Evaluation of The Microleakage of Polyacid Modified Composite Compared to Hybrid Composite and Resin Modified Glass Ionomer Cement in Primary and Permanent Teeth Restoration *(An in vitro study)*

Ayat Fadhil AL-Shimmary, B.D.S. [(1)]
Abeer M. Hassan, B.D.S., M.Sc. [(2)]

ABSTRACT

Background: Dental caries is one of the most significant problems in world health care. Restoring carious primary teeth is one of the major treatment goals for Children, and the light activated resin restoration materials like composite, resin-modified glass ionomer and polyacid-modified which was introduced in dentistry in 1970, widely used in clinical dentistry but its application increased dramatically in recent years because of its biocompatibility, color matching, good adhesive properties of its resemblance in physical and mechanical aspects to tooth.
The aim of this study: To evaluate the microleakage of Polyacid-Modified Composite resin Compared to Flowable Hybrid Composite and Resin-Modified Glass ionomer cement.
Materials and methods: Thirty extracted primary molar teeth and thirty extracted permenant premolar teeth were used in this study 20 for each material, then standardized Class V cavities of teeth was prepared in the buccal and lingual surfaces. Using Polyacid-modified composite Resin (Compomer), flowable composite resin and Resin-modified glass Ionomer RMGI. The samples will be divided into three groups according to type of restorative material used and light cured with a light cure device (Ivoclar Vivadent Bluephace), after complete curing the sample will examined by Scanning electron microscope (SEM) and then measure the microleakage.
Results: The RMGI shows the statistically significantly lowest mean value of microleakage, followed by Compomer shows statistically significantly lower mean value. Flowable Composite shows the statistically significantly highest mean microleakage. There is no statistically significant difference in microleakage values between the permanent and primary teeth.
Conclusion: The Resin-modified glass Ionomer is better in term of microleakage than Polyacid-modified composite Resin and Flowable Composite.
Key words: microleakage, SEM, RMGI (Resin-modified glass Ionomer), Compomer (Polyacid-modified composite Resin (PMCR), resin materials. **(Received: 13/1/2019; Accepted: 17/3/2019)**

INTRODUCTION

The demand for esthetic restorations in dentistry has increased over the past few years. Since resin composites were first developed, many efforts have been made to improve the material properties and their clinical behavior from one side, and to satisfy patient's demands for esthetic restorations from the other side. Due to this considerable improvement, contemporary resin composites have been widely used and proven to be well suited for restoring cavities in anterior teeth and more frequently extended to large and deep cavities in posterior teeth though with variable success [(1)].

Restoring carious primary teeth is one of the major treatment goals for Children. Amalgam was the material of choice worldwide. A declining acceptance of amalgam in pediatric dentistry is due to small thickness of enamel wall in primary molars compared to permenant teeth and fear of potential mercury toxicity especially for children. Amalgam restoration have been reported to be less durable in primary molars than in permenant teeth [(2)].

1. Department of Pediatric dentistry, College of Dentistry, Kufa University.
2.Assistant Professor, Department of Pedodontics and Preventive Dentistry, College of Dentistry, University of Baghdad.

The light activated composite resin restoration which was introduced in dentistry in 1970, widely used in clinical dentistry but its application increased dramatically in recent years because of its biocompatibility, color matching, good adhesive properties of its resemblance in physical and mechanical aspects to tooth [(3)].

Although, the composite materials have some limitations and disadvantages that restrict their use as microleakage, sensitivity, recurrent carries, polymerization shrinkage, wear in stress bearing area which may decrease the success of these restorations [(4)].

Glass ionomer cement systems have become important dental restorative materials for use in children. It have several advantages like biocompatibility, its fluoride release and uptake from dentifrice mouthwash and topically applied solution regarded as reservoir and chemical bonding to tooth structure [(5)].

However, Glass ionomer cement has disadvantages like marginal defect, chipping, color changes, sensitive technique due to mixing requirement, low mechanical properties and its solubility in oral cavity fluids so need for moisture protection to prevent surface degradation [(6)].

