EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 68, 1297:1306, April, 2022

Print ISSN 0070-9484 • Online ISSN 2090-2360

Orthodontics, Pediatric and Preventive Dentistry

Submit Date : 05-03-2022 • Accept Date : 17-03-2022 • Available online: 30-03-2022 • DOI : 10.21608/edj.2022.125296.2007

EVALUATION OF FLUORIDE UPTAKE BY DENTINE FOLLOWING PRETREATMENT WITH SILVER DIAMINE FLUORIDE AND POTASSIUM IODIDE UNDER RESIN MODIFIED GLASS IONOMER RESTORATION VERSUS RESIN MODIFIED GLASS IONOMER RESTORATION ALONE IN CARIOUS PRIMARY MOLARS: (IN VITRO STUDY)

Yasmeen Mohsen* , Rania Nasr** *and* Nada Wassef**

ABSTRACT

Purpose: This study aimed to determine whether pretreating primary molars with silver diamine fluoride and potassium iodide (SDF + KI) under resin modified glass ionomer restoration (RMGI) affect the fluoride uptake into dentine or not.

Methods: Twenty carious extracted primary molars were sectioned mesio-distally forming two similar halves into forty sections. Each tooth was placed in a separate container with its 2 halves. Teeth were then randomly allocated either to the control or intervention group. In each tooth, the caries was excavated in each half. The control group received resin modified glass ionomer. The intervention group received silver diamine fluoride and potassium iodide followed by resin modified glass ionomer. After 2 weeks, fluoride percentage by weight in dentine was measured in both groups using energy dispersive x-ray analysis (EDX).

Results: In the RMGI control group, there was a significant increase in the amount of fluoride weight percentage from (0.81±0.47) to (3.49±1.88) after restoration placement ($p<0.001$). In the SDF + KI intervention group, there was a significant increase in the amount of fluoride weight percentage from (0.47±0.44) to (4.14±1.45) after restoration placement ($p<0.001$). There was no significant difference between the mean amount of fluoride weight percentage measured in the control group (3.49±1.88) and the intervention group (4.14±1.45) with ($p=0.398$).

Conclusion: The application of silver diamine fluoride and potassium iodide under resin modified glass ionomer restoration does not interfere with the fluoride uptake from glass ionomer into dentine.

KEYWORDS: Silver diamine fluoride, Potassium iodide, Resin modified glass ionomer, Energy dispersive x-ray analysis, Fluoride uptake.

* B.D.S, Faculty of Dentistry, Cairo University, Egypt.
** Associate Professor of Pediatric Dentistry and Dental Public health, Faculty of Dentistry, Cairo University, Egypt.

INTRODUCTION

Dental caries is one of the most common oral diseases of childhood and is considered as a major public health problem especially in areas with poor access to dental care. In Egypt, ***Abbass et al., (2019)*** conducted a study where a total number of 369 Egyptian children and adolescents were examined to assess the prevalence of dental caries, it was found that 74% of the children had dental caries. So, in order to avoid serious complications of untreated dental caries such as pain, infections, emergency visits and possibly hospitalization ***Çolak et al., (2013),*** an effective low cost treatment should be established particularly in areas with poor dental access.

Silver diamine fluoride (SDF) is considered one of the most important topical fluorides to prevent and treat dental caries in many countries. It combines both the re-mineralizing action of fluoride and the antibacterial effect of silver. It is considered inexpensive, safe, efficient and easily applied. ***Horst, Ellenikiotis, & Milgrom, (2016).***

In a recent systematic review conducted by ***Jabin et al., (2020)***, it was found that the use of 38% concentration of SDF is effective in arresting caries in primary teeth. Also, another systematic review conducted by ***Chibinski et al., (2017),*** stated that SDF was 66% more effective than ART restorations or fluoride varnish in arresting caries, and that SDF was 154% more effective than no treatment in arresting caries in primary teeth.

Furthermore, in a systematic review conducted by ***Crystal & Niederman, (2019),*** to study the efficacy of SDF in preventing caries in primary teeth, it was found that when comparing SDF to placebo for 24 months of follow-up or more, SDF resulted in a significant decrease in the development of dentin carious lesions by 77.5%. It was also concluded that SDF was significantly better than fluoride varnish at a period of 18 and 30 months follow-up. ***Oliveira et al., (2019)***.

However, SDF main disadvantage was that it caused black discolouration of teeth when applied which is a major esthetic problem (Chu, Lo, & Lin, 2002). A solution to this problem was suggested in 2005, by applying potassium iodide (KI) immediately after application of SDF to reduce the discolouration. ***Knight et al., (2005)***.

