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Original Article

Fluoride release of glass ionomer restorations after bleaching with two different bleaching materials

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ABSTRACT

Objective: This study was designed to evaluate the effect of two bleaching agents on the fluoride release of three types of glass ionomer materials. **Materials and Methods:** A total of 90 specimens of the tested materials (Ketac Fil, Photac Fil and F2000) were prepared by a split Teflon ring with an internal diameter of 5 mm and thickness of 2 mm. The tested materials were applied and bleached according to manufacturer instructions. Fluoride release measurements were made by using specific ion electrode. **Results:** Results revealed that bleaching with opalescence Xtra caused little increase in fluoride release from Ketac Fil and Photac Fil but has no effect on F2000. However, Opalescence Quick had no significant effect on the three tested materials. **Conclusions:** Bleaching effect on fluoride release is material dependent and time has a significant role on fluoride release.

Key words: Bleaching, fluoride release, glass ionomer

INTRODUCTION

The use of bleaching materials both hydrogen peroxide and carbamide peroxide has become an attractive procedure in the dental clinic. Furthermore, the use of fluoride-releasing glass ionomer as a dental restorative material has also become popular.[1,2]

The situation where these materials interact within the oral cavity during the bleaching process can occur frequently; thus, understanding their reaction is important.[3,4]

The bleaching process is believed to occur through oxidation by hydroxyl radicals that are generated from the bleaching agent. With clinically favorable and safe aspects for patients, several studies have shown the effectiveness of bleaching agents on dental restorative materials and teeth with regard to surface hardness, or other modifications.[5-7]

During setting of glass ionomer, fluoride ions are produced from strong soluble aluminofluoride complexes like ALF.[2] When a fully set glass ionomer is exposed to neutral aqueous solutions, it absorbs water and releases ions such as sodium, silica, calcium, and fluoride.[8-10] Two processes occur during fluoride release: a fast elution process during the early periods, and a long-term diffusive process.[11]

The elution of fluoride is a complex process. It can be affected by several intrinsic variables, such as formulation and fillers. It is also influenced by experimental factors, *i.e.*, storage media, frequency of change of the storage solution, composition and pH-value of saliva, plaque, and pellicle formation. *In vitro*, fluoride release was dependent on exposed surface area and not on sample weight.[12,13]

Fluoride release increases in acidic media; this was explained by the fact that decreasing pH increases the

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dissolution of the material leading to a higher fluoride level in acidic immersion. Thereby, the proportion of free fluoride to bound fluoride was higher under acidic than under neutral conditions.[14,15]

When hydrogen peroxide is stored, an acidic pH must be maintained to extend the shelf life. Scientists measured the pH of 26 teeth whitening products available in the market. They found that at home bleaching products have a pH range from 5.66 to 7.3. While they found pH of in-office bleaching system were lower and ranged from 3.6 to 6.5.[16,17]

When hydrogen peroxide interacts with dental materials, it decomposes to form hydroxyl radical intermediates and finally to form water and oxygen. Also, carbamide peroxide will dissociate to H_2O_2, CO_2, urea and NH_3, and then H_2O_2 will decompose again to water and oxygen finally.[18,19] Those chemical ingredients may affect the fluoride release of glass ionomer restoratives.[20,21]

The purpose of this study was to evaluate the effect of vital bleaching on the fluoride release of various types of glass ionomer restorations. Also, to compare the fluoride release of various types of glass ionomer restorations.

MATERIALS AND METHODS

Two vital bleaching commercial products and three types of glass ionomer restorative materials were selected for this study. Bleaching materials used were Opalescence Xtra Boost (38% hydrogen peroxide with pH of 7) and Opalescence Quick (35% carbamide peroxide with PH of 6) both manufactured by Ultradent (Inc., South Jordan, Utah, USA).

Glass ionomer materials used were Ketac Fil (conventional glass ionomer), Photac Fil (resin modified glass ionomer), and F2000 (poly acid modified composite resin) manufactured by 3M (Espe, st paul, USA). Shade of all glass ionomer materials used was A2.

Thirty disk shaped specimens (5 mm in diameter and 2 mm in thickness) were prepared for each brand of glass ionomer. A Teflon mold was used for samples preparation. The mold was sandwiched between two glass plates to allow setting of glass ionomer under pressure.

Capsules of Ketac Fil were activated then triturated according to manufacturer instructions for 15 s, injected in the holes of the mold in one increment. The mold was filled to slight excess, the specimen's top surface was covered by a Mylar strip and a glass slide was secured to flatten the surface and pressed with standard load 500 mg over the mold then left for setting.

