

## Evaluation of microleakage and adaptability of glass ionomer and resin sealants with invasive and non invasive technique

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### Abstract

**Introduction:** Both resin based sealants and glass ionomer cement are widely used for sealing the pit and fissures for preventing occlusal caries but the efficacy of one over the other is not conclusively proven. The dilemma of hidden caries has led to invasively opening of the fissure before sealant placement leading to other advantages such as elimination of organic material and plaque, enabling a thicker layer of sealant, higher retention rates and reduced risk of microleakage.

**Aims and objectives:** To compare microleakage and the flow and adaptability of resin based sealant (Voco, Fissurit-F) and glass ionomer sealant (GC, Fuji VII) applied with invasive and non invasive technique.

**Methodology:** 100 non carious young premolars were used for this study and they were divided into four groups of 25 teeth each: Group 1: Non-invasive technique glass ionomer sealant, Group 2: Invasive glass ionomer sealant, Group 3: Non-Invasive resin based sealant, Group 4: Invasive resin based sealant. 5 teeth from each group were evaluated under scanning electron microscope (SEM) for flow and adaptability. For microleakage analysis teeth were immersed in 5% methylene blue, sectioned buccolingually and scored under stereomicroscope.

**Results:** The flow and adaptation of glass ionomer sealant was slightly better than resin based sealant. The invasive technique provided better flow and adaptation but was not statistically significant. Lowest microleakage was seen in Group 4. Irrespective of the technique used resin based sealant had lesser microleakage when compared to glass ionomer sealant, which was statistically significant ( $p=0.01$ ). Microleakage between invasive and non invasive groups was not significant statistically.

**Conclusion:** Resin based sealant is superior in terms of preventing microleakage. Pit and fissure preparation using burs need not be done routinely unless there is presence of suspected fissure caries.

**Key words:** Pit and fissure sealant, Invasive technique, Microleakage, Adaptability

### Introduction

Pit and fissures that harbour food debris and microorganisms have been described as the single most important feature leading to the development of occlusal caries<sup>1</sup>. The high incidence of fissure caries among young individuals is well known. Pit and fissures sealants are one of the best methods of preventing caries as it occludes the fissures and pits from the accumulation of plaque and cariogenic microflora<sup>2</sup>.

Fluoride containing resin based materials are used as sealants often due to their fluoride releasing ability which can contribute to caries prevention along with sealing of the pit and fissure through micro retention created

through tags after enamel acid etching<sup>3</sup>. Glass ionomer cement was introduced as sealant with the consideration of its properties like, continuous fluoride release, ability to bond chemically with untreated enamel and dentin through an ion exchange mechanism, biocompatibility with the tooth tissues and anti carious effect<sup>4,5</sup>.

The deepest parts of the fissures are usually filled with organic debris including bacteria. Abrasive cleaning of tooth surface by prophylaxis, followed by etching removes organic materials and cleans the surface of the teeth but does not penetrate below the visible orifice of the fissure<sup>2</sup>. The practitioner is very often faced with

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the dilemma either to preserve apparently sound dental tissue by merely sealing the fissure or to perform an invasive biopsy in order to assess the extent of caries and then restore the tooth. This dilemma arises from uncertainty about the ability of a sealant to arrest caries in a fissure and this is greatly dependent on the degree of microleakage at the periphery of the sealant<sup>6</sup>.

Both glass ionomer and resin based pit and fissure sealants have been studied using invasive and non invasive techniques but the results regarding the penetration of the sealants and microleakage have not been conclusive<sup>2</sup>. Recently a systematic review with meta analysis reported that there was no evidence that either material was superior to other in the prevention of dental caries<sup>7</sup>.

Sealing ability of the sealants is an important factor contributing to their caries preventing ability. Hence the aim of the present invitro study was to compare the microleakage and the flow and adaptability of glass ionomer sealant and fluoride releasing resin sealant placed on fissures using invasive and non invasive technique.