Another treatment option to reduce the discoloration caused by SDF, is to place glass ionomer restorations directly over SDF to mask its discoloration effect and at the same time act as a restoration over SDF ***Horst et al., (2016).*** Many studies have proven that resin modified glass ionomer restorations (RMGI) have the ability to release fluoride into plaque, saliva and dental tissues and can also act as a fluoride reservoir. ***Cabral et al., (2015) and Nagi et al., (2018).***

Furthermore, various studies have shown that the application of SDF + KI under glass ionomer (GI) restorations did not affect the GI bond strength to dentine. ***Gupta et al., (2019), Zhao et al., (2019) and Uchil et al., (2020).***

Moreover, ***Knight et al., (2006)*** concluded that fluoride uptake into dentine from conventional GI restorations was not affected in the presence of SDF and KI. It was also mentioned that the results may be different if conditioning is applied not etching and recommended this for future investigation.

Therefore, the aim of this study is to determine whether carious primary molars treated with SDF and KI prior to placing resin modified glass ionomer (RMGI) restorations will affect the fluoride uptake into primary dentine or not.

MATERIALS AND METHODS:

The study proposal was reviewed and approved by the Research Ethics Committees (REC) of the Faculty of Dentistry, Cairo University, Egypt on 28/7/2020. With approval number 19.7.39.

Sample Size Calculation:

According to ***Isaac & Michael (1995)***, the sample size in a pilot study can be between 10 and 30. The sample size selected in this study was 20 teeth, 10 teeth in each group.

Sample Collection:

Freshly extracted discarded primary molars ***Nasr & Saber, (2020)*** were collected from outpatient clinic of Pediatric Dentistry Department, Faculty of Dentistry, Cairo University at the end of every day.

Inclusion Criteria:

- Carious primary extracted molars.
- Presence of occlusal or proximal caries.
- Caries extending to dentine.

Exclusion Criteria:

- Presence of restorations.
- Presence of pit and fissure sealant.
- Hypo-plastic teeth.
- Severely destructed teeth.

Thirty two teeth were collected, but only 20 teeth were eligible according to the inclusion and exclusion criteria. Teeth were then stored in distilled water in separate containers, and numbered from 1 to 20. The teeth were then randomly allocated to 2 groups (control & intervention groups) using Random.org and then the generated random sequences for the containers were kept with the third author.

Samples Preparation:

Teeth were mounted on acrylic blocks to be ready for sectioning, then they were sectioned through the center of the carious lesion mesio-distally using a slow-speed cutting saw with coolant (Isomet 4000, USA) forming two similar halves ***Nasr & Saber, (2020)***, so that the 20 molars were sectioned to 40 halves. Each tooth was then placed in a separate container with its 2 halves. The containers were then randomly allocated either to the control or intervention group. **Figure (1).**

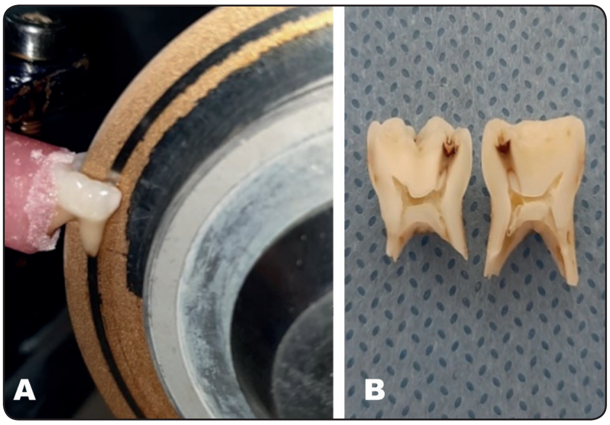

Fig. (1): (a) Tooth during sectioning. (b) Tooth after sectioning into 2 halves.

Control Group:

- Ten teeth were assigned to the control group (each tooth was sectioned into 2 halves). **Figure (2).**
- In one half the caries was removed using a sharp excavator (Maillefer, Dentsply, Switzerland), then conditioned with polyacrylic acid (Ketac, 3M ESPE, Germany) using a micro-brush for 10 seconds then washed with water and then dried with oil-free compressed air.
- In the other half, the same steps were repeated and then restored with resin modified glass ionomer (RIVA LC, SDI, Australia).
- The restoration was then light cured for 20 seconds, then finished using composite finishing burs kit (Kerr, United States) and then polished using composite polishing kit (Kerr, United States) and painted with copal Varnish (JK, Egypt).

