
2. Incisors, canines and molars were excluded.

Sample Collection

1. 45 sound premolars were extracted and collected from Department of Oral Surgery, Jaipur Dental College.
2. The collected teeth were cleaned with scaler to remove any specks of calculus followed by washing with sodium hypochlorite to remove unwanted debris.

Armamentarium

Extracted premolar ,High-speed air rotor ,Bur No. 9 cone,Gloves ,Mouth mask ,Probe Ulterasonicscaler ,Metallic scale ,Sodium hypochlorite solution ,Normal saline ,Silver nitrate dye, Nail polish ,Steriomicroscope ,Composite kit (Acid etchant, Bonding agent) ,Light cure unit,Photodeveloping Solution ,Thermocycle Unit

Procedure of study

According to G. V. Black's Classification of cavity preparation, Class V cavity was prepared on each specimen with the help of straight fissure diamond bur No. 9 cone bur using a high-speed air rotor.

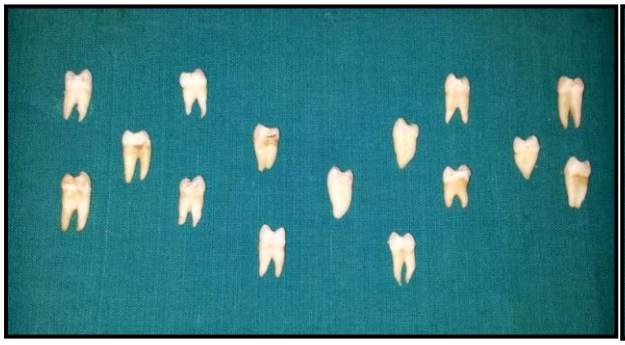

Figure 4: Teeth Specimens **Figure 5: Specimens after Cavity Restoration**

The Class V cavities (Figure 4,5) were made with an straight fissure diamond bur No. 9 in a water-cooled high-speed handpiece and were standardized as 4.0 mm wide, 2.0 mm deep, and 2.0 mm high.

Dye Penetration

After restorations were performed, the samples were initially stored for one day in physiological saline solution at 37°C and then thermocycled in water baths for 500 cycles, alternatively at 5°C and 55°C with a dwell time of 15 seconds. (Figure 6,7) The surfaces of the teeth were coated with two layers of red nail varnish 1mm beyond the restoration margins(Figure 8). All specimens were placed in a 50% w/v silver nitrate aqueous solution in the dark for 2 h. They were then rinsed with water and placed in a radiographic developing solution for 6 hours under a fluorescent light. The teeth were thoroughly washed with water and acetone to remove the nail varnish.

Fig.6: Thermocycle Unit

Figure 7: Specimens Undergoing Thermocycling

Figure 8 : Specimens Applied with Nail Varnish

The specimens were grinded equally on both aspects (mesial and distal) on a tile and abraded with pumice and water to achieve a thickness of 500µm. (Figure 9,10,11)

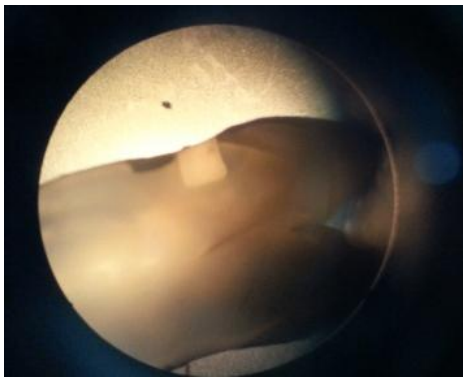

Figure 9: SDR

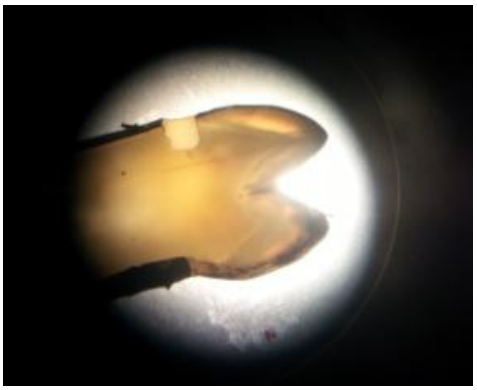

Figure 10: Tetric Evo Cream

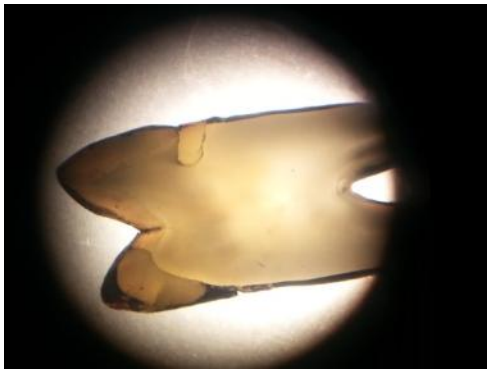

Figure 11: Filtek Z350

The specimens were observed under stereomicroscope with a magnification of 10X and the degree of marginal leakage was determined by the criteria as described by Khera and Chan in 1978 as follows:

0° = No leakage
1° = Less than and up to one-half of the depth of the cavity preparation was penetrated by the dye 2° = More than one-half of the depth of the cavity preparation was penetrated by the dye, but not up to the junction of the axial and occlusal or cervical wall
3° = Dye penetration was up to the junction of the axial and occlusal or cervical wall, but did not include the axial wall
4° = Dye penetration included the axial wall

Dye penetration was evaluated by a single observer.