A new generation of glass ionomer now available are resin reinforced glass ionomer (poly acid modified composite resin) called compomer which is a mixture of composite resin and glass ionomer. It reflect the combination of both component properties of the two materials. They possess advantages superior to Glass ionomer cement or composite like biocompatibility, dual cure polymerization chemical adhesion to dentin without etching it, Fluoride release continuously after placement, insolubility in oral fluorides, low coefficient of thermal expansion, less polymerize shrinkage and its condensable material (7).

The main two shortcomings of resin composites include the residual uncured monomer and the polymerization shrinkage which is the one of the most important cause of microleakage. Uncured monomer is a factor of incomplete depth of cure leading to lower rates of monomer conversion. Many factors can influence the degree of conversion of resin composites such as the filler particle size, filler loading, polymerization initiator concentration, monomer type and amount, silane coupling agent, the shade and translucency of the material, intensity, wavelength and distance of the incident light, irradiation times, design and size of the light guide and increment thickness (8).

This in vitro study is intended to compare between compomer, Glass Ionomer Cement and hybrid composite for restoring the primary and permanent teeth.

MATERIAL AND METHODS:

Materials:

Materials	Manufacture
Flowable Composite	3M (Z350) dental product St. paul Mn. USA
Resin modified glass Ionomer	Riva LC (SDI Australia)
Polyacid modified Resin composite	Dyract (Dentsply (rock) USA)
Single bond adhesive	3M dental product St. paul Mn. USA
Etchan (35% phosphoric acid)	(Dentsply)

Grouping of the specimens:

Thirty extracted primary molar teeth and thirty extracted permenant premolar teeth were used in this study, twenty for each material, then standardized Class V cavities of teeth was prepared in the buccal and lingual surfaces (3mm length, 3mm width and 2mm depth) (Hamid et,al. 2016), The teeth was divided into two groups according to type of restorative material used

(Group 1): 10 primary molar teeth and 10 permenant premolar teeth were restored wit composite resin restoration on both buccal and lingual surface Class V cavity.

(Group 2): 10 primary molar teeth and 10 permenant premolar teeth were restored with compomer on both buccal and lingual surface Class V cavity

(Group 3): 10 primary molar teeth and 10 permenant premolar teeth were restored with resin modified glass ionomer cement on both buccal and lingual surface Class V cavity Fig (1).

For micro-leakage test, the cavities will be filled with restorative material to prevent infiltration of the dye solution then the specimens will be entirely covered with 2 layers of nail varnish except for class V filling and one millimeter beyond the margins.

Teeth will be submitted to thermo-cycles in 500 cycles between water baths held at 5 and 55 C,one minute dwell time .All teeth will be immersed in 2% methylene blue solution for 24 hours at room temperature .Then each tooth will be sectioned longitudinally (buccoligually) at the center of restoration .The sections were evaluated under scanning electron microscope to verify the dye penetration.

Figer (1) the prepared permanent and decidious teeth with Cl V cavity

Specimens' preparation:

These extracted human teeth of children over 10 years and adult with 16-18 years age, free of visible or detectable caries in the buccal and lingual surface, cracks, and restorations, were used in this study. A standardized Class V cavity was prepared on the buccal and lingual surfaces of each tooth. The dimensions of the preparations measured 3 mm in width (mesio-distally), 3 mm in length (occluso-gingivally), and 2 mm in depth (Stalin, 2005) Fig (2 and 3).