Intervention Group:

- Ten teeth were assigned to the intervention group (each tooth was sectioned into 2 halves). **Figure (2).**
- In one half the caries was removed using a sharp excavator (Maillefer, Dentsply, Switzerland),

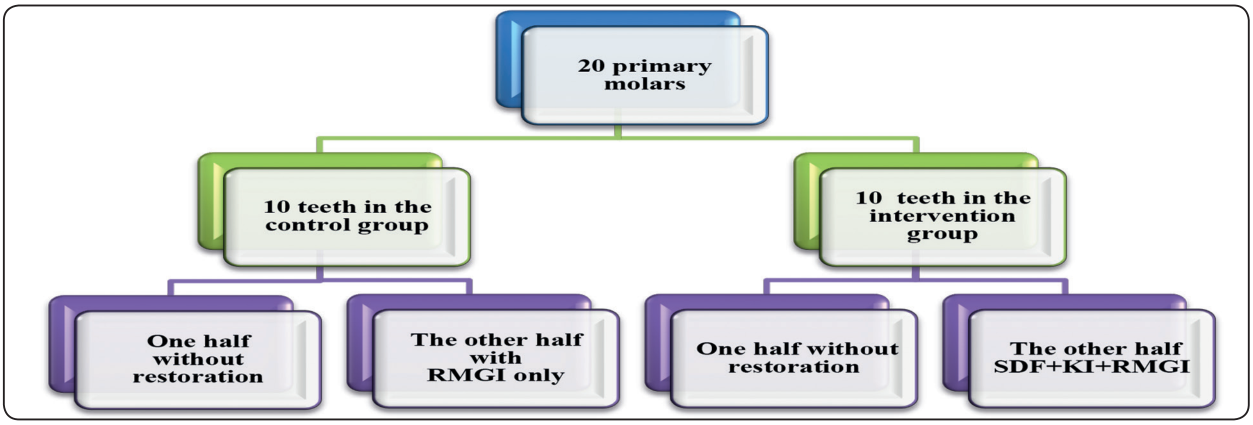

Fig. (2): A diagram showing the control and intervention groups.

then conditioned with polyacrylic acid (Ketac, 3M ESPE, Germany) using a micro-brush for 10 seconds, washed with water and then dried with oil-free compressed air.

- In the other half, the same steps were repeated and then a layer of 38% SDF solution was topically applied to the cavity using a micro-brush, immediately followed by a saturated KI solution using a micro-brush also, then a creamy white precipitate was immediately formed, KI was applied until the white precipitate turned clear. The reaction products were washed off with copious water, then the cavity was dried with oil-free compressed air and filled with resin modified glass ionomer (RIVA LC, SDI, Australia).
- The restoration was then light cured for 20 seconds and then finished using composite finishing burs kit (Kerr, California, United States) and then polished using composite polishing kit (Kerr, California, United States) and painted with copal Varnish (JK, Egypt).

Samples Preparation for SEM/EDX Analysis:

- After restoration placement in both groups, each tooth was stored in distilled water in separate containers at 37 C for 2 weeks ***Knight et al., (2006)***. The specimens were then dried for 4 hours in an oven (SHEL LAB, Cornelius, United States of America) ***Scholz et al., (2019)***.
- After dehydration, teeth were mounted on stubs using double-sided carbon tape, and sputter coated with gold for 20 s using a Turbomolecular pumped coater (QUORUM 150T ES, Laughton, United Kingdom). ***Power et al., (2014).***
- The fluoride uptake of the samples was examined using energy dispersive X-ray spectrometry (EDX) under scanning electron microscopy (SEM) (TESCAN VEGA3, Brno, Czech). An elemental assessment was performed by measuring five areas 5×5 µm2 along dentin thickness. Three scans were made at each location and the three readings averaged. The mean weight percentage of fluoride uptake was calculated. ***Mei et al. (2015).***
- The results of a sample are shown in **Figure (3).**

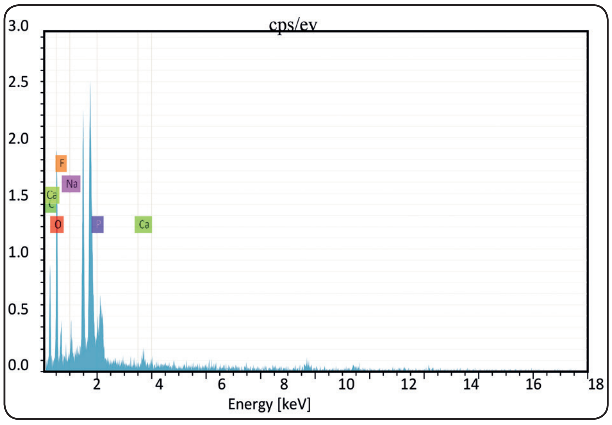

Fig. (3): A photograph showing EDX results for a sample.

RESULTS

Statistical Analysis

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. Independent and paired t-tests were used for inter and intragroup comparisons respectively. The significance level was set at p ≤0.05 within all tests. Statistical analysis was performed with R statistical analysis software version 4.0.3 for windows ***R Core Team, (2020)***.