#### **Materials and methods**

Hundred non carious, non hypoplastic premolars extracted for orthodontic purpose were selected. The teeth were divided randomly into 4 groups of 25 teeth each. Group 1 - Non Invasive glass ionomer sealant; Group 2- Invasive glass ionomer sealant; Group 3- Non Invasive Resin based sealant; Group 4- Invasive Resin based sealant. In this study two fluoride releasing sealants were used which were Fuji VII (glass ionomer sealant) known for its fluoride release and Fissurit -F (filled, resin based sealant) which contains 1.3% by weight sodium fluoride. The teeth were prepared as follows:

**Group 1:** Non invasive technique sealed with Fuji VII (GC corporation, Japan)

Teeth were conditioned using GC dentine conditioner (GC corporation, Japan) for 20 seconds. The surface was then washed and dried with an air syringe. The material was manipulated according to the manufacturer's instructions (Fuji VII, GC Corporation, Japan). Powder and liquid were mixed with a plastic spatula to achieve a uniform mix. The cement was applied on the fissures on occlusal surface of the teeth with plastic filling instrument and was cured for 20 seconds using light curing unit. After the sealant was set Vaseline was applied over the occlusal surfaces.

**Group 3:** Non invasive sealed with Fissurit-F (Voco, Germany)

Etchant gel (37% phosphoric gel; Scotchbond, 3M ESPE, USA) was applied for 15 seconds, and the tooth was then flushed with water for 15 seconds again to remove all of the etchant. The tooth was then dried with oil-free compressed air thoroughly to achieve a complete frosty white appearance. The sealant applicator nozzle was attached to the dispenser, and the tip was bent for easy access and convenient handling. The sealant was allowed to flow into the fissures, avoiding incorporation of air bubbles. The tip of the curing light was held vertical to the resin surface at a distance of about 1 mm then the sealant was light cured for 20 seconds.

Invasive technique: **Group 2-** (Glass Ionomer- Fuji VII) and **Group 4 -** (Resin Based Sealant- Fissurit-F)

The fissures of the teeth were prepared with a diamond tapered fissure bur (Horico FG 170 008) in a high speed hand piece. Width of the fissure preparation was equivalent to the diameter of the bur and depth at 1.5mm mark from the tip of the bur. The depth of the prepared enamel was verified with a probe.

In each group, the fissures were sealed with respective restorative material as per manufacturers' instructions (Group 2 with Fuji VII and Group 4 with Fissurit-F). All the sealed teeth were stored in the saline.

Specimens were subjected to thermocycling for 250 cycles at temperatures of 4°C ± 2°C, 37°C ± 2°C and 60°C ± 2°C with dwell time of 30 seconds in controlled water bath. Thermocycling was done to reproduce the different temperatures to which the teeth are subjected during eating and drinking under clinical conditions.

#### **Evaluation of flow and adaptability using Scanning electron microscope (SEM)**

From each group 5 teeth were randomly selected. The root portions of the teeth were cut and the crown was sectioned buccolingually with a carborundum disk. These samples were allowed to dry for 24 hours in the sunlight before subjecting them to gold sputtering. This was done to prevent any moisture contamination during SEM study.

The sections were mounted on aluminum stubs with silver paint and were sputter coated with gold-palladium in JEOL JFC -1600 Auto fine coater for 120 seconds. This ensured proper conducting surface to the non conducting specimens. These specimens were then loaded in a special aluminum tray, the surface to be examined was placed facing upwards and stabilized by the carbon tape. This tray containing specimens were placed in the vacuum chamber of the Scanning Electron Microscope. The sections were then examined with an Analytical Scanning Electron Microscope (JEOL JSM-

6380LA, Japan) using acceleration voltage of 5kV at magnification of 50X. The structure analyzed was the complete fissure, which was observed on the screen.