STATISTICAL ANALYSIS

Data were subjected to statistical analysis using SPSS (IBM® SPSS (software package used for statistical analysis)® Statistics 20 Student Version (manufactured in august 2011)) Software (Version 20). Data was subjected to statistical analysis to compare the microleakage among the three groups. For each group the values of mean and standard deviation were calculated. To find whether the microleakage in the three groups is homogenous, analysis of variance was conducted. To find between which two groups there was significant difference in the leakage, unpaired 't' test was conducted.

RESULTS

Table 1 :Distribution of micro-leakage among different groups

Chi-square test was applied. There was a significant difference between the groups .($p < 0.05$).

Score	Groups		
	Group I(SDR)	Group II (Filtek 350)	Group IIII (TetricEvoceram)
0	15 (100.0%)	0	0
1	0	15 (100.0%)	12 (80.0%)

2	0	0	3 (20.0%)
Total	15 (100.0%)	15 (100.0%)	5 (100.0%)
Chi-square value = 16.667, p-value = 0.002* **Chi-square test * Significant difference**			

Table 2 :Distribution of micro-leakage among Group I and Group II

Chi-square test was applied.There was a significant difference between Group I and Group II.

Score	Group I(SDR)	Group II (Filtek 350)
0	15 (100.0%)	0
1	0	15 (100.0%)
2	0	0
Total	15 (100.0%)	15 (100.0%)
Chi-square value = 26.133, p-value = < 0.001* **Chi-square test* Significant difference**		

Table 3 :Distribution of micro-leakage among Group I and Group III

Chi-square test was applied. There was a significant difference between Group I and Group III .

Score	Group I(SDR)	Group III (TetricEvo cream)
0	15 (100.0%)	0
1	0	12 (80.0%)
2	0	3 (20.0%)
Total	15 (100.0%)	5 (100.0%)
Chi-square value = 30.000, p-value = < 0.001* **Chi-square test** *** Significant difference**		

Table 4 :Distribution of micro-leakage among Group II and Group III

Chi-square test was applied. There was no significant difference between Group II and Group III .

Score	Group II (Filtek 350)	Group III (TetricEvo cream)
0	0	0
1	15 (100.0%)	12 (80.0%)
2	0	3 (20.0%)
Total	15 (100.0%)	5 (100.0%)

Chi-square value = 1.481, p-value = 0.224[#]
Chi-square test
[#] Non-significant difference

Table 5 : Comparison of mean values among the groups

The highest mean value was found among Group III . (1.20±0.41) followed by Group II. (1.00±0.00) and Group I. (0.00±0.00).

	Number	Mean	Std. Deviation	Std. Error
Group I(SDR)	15	0.00	0.00	0.00
Group II (Filtek 350)	15	1.00	0.00	0.00
Group III (TetricEvo cream)	15	1.20	0.41	0.11

Table 6 :Analysis of Variance Summary Table Comparing Material to values

Analysis of Variance test between was applied between three groups.It showed that there was a significant difference between the groups.

	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	12.400	2	6.200	108.500	< 0.001*
Within Groups	2.400	42	0.057		
Total	14.800	44			

Table 7: The inter-group comparison of mean values between SDR, Filtek-Z 350 and TetricEvo cream was done using the post-hoc Bonferroni test.

The inter-group comparison of mean values between the three groups was done using the post-hoc Bonferroni test. The mean value was significantly more among Group II and Group III in comparison to Group I (P<0.05) . The mean value was more among Group II in comparison to Group III but there was no significant difference.(P=0.081)

Groups	Groups	Mean Difference	Std. Error	p-value
Group I(SDR)	**Group II(Filtek 350)**	-1.00	0.087	< 0.001*

Group I(SDR)	**Group III (TetricEvo cream)**	-1.20	0.087	< 0.001*
Group II(Filtek 350)	**Group III (TetricEvo cream)**	-0.20	0.087	0.081[#]
Post-hoc Bonferroni test *** Significant difference** [#] **Non-significant difference**				

DISCUSSION

In the present study, no material could completely eliminate microleakage at the dentine or cementummargin.There was a significant difference between the groups. The 0 score was significantly more among Group I whereas 1was significantly more among Group II and Group III .(Table 1)
There was a significant difference between Group I and Group II . Score 0 was present among SDR group only whereas score 1 was present among Filtek 350 only.(Table 2)There was a significant difference between Group I and Group III. Score 0 was present among Group II only. Whereas, among Group III group, score 1 was present among 12 (80.0%) and score 2 was present among 3 (20.0%).(Table 3)Highest microleakage was observed in Group III (1.20±0.41) followed by Group II (1.00±0.00) and Group I(0.00±0.00). (Table 5,6,7)

Microleakage evaluation is the most common method of assessing the sealing efficiency of a restorative material. The class V lesion presents special problems with any restorative material because the selected material is required to bond to enamel and dentin/cementum. Dentin is a less favorable substrate than enamel for resin bonding. It was difficult to obtain good adhesion to dentine or cementum.