1. Descriptive Statistics

Descriptive Statistics for fluoride weight (%) before and after restoration placement are presented in **Figure (4).**

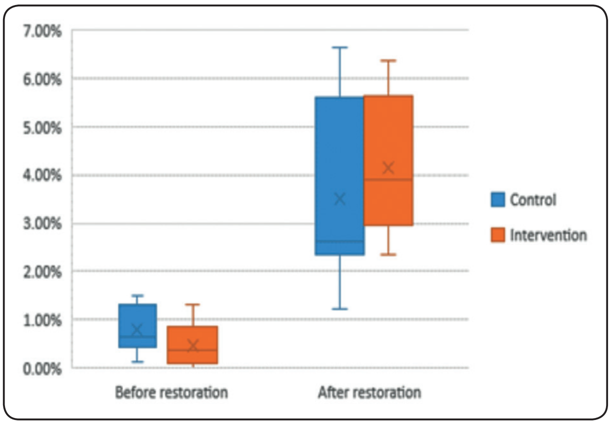

Fig. (4): Box plot chart showing fluoride wt. (%) for both groups.

2. Intergroup Comparison

The mean amounts of fluoride wt. (%) between both groups are presented in **Figure (5).**

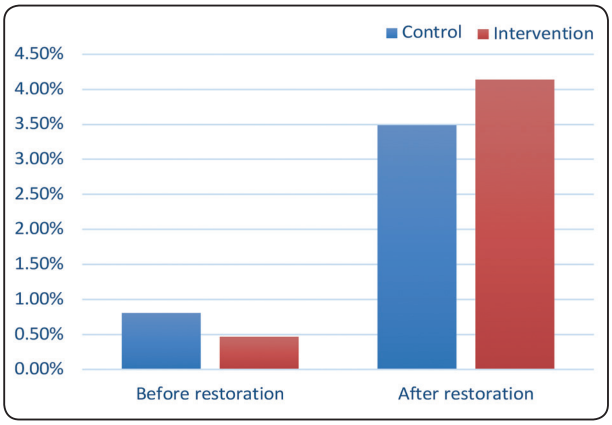

Fig. (5): Bar chart showing mean fluoride wt. (%) for both groups.

Before Restoration

There was no significant difference between the mean amount of fluoride weight measured in the control group (0.81±0.47) and the intervention group (0.47±0.44) (p=0.110).

After Restoration

There was no significant difference between the mean amount of fluoride weight measured in the control group (3.49±1.88) and the intervention group (4.14±1.45) (p=0.398).

3. Intragroup Comparison

The mean amounts of fluoride wt. (%) before and after restoration are presented in **Figure (6),** showing a significant increase in the amount of fluoride weight percentage after restoration placement in both the intervention and control groups.

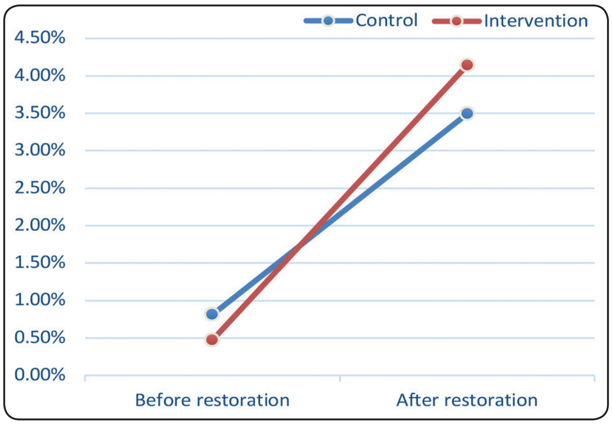

Fig. (6): Line chart showing mean fluoride wt. (%) for both groups.

4. Differences in Intergroup Comparison

The mean amount of fluoride wt. (%) difference after restoration placement are presented in **Figure (7),** showing no significant difference between the mean amount of fluoride weight difference measured in both the control group and the intervention group.

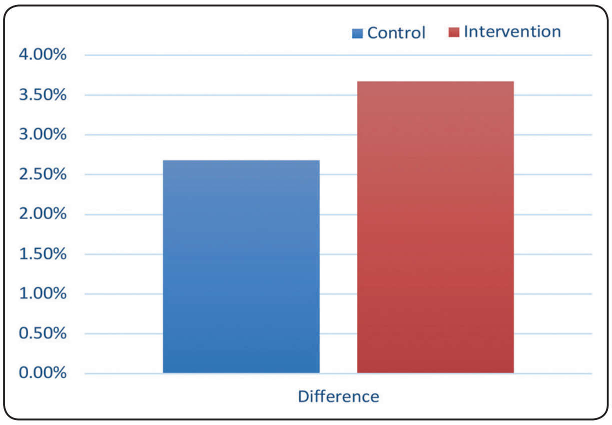

Fig. (7): Bar chart showing mean fluoride wt. (%) difference for both groups.