Figure (2) Before cavity preparation

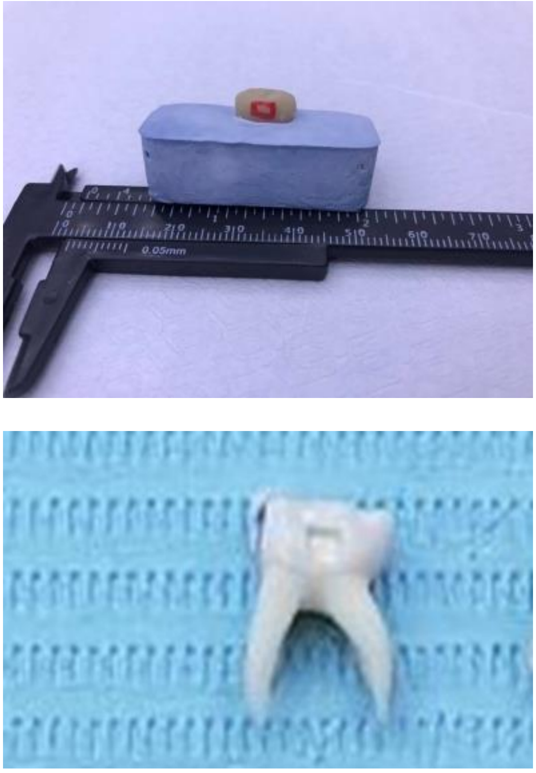

Figure 3: Cl V cavity preparation

Evaluation of the microleakage:

Subsequently for both the permanent and deciduous teeth were randomly assigned into three experimental groups (n = 10).. Then all the teeth were subjected to a thermocycling regimen of 500 cycles between 5°C and 55°C with a dwell time of 30 sec. and 3 sec transfer time between Fig (4).

Figure 4: Thermocycling

The teeth were dried after thermocycling. The specimens were coated with two layers of nail varnish of different color to simplify the grouping during measurement, leaving 1 mm window around the cavity margins. Root apices were sealed with sticky wax. Then the teeth were immersed in 2% Methylene Blue Dye for 24 h at 37°C and kept in an incubator (20).

After removal of the specimens from the dye solution, the surface was rinsed in water and nail varnish was removed with a BP blade. The teeth were sectioned longitudinally in a buccolingual direction through the center of the restorations using a water-cooled low speed diamond disc . The degree of dye penetration was assessed separately under a Scanning electron microscope at 500X magnification using the following scoring criteria given by (Fabio et al, 2015):

*Definitely absent: No leakage

*Probably absent: Leakage extending one-thirds to the deepest point of restoration

*Uncertain: Leakage extending two-thirds to the deepest point of restoration

*Probably present: Leakage extending to the deepest point of restoration

*Definitely present: Leakage extending beyond the deepest point of restoration

SEM Marginal Analysis

For more accurate measurement, after thermocycling and before placement of the samples in tubes of Ethylene blue to be assessed under a scaning electron microscope(SEM), the samples was fixed at sputter coating for coating the samples with gold for increasing the contrast and accurate measurement and then fixed on a holder for the SEM (ZA-WR 1006 Germany) analysis at 500X magnification to determine the percentage of continuous margin at the cervical dentinal and cervical enamel margin. A continuous margin was defined as having no gaps, irregularities, or fractures; examples of continuous margin and margin with gaps are shown in (Fig. 5).

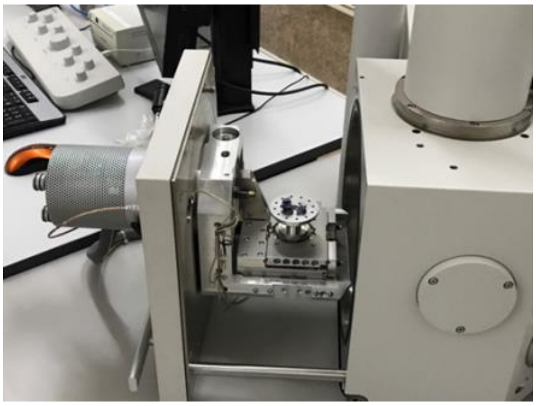

Figure 5: scaning electron microscope

RESULTS:

1. Microleakage

a. Deciduous teeth

Table (1) shows there is statistically significant difference between microleakage values of deciduous teeth in the three groups (*P*-value = 0.017, Effect size = 0.268).

Pair-wise comparisons between the groups revealed that Composite shows the statistically significantly highest mean microleakage with non-statistically significant difference from PMGR (Compomer) and a statistically significantly higher mean microleakage than GIC. GIC shows the lowest mean microleakage with non-statistically significant difference from Compomer and a statistically significantly lower mean microleakage than Composite.