Capsules of both photac Fil and F2000 were triturated according to manufacturer instructions for 15 s and injected into holes, covered with glass slide, and light cured for 40 s per each side using a light source (Pencure, J Morita MFG corp., Japan).

Each disk specimen was removed from the mold by separating its two halves and placed in a numerated plastic tube containing 5 ml of distilled water, tightly sealed with a cap. The specimens were incubated at 37°C during the whole experimental period (3 months).

After 24 h, samples were divided into three groups (30 samples per each). Each group represents a type of glass ionomer used. Each group was further subdivided into three sub-groups, 10 samples for each group. The first sub group was a control group, the second sub group was bleached with Opalescence Xtra (OX), and the last one was bleached with Opalescence Quick (OQ).

Second and third subgroups were bleached with the two bleaching agents OX and OQ according to their manufacturer instructions, every sample was covered with 2 ml of the bleaching material and left for 1 h. Disks were then washed thoroughly with distilled water, and then returned back to their tubes. Control samples (the first sub group) returned back to the tubes after water in the tubes of all subgroups being changed with new 5 ml of distilled water.

The measurements were performed after 1 week, 1 month, and 3 months and every time, samples were rinsed with distilled water and water in the tubes changed with new 5 ml of distilled water.

Fluoride release measurements were performed using specific ion electrode (PH meter F-22 "HORIBA") after adding total ionic strength adjustment buffer (TISAB) solution. The amount of fluoride released from the three tested materials was expressed in ppm.

Statistical analysis

Data were recorded and analyzed by using one-way Analysis Of Variance (ANOVA) followed by Bonferroni multiple comparison *post hoc* test at the significance level of α =0.05. The analysis of variance was carried out considering the factors (material, time, and interaction).

RESULTS

Time had highly significant effect on fluoride released from all glass ionomer materials under test at $P < 0.05$ [Table 1]. Ketac Fil showed initial burst in fluoride release in the first week (T_1) of 58.6 ppm, then concentration of fluoride decreased sharply after 1 month (T_2) of 10.94 ppm. After 3 months (T_3), the concentration of fluoride decreased again of 5.94 ppm [Figure 1]. For Photac Fil, time had only a significant effect on fluoride release [Figure 2]. Fluoride release of F2000 was also affected by time and this was highly significant [Figure 3].

Studying fluoride release as affected by the type of glass ionomer material regardless the type of bleaching and time; the result was highly significant at $P < 0.01$. Comparing the three brands; Ketac Fil and Photac Fil released more fluoride than F2000.

There was no significant difference at $P > 0.05$ in fluoride release considering only the type of bleaching regardless type of glass ionomer and time.

A significant increase in the mean fluoride released from Ketac Fil bleached with Opalescence Xtra compared to the untreated control group and the group bleached with Opalescence Quick.

For Photac Fil, Opalescence Xtra caused slight increase in fluoride release while no significant differences in fluoride release were found after bleaching F2000.

Table 1: Effect of time on fluoride release for three types of glass ionomer materials

Material	Bleaching	T_1	T_2	T_3
G1	B0	58.6±85.9	10.9±0.7	5.9±0.7
	B1	71.1±34.9	19.1±3	5.9±1.2
	B2	51.1±19.0	22.9±7.83	4.7±1.7
G2	B0	40.5±16.4	20.1±1.8	5.2±0.2
	B1	57.4±34.2	16.7±2.2	2.7±0.1
	B2	38.7±3.2	14.4±0.1	3.3±0.2
G3	B0	12.8±0.8	11.0±0.6	1.5±0.1
	B1	11.1±0.5	6.7±1.1	1.3±0.1
	B2	11.3±0.2	7.5±0.5	2.2±0.5

Mean values and standard deviation of fluoride release measured in ppm. B_0: Control samples (without bleaching), B_1: Samples bleached with opalescence xtra, B_2: Samples bleached with opalescence quick. G_1: Ketac fil, G_2: Photac fil, G_3: F2000. (T_1): Fluoride release in the first week, (T_2): Fluoride release after 1 month, (T_3): Fluoride release after 3 months

According to the type of bleaching and the time, highly significant difference was found between the tested materials at $P < 0.01$. Opalescence Xtra increased fluoride release only by T_1. Opalescence Quick had no effect on fluoride release through all periods of the test.