DISCUSSION

The addition of fluoride to restorative materials has attracted the attention of dental researchers and clinicians in the last two decades, as these restorative materials can provide a source of low fluoride release to the teeth, within long intervals. ***Garcez et al., (2007)***. These so-called "intelligent" dental materials have been introduced aiming to reduce secondary caries and neutralize the pH decrease, especially in patients with high-caries risk. ***Garcez et al., (2007)***.

These characteristics were initially found in conventional glass ionomer cements. However, glass ionomer materials showed some disadvantages, such as the short working time, long setting time, susceptibility to early moisture and salivary contamination and loss of brightness ***Garcez et al., (2007)***. Thus, in order to overcome these disadvantages, two types of hybrid materials, glass ionomers and composite resins have been combined together to achieve the advantages of conventional glass ionomers and the superior esthetic properties of the composite resins into one material with better mechanical and biological properties which is resin modified glass ionomer restoration used in the present study. ***Berzins et al., (2010)***.

In the present study, resin modified glass ionomer (RMGI) restoration was selected as the restorative material as it has the following advantages over the conventional glass ionomer: higher strength, better bond strength, lower solubility and less sensitivity to moisture. ***Arora et al., (2010)***.

Furthermore, silver diamine fluoride (SDF) plays a significant role in managing caries especially in children with high caries risk, medically compromised, those with behavioral challenges and those who have difficulty in accessing dental care ***Chibinski et al., (2017)***. SDF also has the ability to form a good biological seal at the restorative interface thus enhancing the prognosis of teeth treated with atraumatic restorative technique (ART). ***Chu et al., (2002).***

Studies have also shown that in silver modified atraumatic restorative technique, which aims to limit the progression of caries, SDF is applied after selective caries removal and then immediately followed by glass ionomer restoration to ensure complete seal. ***Quock et al., (2012) & Fa et al., (2016)***.

However, one of the limitations of SDF is that it can cause black discoloration of teeth after its application which may not be acceptable to many patients ***Zhao et al., (2017)***, thus the solution to this problem was to apply KI immediately after SDF application ***Knight et al., (2005)***. The commercial product of SDF + KI used in the current study was Riva star from SDI Limited as it is the only commercial product of SDF + KI available in the market.

Soft caries was removed and 10% polyacrylic acid conditioner (Ketac, 3M ESPE) was applied as the traditional protocol before RMGI restorations as it removes the smear layer and leaves only the smear plugs, partially demineralizes the dentine and enhances the chemical interaction between the hydroxyapatite crystals and RMGI components. ***Hamama et al., (2014)***.

After SDF application, KI was immediately applied and the white precipitate formed was immediately washed off and the cavity dried before dentine bonding. This protocol was made as ***Knight & McIntyre, (2006)*** found that leaving the white precipitate adversely affects the bond strength of GI to dentine and recommended immediately washing it before bonding to dentine.

The teeth were then kept in distilled water for 2 weeks to ensure that a sufficient uptake of fluoride ions had occurred in the dentine of the specimens ***Knight et al., (2006)*** and it was also found that fluoride release from GI restorations initially increases rapidly in the first 24-72 hours and then gets stable to a nearly constant level within 10-20 days. ***Dionysopoulos et al., (2003)***.

Teeth were then dried and mounted on stubs to be ready for gold sputtering. Gold sputtering should be made before Scanning Electron Microscope (SEM) to improve the conductivity of the sample surface to the electron beam thus enabling high resolution image due to higher sample stability under the electron beam, otherwise the image will be distorted. ***Power et al., (2014)***.

EDX was the method selected to measure fluoride weight percentage in the current study as it has the ability to provide elemental analysis to mineralized tissues and at the same time not causing sample deterioration. ***Gandolfi et al., (2017)***.

In the present study, the fluoride weight percentage (wt. %) was measured in both groups (control and intervention group) before and after the restoration placement, so that each tooth acts as a self-control. In the present study there was no significant difference between the mean amount of fluoride wt. % measured in both groups ($p=0.110$) before restoration placement, as it is known that before restoration placement, the teeth have very low amounts of fluoride.

Regarding the comparison between the mean amount of fluoride wt. (%) before and after the restoration placement in the same group, it was found that there was a significant increase in the fluoride wt. % after restoration placement in the control group (RMGI group) ($p<0.001$), this result is in accordance with various studies by ***Delbem et al., (2005), Dionysopoulos et al., (2013), Cabral et al., (2015) and Nagi et al., (2018).*** These studies all agreed that when using RMGI and comparing it to different restorative materials, the fluoride weight percentage significantly increases in dentine after using RMGI.