Table 1: Descriptive statistics and results of one-way ANOVA test for comparison between microleakage values of deciduous teeth in the three groups

	Composite	**Compomer**	**GIC**	***P*-value**	***Effect size (Eta Squared)***
Mean (SD)	1.022 (0.251)	0.938 (0.303)	0.620 (0.234)	0.017*	0.268
95% CI	0.843 – 1.201	0.721 – 1.155	0.364 – 0.877		

**: Significant at $P \leq 0.05$, Different superscripts are statistically significantly different*

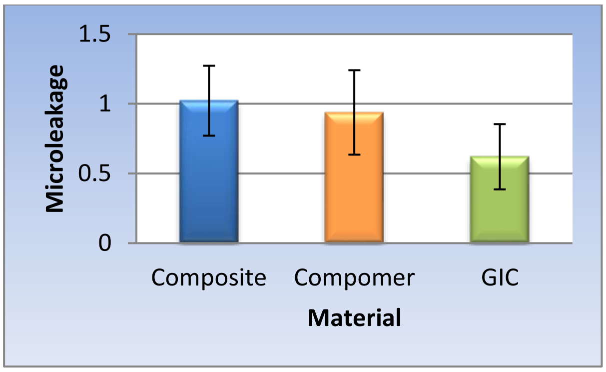

Figure 6: Bar chart representing mean and standard deviation values for microleakage of deciduous teeth in the three groups

b. Permanent teeth

Table (2) shows there is statistically significant difference between microleakage values of permanent teeth in the three groups (*P*-value = 0.011, Effect size = 0.314).

Pair-wise comparisons between the groups revealed that Composite shows the statistically significantly highest mean microleakage with non-statistically significant difference from PMCR (Compomer) and a statistically significantly higher mean microleakage than GIC. GIC shows the lowest mean microleakage with non-statistically significant difference from Compomer and a statistically significantly lower mean microleakage than Composite.

Table 2: Descriptive statistics and results of one-way ANOVA test for comparison between microleakage values of permanent teeth in the three groups

	Composite	**Compomer**	**GIC**	***P*-value**	***Effect size (Eta Squared)***
Mean (SD)	0.984 (0.38)	0.867 (0.064)	0.607 (0.188)	0.011*	0.314
95% CI	0.692 – 1.276	0.818 – 0.916	0.462 – 0.751		

**: Significant at P ≤ 0.05, Different superscripts are statistically significantly different*

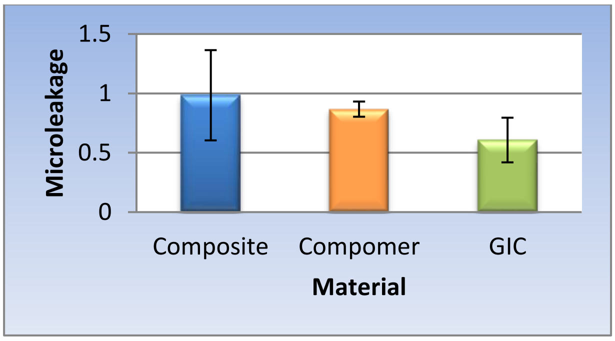

Figure 7: Bar chart representing mean and standard deviation values for microleakage of three groups in permanent teeth

c. Comparison between deciduous and permanent teeth in Composite group

Table (3) shows there is no statistically significant difference between microleakage values of deciduous and permanent teeth using Composite (*P*-value = 0.798, Effect size = 0.118).

Table (3): Descriptive statistics and results of Student's t-test for comparison between microleakage values of deciduous and permanent teeth in composite group

	Permanent	**Deciduous**	***P*-value**	***Effect size (Cohen's d)***
Mean (SD)	0.984 (0.38)	1.022 (0.251)	0.798	0.118
95% CI	0.692 – 1.276	0.843 – 1.201		