Our results showed that Group I [SDR(Dentsply)] had the least microleakage in most of the samples tested for SDR. This is due to the excellent biocompatibility of the material and its tendency to adapt to the tooth structure, creating a bond that is highly exceptional in strength, adhesiveness and less shrinkage.

Our results are consistent with NashaatMagdy et al[7] who conducted a study that compared the Marginal Integrity of SDRand TetricEvo cream when used as a retrograde filling material and concluded that SDR as 4 mm bulk fill dentin replacement material showed good performance as a liner under nano hybrid composite resin restorations.[47]

Our results are consistent with MirosławOrłowski et al[8]who did a study to compare under in vitro conditions marginal sealing of 4 different bulk-fill materials composite restorations of class II.The highest rating (score 0, no dye penetration) was achieved by 93.33% of the restorations made of the SDR material, 90% of restorations of SonicFill system, 86.66% of restorations of the composite Filtek Bulk Fill, and 73.33% of restorations of the TetricEvoCeram Bulk Fill..

Our results are inconsistent with Mithra N Hegde et al [9] whoConducted an in vitro study to measure and compare the microleakage in three different newer direct composite resins using a self-etch adhesive bonding system in class V cavities by fluorescent dye penetration technique. All specimens were applied with one coat of G-Bond (GC Japan) and light cured and then equally divided into 3 Groups i.e Group 1 : Filtek Z350 (3M ESPE), Group 2 : Ceram X duo (Dentsply Asia) and Group 3 : Synergy D6 (Coltene/Whaledent) resin composites. Results concluded that no statistically significant differences were seen among the 3 Groups tested and none of the materials tested was able to completely eliminate the microleakage in class V cavities

CONCLUSION

In the present study, no material could completely eliminate microleakage at the dentine or cementummargin.We found that SDR *(*Dentsply)Nanoceramiccomposite material, proved itself to be a superior restorative material, less microleakage ability, whereas Filtek Z 350 (3M ESPE) Nanocompositematerial andTetricEvoCeram (Ivoclar) Nanohybridshowed poor sealing capability.

Newer materials in the market nowadays aspire for better adaptability, great strength, absence of microleakage and bulk fill material. Any material that imparts these qualities shall be a boon in the field of restorative dentistry.With the outcome of the present study, still further clinical trials and studies would prove to be beneficial and helpful in finding out the next best material which shall overcome all the drawbacks of the materials in the past

REFERENCES

1. KanikaVerma Gupta, PradhumanVerma, AshwaryaTrivedi. Evaluation of microleakage of various restorative materials: an in-vitro study. Journal of Life Sciences 2011; 3(1):29-33.

2. TeenaSingla, I.K.Pandit, Nikhil Srivastava, NeerajGugnani and Monica Gupta. An evaluation of microleakage of glass-ionomer based restorative materials in deciduous and permanent teeth: An in-vitro study. Saudi Dental Journal January 2012; 24(1):35-42.

3. Zainab A. Al-Dahan et al. A comparative study evaluating the microleakage of different types of restorative materials used in the restoration of pulpotomized primary molars. J Bagh College Dentistry 2012; 24(2):150-154.

4. S.C. Bayne, H.O. Heymann and E.J. Swift, Update on dental composites, Journal of dentistry of the American Dental association 1994;125(6):687-701.

5. N. Attar and M.D. Turgut. "Fluoride Release and Uptake Capacities of Fluoride Releasing Restorative Materials" Operative dentistry 2003;28(4): 395-402.

6. Toledano M, Osorio E, Osorio R, Garcia-Godoy F. Microleakage of Class V resin-modified glass ionomer and compomer restorations. J Prosthet Dent 1999;81(5):610–5

7. NashaatMagdy, HananHegazi and Nadia ZaghlolClinical Investigation of Nano-hybrid Resin Composite Lined with Smart Dentin Replacement Flowable Resin Composite Mansoura Journal of Dentistry 2014;1(3):96-100.

8.MirosławOrłowski, BożenaTarczydło, and RenataChałas. Evaluation of Marginal Integrity of Four Bulk-Fill Dental Composite Materials: In Vitro Study The Scientific World Journal Volume 2014.

9.Mithra N Hegde, PallaviVyapaka, ShishirShetty A comparative evaluation of microleakage of three different newer direct composite resins using a self-etching primer in class V cavities: An *in vitro* study. J Conser Dent 2009;12(4):160-163.