Since the inorganic filler composition affects the fluoride release, fluoroaluminosilicate glass which is the major component filler of glass ionomers is more soluble than the barium and strontium present in most compomers and composites, so, it is able to release more fluoride. ***Mousavinasab & Meyers, (2009).*** It has also been proved that reducing the inorganic filler size in RMGI can increase the fluoride release because smaller particles have larger surface areas. ***Mungara et al., (2013)***.

It was also found that material's porosity affect the fluoride release, the higher porosity allows deeper diffusion of the recharge agent into the sample and leads to more fluoride storage and release. ***Xu & Burgess, (2003)***. ***Xu & Burgess, (2003)*** also found that resin-modified glass ionomers have less resin content and higher porosity thus they have higher fluoride recharge capabilities than compomers or composites. The above factors all give an explanation for the significant increase in the fluoride concentration after RMGI restoration placement.

Furthermore, the present study found that there was also a significant increase in the fluoride wt. % after restoration placement in the intervention group (SDF + KI followed by RMGI) ($p<0.001$), this result is in agreement with the results of ***Knight et al., (2006), Mei et al., (2013) and Patel et al., (2019)***. This is due to the chemical composition of silver diamine fluoride which contains silver difluoride which resulted in the high fluoride concentrations measured. ***Knight et al., (2005).*** Also, Riva star used contains 38% SDF, and SDF at a concentration of 38% contains 44,800 ppm fluoride ion that at pH 10 is 25% silver, 8% ammonia, 5% fluoride, and 62% water. ***Mendi & Eden, (2021).*** So, this composition of Riva star may have contributed to the increase in fluoride uptake.

However, after restoration placement there was no significant difference between the mean amount of fluoride wt. % measured in both groups (p=0.398). This result is in contrast to ***Knight et al., (2006)*** who found that after SDF application under GI, there was a significant increase in the fluoride wt. %. This controversy may be due to the small sample size. Also, in the present study the two interventions were placed in two different teeth, which is different from the methods conducted in the study by ***Knight et al., (2006)***, were both interventions were placed in the same tooth. So, further studies in which placing the two interventions in the same tooth are needed as it may affect the results.

CONCLUSIONS

- Resin modified glass ionomer restoration significantly increased the fluoride concentration within dentine.
- The application of silver diamine fluoride and potassium iodide under resin modified glass ionomer restoration did not interfere with the fluoride uptake from glass ionomer into dentine.

LIMITATIONS

- Sound primary molars where artificial caries is induced are needed for more standardized results.
- Placement of the two interventions in the same tooth is needed for more standardized results.
- The sample size used in the study was small as it is a pilot study.

REFERENCES

- Abbass, M., Mahmoud, S., El Moshy, S., Rady, D., AbuBakr, N., Radwan, I., Ahmed, A., Abdou, A., & Al Jawaldeh, A. (2019). The prevalence of dental caries among egyptian children and adolescences and its association with age, socioeconomic status, dietary habits and other risk factors. A cross-sectional study. F1000Research, 8(8). https://doi.org/10.12688/f1000research.17047.1
- Arora, V., Kundabala, M., Parolia, A., Thomas, M., & Pai, V. (2010). Comparison of the shear bond strength of RMGIC to a resin composite using different adhesive systems: An in vitro study. J Conserv Dent., 13, 80–83. https://doi.org/10.4103/0972-0707.66716
- Berzins, D., Abey, S., Costache, M., Wilkie, C., & Roberts, H. (2010). Resin-modified glass-ionomer setting reaction competition. J Dent Res., 89(1), 82–86. https://doi.org/10.1177/0022034509355919
- Cabral, M. F. C., Martinho, R. L. de M., Guedes-Neto, M. V., Rebelo, M. A. B., Pontes, D. G., & Cohen-Carneiro, F. (2015). Do conventional glass ionomer cements release more fluoride than resin-modified glass ionomer cements? Restor Dent Endod., 40(3), 209–215. https://doi.org/10.5395/rde.2015.40.3.209
- Chibinski, A., Wambier, L., Feltrin, J., Loguercio, A., Wambier, D., & Reis, A. (2017). Silver Diamine Fluoride Has Efficacy in Controlling Caries Progression in Primary Teeth: A Systematic Review and Meta-Analysis. Caries Res., 51(5), 527–541. https://doi.org/10.1159/000478668
- Chu, C., Lo, E., & Lin, H. (2002). Effectiveness of Silver Diamine Fluoride and Sodium Fluoride Varnish in Arresting Dentin Caries in Chinese Pre-school Children. J Dent Res., 81(11), 767–770. https://doi.org/10.1177/0810767
- Çolak, H., Dülgergil, Ç., Dalli, M., & Hamidi, M. (2013). Early childhood caries update: A review of causes, diagnoses, and treatments. J Nat Sci Biol Med., 4(1), 29–38. https://doi.org/10.4103/0976-9668.107257
- Delbem, A., Pedrini, D., França, J., & Machado, T. (2005). Fluoride release/recharge from restorative materials - Effect of fluoride gels and time. Oper Dent., 30(6), 690–695.
- Dionysopoulos, D., Koliniotou, E., Helvatzoglou, M., & Kotsanos, N. (2013). Fluoride release and recharge abilities of contemporary fluoride-containing restorative materials and dental adhesives. Dent Mater J., 32(2), 296–304. https://doi.org/10.4012/dmj.2012-144