**: Significant at P ≤ 0.05*

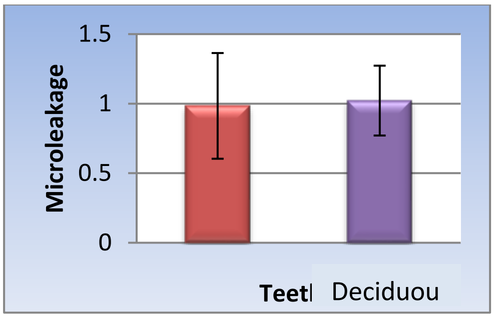

Figure 8: Bar chart representing mean and standard deviation values for microleakage of deciduous and permanent teeth in composite group

d. Comparison between deciduous and permanent teeth in Compomer group

Table (4) shows there is no statistically significant difference between microleakage values of deciduous and permanent teeth using Compomer (*P*-value = 0.500, Effect size = 0.324).

Table 4: Descriptive statistics and results of Student's t-test for comparison between microleakage values of deciduous and permanent teeth in Compomer group

	Permanent	Deciduous	*P*-value	*Effect size (Cohen's d)*
Mean (SD)	0.867 (0.064)	0.938 (0.303)	0.500	0.324
95% CI	0.818 – 0.916	0.721 – 1.155		

*: *Significant at P ≤ 0.05*

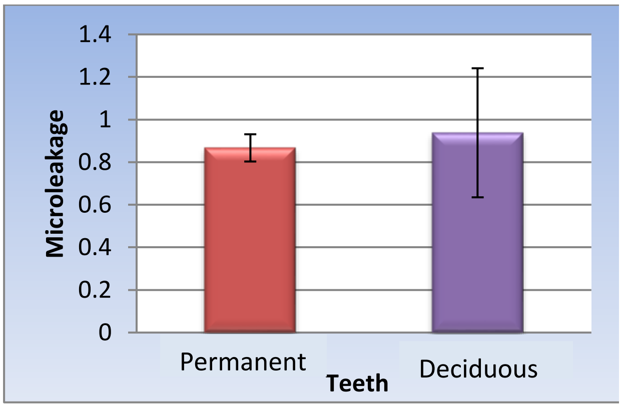

Figure 9: Bar chart representing mean and standard deviation values for microleakage of deciduous and permanent teeth in Compomer group

e. Comparison between deciduous and permanent teeth in GIC group

Table (5) shows there is no statistically significant difference between microleakage values of deciduous and permanent teeth using GIC (*P*-value = 0.915, Effect size = 0.061).

Table 5: Descriptive statistics and results of Student's t-test for comparison between microleakage values of deciduous and permanent teeth in GIC group

	Permanent	**Deciduous**	***P*-value**	***Effect size (Cohen's d)***
Mean (SD)	0.607 (0.188)	0.620 (0.234)	0.915	0.061
95% CI	0.462 – 0.751	0.364 – 0.877		

*: *Significant at P ≤ 0.05*

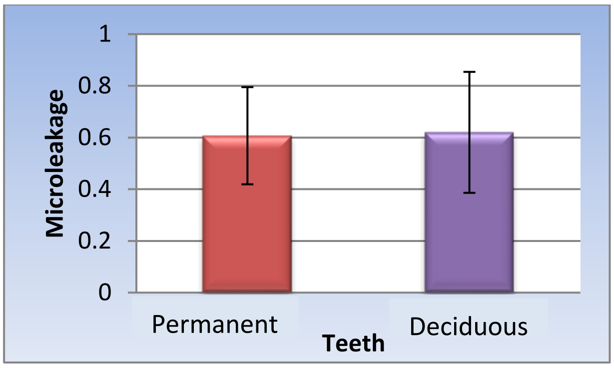

Figure 10: Bar chart representing mean and standard deviation values for microleakage of deciduous and permanent teeth in GIC group

DISCUSSION

Restoration of primary teeth differs from restoration of permanent teeth, due in part to the differences in tooth morphology. The mesiodistal diameter of a primary molar crown is greater than the cervicoocclusal dimension. The buccal and lingual surfaces converge toward the occlusal. The enamel and dentin are thinner. The cervical enamel rods slope occlusally, ending abruptly at the cervix rather than being oriented gingivally and gradually becoming thinner as in permanent teeth [9].