They were scored as follows: (Fig1, 2, 3)

1 = good: complete adaptation and penetration to all fissures

2 = fair: one interface failure of adaptation or penetration

3 = poor: more than one interface failure of adaptation or penetration

The gaps between the sealant and the tooth surface were measured, under higher magnification (100X to 450X) by placing the two indicator marks at two extremes of the gaps and the distance between them was recorded as given by the computer. The minimum and the maximum gap were noted in  $\mu\text{m}$ .

### Evaluation of Microleakage

The apices of all the remaining 80 teeth were sealed with self cure acrylic resin. Each tooth was covered with two coats of nail varnish except an area approximately 2mm from the periphery of the sealant. After nail varnish was dried all the teeth were immersed in 0.5% methylene blue dye for 24 hours. After removal from the dye solution, the teeth were allowed to dry. They were then sectioned buccolingually through center of the fissure using carborundum disk.

The specimens were then studied under stereomicroscope (Sterostar zoom stereomicroscopic microscope, Reichert Jung Co. Germany) with a capacity of 0.7 to 4.2X and 10X eyepiece magnification to measure the depth of dye penetration on buccal and lingual wall of both halves of teeth. Microleakage was scored according to the level of leakage in the interface of the sealant and the tooth from the occlusal surface. The scoring was done as described Blackwood et al<sup>8</sup> and Ovrebo and Raadal<sup>9</sup>.

Scoring criteria:

0 = No dye penetration

1 = penetration up to one half the sealant's length

2 = penetration greater than one half, not including the underlying fissure

3 = penetration into the underlying fissure

The carborundum disc was sufficiently thick (0.3 mm) to prevent adjacent surfaces from being mirror images of each other. Hence both the sections of the teeth (buccal

and the lingual surfaces) were examined, which gave 4 scores per tooth. The overall score for each tooth equaled the highest score of the 4 potential readings from the buccal and lingual surfaces. All specimen were evaluated by two examiners independently and inter examiner reliability was calculated using Kendall's tau b. The scores were recorded and data was analyzed using SPSS for Windows release 11.5 (SPSS, Chicago, IL, USA). Kruskal Wallis and Mann Whitney U test was applied at the level of significance of  $p < 0.05$ .

### Results

Inter observer variability was found to be non significant in all the groups (Kendall's tau b value  $\leq 1$ ). The mean microleakage scores of four groups are listed in Table 1. The mean score for the non- invasive glass ionomer sealants (Group 1) was  $1.30 \pm 0.73$  which was the highest among four groups. Kruskal Wallis test showed no statistically significant difference ( $p = 0.08$ ). The mean score for the invasive technique was less than that of the non invasive technique in both the sealant materials.

Irrespective of technique used, glass ionomer sealant showed higher microleakage. The mean score of glass ionomer was  $1.27 \pm 1.01$  which is higher than that of resin based sealant  $0.82 \pm 1.19$ . Mann Whitney-U test showed that the difference seen between these two groups was statistically significant ( $Z = 2.39$ ;  $p = 0.016$ ).

Invasive technique resulted in lesser microleakage. The mean score for invasive technique irrespective of the material was  $1.02 \pm 1.12$  which is less than that of non-invasive  $1.07 \pm 1.07$ . Mann Whitney-U test ( $Z = 0.311$ ;  $p = 0.75$ ) showed that there was no statistical difference in microleakage between two techniques.