- Dionysopoulos, P., Kotsanos, N., & Pataridou, A. (2003). Fluoride release and uptake by four new fluoride releasing restorative materials. J Oral Rehabil., 30(9), 866–872. https://doi.org/10.1046/j.1365-2842.2003.00993.x
- Fa, B., Jew, J., Wong, A., & Young, D. (2016). Silver modified atraumatic restorative technique (SMART): an alternative caries prevention tool. CZAS Stomatol J., 3(3), 243–249. https://doi.org/10.1016/j.adaj.2020.06.002
- Forsten, L. (1995). Resin-modified glass ionomer cements: Fluoride release and uptake. Acta Odontol Scand., 53(4), 222–225. https://doi.org/10.3109/00016359509005976.
- Gandolfi, M. G., Iezzi, G., Piattelli, A., Prati, C., & Scarano, A. (2017). Osteoinductive potential and bone-bonding ability of ProRoot MTA, MTA Plus and Biodentine in rabbit intramedullary model: Microchemical characterization and histological analysis. Dent Mater., 33(5), e221–e238. https://doi.org/10.1016/j.dental.2017.01.017
- Garcez, R., Buzalaf, M., & De Araújo, P. (2007). Fluoride release of six restorative materials in water and pH-cycling solutions. J Appl Oral Sci., 15(5), 406–411. https://doi.org/10.1590/s1678-77572007000500006
- Gupta, J., Thomas, M., Radhakrishna, M., Srikant, N., & Ginjupalli, K. (2019). Effect of silver diamine fluoride-potassium iodide and 2% chlorhexidine gluconate cavity cleansers on the bond strength and microleakage of resin-modified glass ionomer cement. J Conserv Dent., 22(2), 201–206. https://doi.org/10.4103/JCD.JCD_485_18
- Hamama, H., Burrow, M., & Yiu, C. (2014). Effect of dentine conditioning on adhesion of resin-modified glass ionomer adhesives. Aust Dent J., 59(2), 193–200. https://doi.org/10.1111/adj.12169
- Horst, J., Ellenikiotis, H., & Milgrom, P. (2016). UCSF protocol for caries arrest using silver diamine fluoride: rationale, indications and consent. J Calif Dent Assoc., 44(1), 16–28.
- Isaac, S. & Michael W. Handbook in research and evaluation : a collection of principles, methods, and strategies useful in the planning, design, and evaluation of studies in education and the behavioral sciences. 3rd ed. California: EDITS Publishers; 1995.
- Jabin, Z., Vishnupriya, V., Agarwal, N., Nasim, I., Jain, M., & Sharma, A. (2020). Effect of 38% silver diamine fluoride on control of dental caries in primary dentition: A Systematic review. J Fam Med Prim Care Rev., 9(3), 1302–1307.
- Knight, G., & McIntyre, J. (2006). The effect of silver fluoride and potassium iodide on the bond strength of auto cure glass ionomer cement to dentine. Aust Dent J., 51(1), 42–45. https://doi.org/10.1111/j.1834-7819.2006.tb00399.x
- Knight, G., McIntyre, J., Craig, G., & Mulyani. (2006). Ion uptake into demineralized dentine from glass ionomer cement following pretreatment with silver fluoride and potassium iodide. Aust Dent J., 51(3), 237–241. https://doi.org/10.1111/j.1834-7819.2006.tb00435.x
- Knight, G., McIntyre, J., Craig, G., Mulyani, Zilm, P., & Gully, N. (2005). An in vitro model to measure the effect of a silver fluoride and potassium iodide treatment on the permeability of demineralized dentine to Streptococcus mutans. Aust Dent J., 50(4), 242–245. https://doi.org/10.1111/j.1834-7819.2005.tb00367.x
- Mei, M., Chu, C., Lo, E., & Samaranayake. (2013). Fluoride and silver concentrations of silver diammine fluoride solutions for dental use. Int J Paediatr Dent., 23(4), 279–285. https://doi.org/10.1111/ipd.12005
- Mei, M., Ito, L., Zhang, C., Lo, E., & Chu, C. (2015). Effect of laser irradiation on the fluoride uptake of silver diamine fluoride treated dentine. Lasers Med Sci., 30(3), 985–991. https://doi.org/10.1007/s10103-014-1521-8
- Mendi, B., & Eden, E. (2021). Medical management of caries: silver diamine fluoride. Clin. Dent., 5(1), 1–5. https://doi.org/10.1007/S41894-021-00093-3
- Momoi, Y., & McCabe, J. (1993). Fluoride release from light-activated glass ionomer restorative cements. Dent Mater., 9(3), 151–154. https://doi.org/10.1016/0109-5641(93)90112-4
- Mousavinasab, S., & Meyers, I. (2009). Fluoride release by glass ionomer cements, compomer and giomer - PubMed. Dent Res J., 6(2), 75–81.
- Mungara, J., Philip, J., Joseph, E., Rajendran, S., Elangovan, A., & Selvaraju, G. (2013). Comparative evaluation of fluoride release and recharge of pre-reacted glass ionomer composite and nano-ionomeric glass ionomer with daily fluoride exposure: An in vitro study. J Indian Soc Pedod Prev Dent, 31(4), 234–239. https://doi.org/10.4103/0970-4388.121820
- Nagi, S., Moharam, L., & El Hoshy, A. (2018). Fluoride release and recharge of enhanced resin modified glass ionomer at different time intervals. Futur Dent J., 4(2), 221–224. https://doi.org/10.1016/j.fdj.2018.06.005
- Nasr, R., & Saber, H. (2020). MicroTensile Bond Strength of Glass Ionomer Cement to Silver Fluoride