The adhesive materials that used in this study were composite resin restorative materials, compomers and resin-modified glass ionomers. Composite resin materials demonstrate the best strength, wear resistance, esthetics and color-matching, compomers(PMCR) have many of the same characteristics as composite resins, with similar esthetics, PMCR may have some fluoride release and be a little more moisture tolerant than composite resins, but they are essentially handled the same way as resins and resin-modified glass ionomers act more like glass ionomers than composite resins.[10], RMGI release fluoride, conditioning without etching, and are less moisture sensitive. Esthetics can be good, but not as good as compomers or composite resins [11].

Despite the advancement in the chemistry of resin-containing restorative material, microleakage is still the main concern. Modern methacrylate-based resin material still have microleakage, and one of the main cause of microleakage is polymerization shrinkage which its values ranging from about 1.78% to 5.7%. So, the microleakage will increased when the percentage of the polymerization shrinkage increased [12].

in current study the measurement of microleakage of the three restorative resin materials which are the flowable Composite, resin modified glass ionomer and Polyacid modified composite resin (compomer) in class V cavity preparation for both the primary and permanent. In this investigation, the microleakage results of the three groups, resin modified glass ionomer (RMGI) show lowest microleakage compared to polyacid modified resin composite (PMRC) and resin flowble composite in these properties (P-value <0.001), followed by the result of Polyacid Modified composite resin showed a lower microleakage compared to Hybrid Composite (P-value <0.001).

Polymerization shrinkage of resin-containing restorative materials may result in marginal discrepancies that lead to microleakage, marginal discoloration, and sensitivity. Hygroscopic expansion can compensate, to some degree, for polymerization shrinkage. Water sorption can help to reduce marginal gaps; for this reason, glass ionomer, which absorb the most water during the first 24 hours after placement, can display less microleakage than other resins [13]. So, this study reported why SDI glass ionomer (RMGI) expanded after curing and immersion in water, whereas Dyract (PMRC) resin composite and 3M (RBC) revealed a total volumetric loss. Thus, the researchers concluded that water expansion is an important factor that reduces the leakage. Also, The differences in bond strength values of the three materials could contribute, among other factors, to explain the differences in the microleakage patterns recorded in our study [14].

The present study agreed with (Manuel et,al. 2005); which revealed statistically significant differences between resin modified glass ionomer and polyacid modified resin composite, both for the occlusal (P=.005) and gingival (P=.005) margins and also as an overall evaluation (P=.01) (combining the occlusal and gingival margins scores) with resin modified glass ionomer demonstrating the least dye penetration between these two products

In addition, Al Nowaiser et,al. (2017) agreed with current study, concluded that flowble composite restorations (Degufill H) exhibited greater gingival microleakage than compomer (Dyract) restorations, after one week, although no statistically significant difference was found between the two materials. This difference in the results obtained may be related to the amount of resin content and filler particles of the materials. In addition, the difference could be contributed to the placement procedures, material manipulation or surface treatment.

The present results disagree with those of (Yap et,al. 1995) who compared the microleakage of Dyract resin composite and glass ionomer and reported no statistically significant differences in microleakage scores. In their study, they reported a significant difference between enamel and dentin; in our study, even if microleakage was less common in enamel, the difference was significantly different. These differences between the studies could be because the researcher stored their specimens in a saline solution for 1 week before testing. This storage time allows hygroscopic expansion of the material (Attin et,al. 1995), which may compensate the original polymerization shrinkage of the material, which allows less microleakage. In current study, specimens were thermally cycled for approximately 3 days, and the material may not have expanded completely. (Yap et,al. 1995)

CONCLUSION

The RMGI is better in term of microleakage than Compomer and Flowable Composite due to a correlation between the microleakage and filler mass fraction.