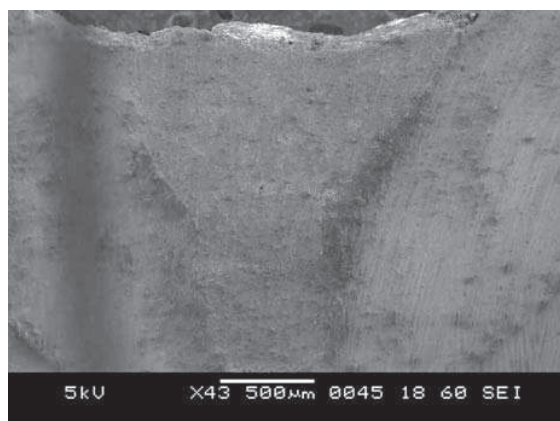
On observation under the SEM there was evidence of cracks and voids within the specimens of glass ionomer sealant groups but none of the resin based sealants groups showed this defect. In the non invasive groups there was presence of plaque and debris in the fissures. All groups showed presence of the gaps between tooth and sealant interface. Glass ionomer sealant applied with invasive technique (Group 2) had lowest average gap width ( $7.7\mu$ ) between the tooth surface and sealant and mean score of flow and adaptability was lowest among all the groups ( $1.80 \pm 0.83$ ) (Table 2). Kruskal Wallis test showed no statistically significant difference in the mean of the score values between the groups ( $p = 0.166$ ).

**Table 1:** Distribution of microleakage scores and mean microleakage score values

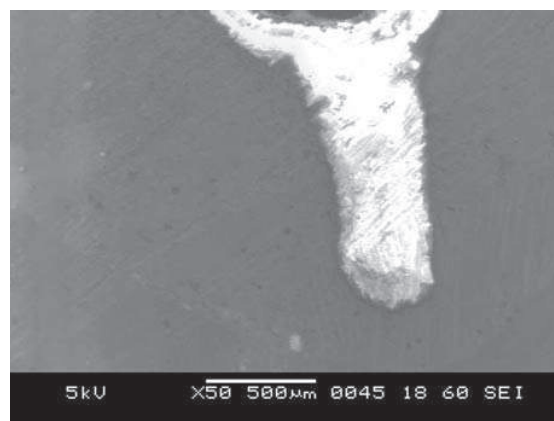
Group	Score				N	Mean score value with S.D
	0	1	2	3		
Group 1	2	11	6	1	20	1.30± 0.73
Group 2	7	7	0	6	20	1.25±1.25
Group 3	13	2	0	5	20	0.85±1.30
Group 4	9	8	1	2	20	0.80±0.95
<b>Total</b>	<b>31</b>	<b>28</b>	<b>7</b>	<b>14</b>	<b>80</b>	

**Table 2:** Mean scores of *flow and adaptability* and *marginal gap* width of the different groups observed under SEM and observed under SEM

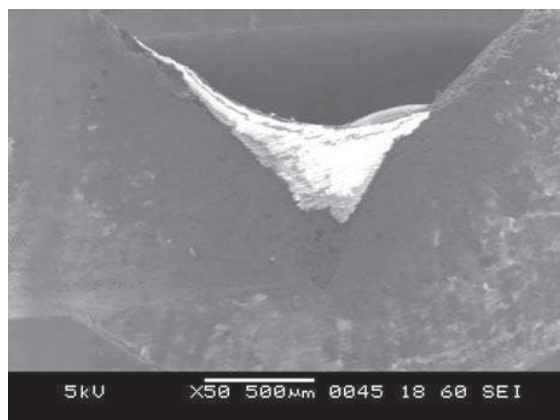
Group	N	Mean gap width (μ)	S.D	Minimum gap width (μ)	Maximum gap width (μ)	Mean score values with S.D
Group 1	5	40.61	39.5	11.1	109.1	2.4± 0.54
Group 2	5	7.786	8.9	0.00	21.4	1.8± 0.83
Group 3	5	103.54	51.01	50.1	185.35	2.6± 0.89
Group 4	5	93.66	92.08	36.5	255.0	2.8±0.44