and Potassium Iodide-Treated Carious Primary Dentin. Egypt Dent J., 66(2), 815–827. https://doi.org/10.21608/EDJ.2020.25838.1073

- Niderman Crystal, Y.O., & Niederman, R. (2019). Evidence-Based Dentistry Update on Silver Diamine Fluoride. Dent. Clin. N. Am., 63(1), 45–68. https://doi.org/10.1016/j.cden.2018.08.011
- Oliveira, B., Rajendra, A., Veitz-Keenan, A., & Niederman, R. (2019). The effect of silver diamine fluoride in preventing caries in the primary dentition: A systematic review and meta-analysis. Caries Res, 53(1), 24–32.
- Patel, J., Anthonappa, R., & King, N. (2019). Fluoride Leachate Profile of Silver Diamine Fluoride. Mod Res Dent., 4, 359–363. https://doi.org/10.1111/ipd.12005
- Power, R., Salazar-García, D., Wittig, R., & Henry, A. (2014). Assessing use and suitability of scanning electron microscopy in the analysis of micro remains in dental calculus. J Archaeol Sci., 49(1), 160–169. https://doi.org/10.1016/j.jas.2014.04.016
- Quock, R., Barros, J., Yang, S., & Patel, S. (2012). Effect of silver diamine fluoride on microtensile bond strength to dentin. Oper Dent., 37(6), 610–616. https://doi.org/10.2341/11-344-L
- R Core Team (2020). R: A language and environment for statistical computing. R Foundation for statistical Computing, Vienna, Austria. URL https://www.R-project.org/
- Rusmah, M., Chan, J., Wei, S., & Lee, S. (1993). Fluoride release from dual-cured glass-ionomer liners: An in vitro study. Clin Mater., 14(3), 217–221. https://doi.org/10.1016/0267-6605(93)90005-R
- Scholz, K., Federlin, M., Hiller, K., Ebensberger, H., Ferstl, G., & Buchalla, W. (2019). EDX-analysis of fluoride precipitation on human enamel. Sci Rep., 9(1), 1–11. https://doi.org/10.1038/s41598-019-49742-5
- Uchil, S., Suprabha, B., Suman, E., Shenoy, R., Natarajan, S., & Rao, A. (2020). Effect of three silver diamine fluoride application protocols on the microtensile bond strength of resin-modified glass ionomer cement to carious dentin in primary teeth. J Indian Soc Pedod Prev Dent., 38(2), 138. https://doi.org/10.4103/JISPPD.JISPPD_159_20
- Xu, X., & Burgess, J. (2003). Compressive strength, fluoride release and recharge of fluoride-releasing materials. Biomaterials, 24(14), 2451–2461. https://doi.org/10.1016/s0142-9612(02)00638-5
- Zhao, I., Chu, S., Yu, O., Mei, M., Chu, C., & Lo, E. (2019). Effect of silver diamine fluoride and potassium iodide on shear bond strength of glass ionomer cements to caries-affected dentine. Int Dent J., 69(5), 341–347. https://doi.org/10.1111/idj.12478
- Zhao, I., Mei, M., Burrow, M., Lo, E., & Chu, C. (2017). Effect of silver diamine fluoride and potassium iodide treatment on secondary caries prevention and tooth discolouration in cervical glass ionomer cement restoration. Int J Mol Sci., 18(2), 340. https://doi.org/10.3390/ijms18020340