REFERENCES

1- Opdam NJ., Bronkhorst EM., Loomans BA. and Huysmans MC. (2010). 12- year survival of composite vs. amalgam restorations. J Dental Research; 89:1063–1067.
2- Jennifer Ann Soncini and Catherine Hayes. (2007). The longevity of amalgam versus compomer / composite restoration in posterior primary and permenant teeth : findings from the new England childrens Amalgam Trial . J. American Dental Association; 138: 763-772.
3- Mithra N. H., Priyadarshini H. and Babita M. (2010). Evaluation of depth of cure and knoop hardness in dental composite, photo-activated using different methods. Conserv Dent; 11: 76-81.
4- John Burgess and Deniz Cakir. (2010). Comparitive properties of low-shrinkage composite Resin. J compendium; 31: 10-15.
5- David John Manton and Katie Bach. (2016). The Role of Glass-ionomers in Pediatric Dentistry. J Springer.2016; 24 :113-123.
6- Michael T. Stallings, Daniel C. Stoeckel, Kenneth G. Rawson and Dan B. Welch. (2017).Significant Shear bond strength improvement of resin-modified glass ionomer cement with a resin coating . . J General Dentestry; 36: 75-78.
7- Shirayogi M. Hugar, Diryata Kohli and Mandhura V Mundada. (2017). Compative Assessment of conventional composite and coloured compomers in Permanent Molars of children with mixed Dentition: A Pilot study. J clin Diagn Res; (11): 69-72.
8- Polydorou O., Manolakis A., Hellwig E. and Hahn P. (2008). Evaluation of the curing depth of two translucent composite materials using a halogen and two LED curing units. J Clin Oral Investing; 12: 45-51.
9- Waggoner WF.(2005). Restorative dentistry for the primary dentition. J. Pediatric Dentistry; 24: 341-374.
10- Croll TP, Bar-Zion Y, Segura A and Donly KJ. (2001). Clinical
performance of resin-modified glass ionomer cement restorations in primary teeth. JADA.; 132: 1110-1116.
11- Alrahlah A., Silikas N. and Watts D.C. (2014). Post-cure depth of cure of bulk fill dental resin-composites. J Dent Mater; 30: 149–154.
12- Pital M. L. (2013). Low-Shrink Composite Resins: A Review of Their History, Strategies for Managing Shrinkage, and Clinical Significance. J Compendium of Continuing Education in Dentistry; 34: 578-588.
13- Feilzer AJ, de Gee AJ and Davidson CL. (1990). Relaxation of polymerization contraction shear stress by hygroscopic expansion. J Dent Res; 69: 36-39.
14- Davidson CL. (1986). Resisting the curing contraction with adhesive composites. J Prosthet Dent;55: 446-7.
15- Manuel Toledano, Estrella Osorio, Raquel Osorio and Franklin García-Godoy. (2005). Microleakage of Class V resin-modified glass ionomer and compomer restorations. J Prosthet Dent ;81:610-615.
16- Al Nowaiser. (2017). AComparison between Polyacid-Modified Composite Resin and Conventional Composite Resin used for Primary Molars Restoration. J of Dentistry and Oral Care Medicine; 3 : 1-9.
17- Yap AU, Lim CC and Neo JC. (1995). Marginal sealing ability of three cervical restorative systems. J Quintessence Int; 26: 817-20.
18- Attin T, Buchalla W, Kielbassa AM and Helwig E. (1995). Curing shrinkage and volumetric changes of resin-modified glass ionomer restorative materials. J Dent Mater ;11:359-362.
19- Hamid Reza Mozaffari, Alireza Ehteshami, Farshad Zallaghi, Nasim Chiniforush, and Zohreh Moradicorresponding. (2016). Microleakage in Class V Composite Restorations after Desensitizing Surface Treatment with Er:YAG and CO2 Lasers. J Laser Therapy; 25(4): 259–266.
20- Teena Singlaa, I.K. Panditb, Nikhil Srivastavac, Neeraj Gugnanib, MonikaGupta. (2012). An evaluation of microleakage of various glass ionomer based restorative materials in deciduous and permanent teeth .J. The Saudi Dental Journal; 24: 35-42.
21- Stalin, Varma and Jayanthi. (2005). Comparative evaluation of tensile-bond strength, fracture mode and microleakage of fifth, and sixth generation adhesive systems in primary dentition. J Indian Soc Pedod Pre; 23(2): 83-88.