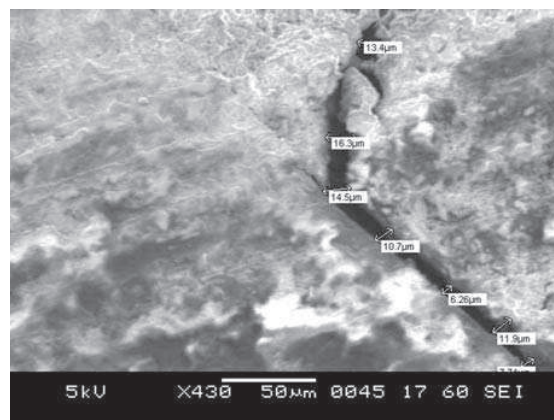
**Fig 1:** Sealant tooth interface using Fuji VII with invasive technique under SEM, showing score 1



**Fig 2:** Sealant tooth interface using Fissurit -F with invasive technique under SEM, showing score 2



**Fig 3:** Sealant tooth interface using Fissurit-F with non invasive technique under SEM, showing score 3



**Fig 4:** Measurement of the gap width observed in higher magnification (X 430)

## Discussion

In this study all the groups exhibited some degree of dye penetration. This finding is in accordance to those reported by Theodoridou – Pahini et al<sup>6</sup> and do Rego et al<sup>10</sup> who stated that microleakage can be expected in all restorative materials. This may be because the coefficient of thermal expansion of sealants is much greater than the coefficient of thermal expansion of the teeth. Sealants have one of the highest coefficient of thermal expansion among the dental materials used for restoration<sup>11</sup>. In this study thermocycling was performed which may have contributed to high degree of microleakage in glass ionomer group. Theodoridou-Pahini et al<sup>6</sup> found that the non-thermocycled glass ionomer sealant group had lower degree of microleakage in comparison to resin based sealant group.

Among the examined groups there were 31 samples which did not exhibit any dye penetration. There was no evidence of extensive dye leakage throughout the material in any of the groups but dye penetration was seen into the cracks in the glass ionomer sealant groups. Resin based sealant showed significantly less microleakage (mean score  $0.825 \pm 1.12$ ) when compared to glass ionomer sealant (mean score  $1.27 \pm 1.01$ ). This finding was similar to other studies between glass ionomer sealant and resin based sealant<sup>2,12</sup>. Higher microleakage in glass ionomer sealant could be due to the solubility and disintegration of the material in water medium which is higher than the resin sealant.

The invasive technique was said to provide certain advantages, such as better diagnosis of underlying decalcifications, elimination of organic material and plaque, exposing a more reactive tooth enamel therefore enabling a thicker layer of sealant, higher retention rates and reduced risk of microleakage by widening and deepening the pits and fissures<sup>6,10,13,14</sup>. According to DeCraene et al<sup>15</sup> while applying the invasive sealing technique, the choice of an adequate bur is important to obtain a caries free fissure in combination with a minimal loss of tooth structure. Geiger et al<sup>16</sup> have reported that tooth preparation with a tapered fissure diamond bur showed less microleakage than round carbide bur. In this study tapered fissure bur was used.

In this study when the enamel preparation technique was compared, there was no statistical difference between the techniques but the microleakage mean score for the invasive technique was less compared to the mean score of non invasive technique. Similar finding was reported in some studies<sup>8,17,18,19</sup>. In some studies there was statistically less microleakage in the fissures prepared with bur followed by acid etching prior to sealant placement than laser, air abrasion or conventionally prepared sealants<sup>20,21</sup>.

This finding of non significant difference in microleakage between the invasive and non invasive technique may have clinical implication regarding sealant placement. It suggests that dentists may be using more aggressive sealant preparation technique on sound, healthy tooth structure than necessary. It may not be very cost effective as it also requires more dentists' time. But in certain situations like suspected carious fissures, there is need for enameloplasty prior to sealant application to disclose potential caries. This study also suggests that the method of pit and fissure penetration is not the critical step in the sealant technique. It is more likely conditions such as tooth isolation and moisture control, eruption status of tooth, patient cooperation and a proper etch that determine sealant success.

### Flow and adaptability

It was seen that the flow and adaptability was better in the glass ionomer sealant applied with invasive technique but not statistically significant. Glass ionomer sealant showed good adaptation with the tooth surface, but none of the samples from the resin based sealant showed good adaptation. This was similar to the results seen by Smales et al<sup>22</sup> and Herle et al<sup>2</sup>. Glass ionomer sealant used in this study (Fuji VII) is designed with a flowable consistency for improved application to narrow regions like pit and fissures. Also the finger pressure during application of Vaseline must have increased the penetration of the material resulting in better adaptation.

The penetration of liquids into cracks and crevices depends on the factors like depth and width of crevice, surface tension of the liquid, advancing contact angle of the liquid, viscosity and time<sup>23</sup>. Variation in fissure morphology of teeth in various groups may have contributed to the penetration of the sealants<sup>24</sup>. The resin based sealant used in this study is a filled sealant and it should be noted that the filled sealant has a higher filler load and is more viscous<sup>25</sup>. The viscosity of sealants is inversely proportional to the penetration, thus higher viscosity sealants may cause poorer adaptation of sealant to enamel and incomplete penetration to the bottom of the pits and fissures<sup>26</sup>.

Sealant in non invasive group had lesser penetrability in both glass ionomer and resin sealant groups. The sealant material did not flow beyond the constriction of the fissure. Residual materials in the fissure and air entrapment may have contributed to limiting sealant penetration into deep constricted fissures.

This study showed that resin based sealant was superior showing less microleakage when compared to glass ionomer sealant but regarding the flow and adaptability

glass ionomer sealant was better (not statistically significant). The difference between the invasive and non invasive technique was statistically non significant for both microleakage and adaptability. In an in vitro study Selegman et al<sup>27</sup> showed that there is no correlation between microleakage and penetrability. SEM findings suggest that total penetration of the sealant material is unnecessary if an adequate bond has occurred coronal to the base of the fissure and adjacent to the cuspal inclines.

### Conclusions

Invasive technique may not be required in routine fissure sealant procedure unless there is presence of suspected fissure caries as it permits diagnosis of the presence or extent of carious lesion. The choice of the preparation technique and the sealant should depend on the clinical situation. Resin based sealant should be used routinely and only in conditions like in very young children and partially erupting teeth where isolation is difficult, glass ionomer can be used as alternative material. These results need to be confirmed by studying the caries preventing ability of these sealants using invasive/noninvasive technique in clinical situation.

### References

1. Paynter KJ, Grainger RM. Relationship of morphology and size of teeth to caries. *Int Dent J* 1962; 12:147.
2. Herle GP, Joseph T, Verma B, Jayanthi M. Comparative evaluation of glass ionomer and resin based fissure sealant using noninvasive and invasive techniques- A SEM and microleakage study. *J Indian Soc Pedo Prev Dent* 2004; 22(2):56-62.
3. Simonsen RJ. Pit and fissure sealant: Review of the literature. *Pediatr Dent* 2002; 24:393-414.
4. Garcia –Godoy F, De Araujo FB. Enhancement of fissure sealant penetration and adaptation: The enameloplasty technique. *J Clin Pediatr Dent* 1994; 19:13-18.
5. Mejare I, Ivar A, Mjor. Glass ionomer and resin- based fissure sealants: A clinical study. *Scand J Dent Res* 1990; 98:345-50.
6. Theodoridou-Pahini S, Tolidis K, Papadogiannis Y. Degree of microleakage of some pit and fissure sealants: an in vitro study. *Int J Pediatr Dent* 1996; 6(3):173-176.
7. Yengopal V, Mickenautsch S, Bezerra A.C, Leal S.C. Caries – preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth: a meta analysis. *J Oral Sci* 2009; 51(3):373-382.
8. Blackwood JA, Dilley DC, Roberts MW, Swift EJ. Evaluation of pumice, fissure enameloplasty and air abrasion on sealant microleakage. *Pediatr Dent* 2002; 24:199-203.
9. Ovrebø CR, Raadal M. Microleakage in fissures sealed with resin or glass ionomer cement. *Scand J Dent Res* 1990; 98: 66-69.
10. do Rego MA, de Araujo MAM. Microleakage evaluation of pit and fissure sealants done with different procedures, materials, and laser after invasive technique. *J Clin Pediatr Dent* 1999; 24(1):63-68.
11. Powers JM, Hostelier RW, Dennison JB. Thermal expansion of composite resin sealants. *J Dent Res* 1979; 58: 584-587.
12. Ganesh M, Tandon S. Clinical evaluation of Fuji VII sealant material. *J Clin Pediatr Dent* 2006; 31(1):52-57.
13. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealant: 3- year follow-up. *J Pedod* 1984; 8:272-277.
14. Shapira J, Eidelman E. Six year clinical evaluation of fissure sealants placed after mechanical preparation: A matched pair study. *Pediatr Dent* 1986; 8:204-205.
15. De Craene, Martens C, Dermaut R. The invasive pit and fissure sealing technique in pediatric dentistry: An SEM study of a preventive restoration. *J Dent Child* 1988; 55(1): 34-41.
16. Geiger SB, Gulayev S, Weiss EI. Improving fissure sealant quality- Mechanical preparation and filling level. *J Dent* 2000; 28:407-412.
17. Boj JR, Xalabrade A, Garcia-Godoy F. Microleakage of fissure sealants after enameloplasty. *Pediatr Dent* 1995; 17: 143.
18. Xalabarde A, Garcia-Gordoy F, Boj JR, Canalda C. Microleakage of fissure sealants after occlusal enameloplasty and thermocycling. *J Clin Pediatr Dent* 1998; 22(3):231-235.
19. Mentés A, Gencoglu N. An in vitro study of microleakage of sealants after mechanical or air abrasion techniques with or without acid etching. *Eur J Paediatr Dent* 2000; 4:151-156.
20. Hatibovic-Kofman S, Wright GZ, Braverman I. Microleakage of sealants after conventional, bur and air-abrasion preparation of pits and fissures. *Pediatr Dent* 1998; 20(3):173-176.
21. Laurence-Lupi P, Bertrand MF, Bolla MM, Rocca JP, Bolla M. Comparative study of microleakage of a pit and fissure sealant placed after preparation by Er:YAG laser in permanent molars. *J Dent Child* 2003; 70(2):134-138.
22. Smales RJ, Gao W, Ho FT. In vitro evaluation of sealing pits and fissures with newer glass-ionomer cements developed for the ART technique. *J Clin Pediatr Dent* 1997; 21(4):321-323.
23. Grewal N, Chopra R. The effect of fissure morphology and eruption time on penetration and adaptation of pit and fissure sealants: an SEM study. *J Indian Soc Pedod Prevent Dent* 2008; 26(2): 59-63.
24. Sutalo J, Pupic V, Ciglar I, Skaljic G, Tuda M. Scanning electron microscope study of penetrability of sealants in relation to fissure morphology of permanent premolars in humans. *Oral Prophylaxe* 1989; 11:83-88.
25. Flanagan RA, Pearson GJ. Evaluation of dye penetration around two resin based materials used as fissure sealants. *Biomaterials* 1988; 9(5): 460-462.

26. Irinoda Y, Matsumura Y, Kito H, Nakano T, Toyama T, Nakagaki H, et al . Effect of sealant viscosity on the penetration of resin into etched human enamel. *Oper Dent* 2000; 25:274-282.
27. Selecmen JB, Owens BM, Johnson WW. Effect of preparation technique, fissure morphology, and material characteristics on the in vitro margin permeability and penetrability of pit and fissure sealants. *Pediatr Dent* 2007; 29(4):308-314.