DISCUSSION

The use of hydrogen peroxide or peroxide releasing agents, such as carbamide peroxide or sodium perborate for brightening discolored teeth has become a popular treatment modality.[22,23] Glass ionomers are often used for restoration of cervical lesions because of bonding to tooth structure and releasing fluoride. The material then is likely to be in contact with tooth whitening products. The influence of various bleaching agents on physical properties, surface morphology, and color of different restorative materials has been investigated in several *in vitro* studies simulating the clinical situation as closely as possible.[24,25]

In our study, it was found that the effect of bleaching on fluoride release of glass ionomer is material dependent depends on the type of bleaching material and the type of glass ionomer. Moreover, time factor was found to have an essential role.

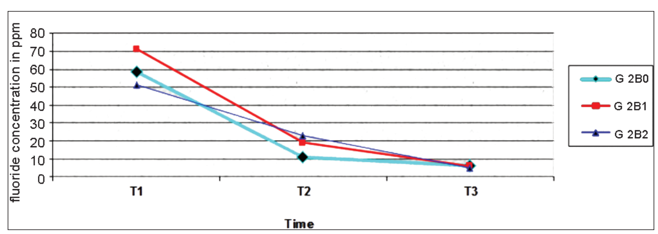

Figure 1: Mean fluoride concentration of Ketac Fil as affected by time.

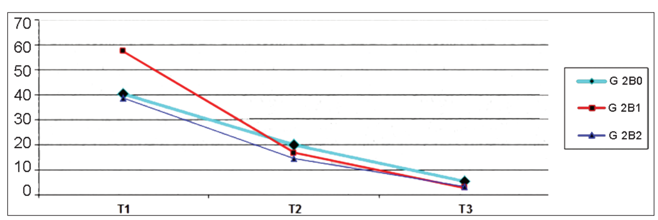

Figure 2: Mean fluoride concentration of Photac Fil as affected by time.

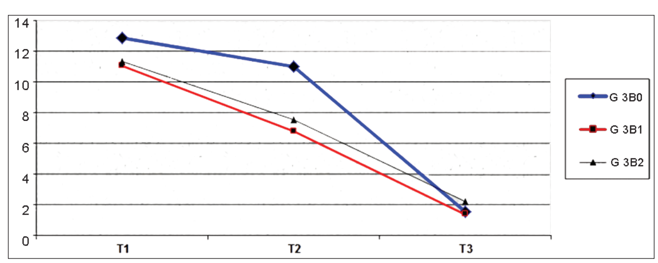

Figure 3: Mean fluoride concentration of F2000 as affected by time.

The high initial fluoride "burst" effect was only observed with Ketac Fil and Photac Fil after 1 week and dropped sharply by the second period after 1 month. This finding is in agreement with previous studies which may be attributed to the high instability and erosion of glass ionomer during the early setting period.[4,14] Those studies have shown that the cumulative amount of fluoride ions released from glass ionomer cements, after a short period of time, is diffusion controlled and follows a decreasing gradient, which is linear to the square root of time. Thereby, the initial high amounts of fluoride rapidly decrease after 24-72 h and plateaued to a nearly constant level within 10-20 days.[26]

In contrast, F2000 is mostly shown to have no initial fluoride ''burst'' effect, but levels of fluoride release remained relatively constant over time.

Significant difference in fluoride release was found between both Ketac Fil, Photac Fil, and F2000 but no significant difference was found between Ketac Fil and Photac Fil. Ranking the three brands according to their fluoride release at the first period of the test; Ketac Fill was the material with the greatest rate of fluoride release, followed by Photac Fill then F2000.

This finding was not corroborated by a study of Attin *et al*., 1999 who found higher fluoride release for compomers than for glass ionomer cements.[27] This difference can be explained by the composition of the compomer brands, which exhibited higher fluoride content and contained smaller fillers, which might lead to a better reactivity due to the greater size of the specific surface.

Bleaching effect on fluoride release was significant. However, it was material dependent and depended on the type of bleaching, type of glass ionomer, and time. Opalescence Xtra increased fluoride release for both Ketac Fil and Photac Fil. This effect was highly significant by the first week and did not prolong to other periods of the test. This result contradicted with the study of Robertelio, *et al*., 1997 who stated that the main daily release of fluoride did not differ significantly between bleaching agent and control. The reason for the contrasting results between the two studies may be attributed to different concentrations of bleaching agents used in both studies.[28]

Opalescence Quick has no significant effect on the fluoride release of the three materials. Excluding the PH factor (as both bleaching materials are close to neutral), this can be attributed to that: carbamide peroxide degrades into approximately one-third hydrogen peroxide and two-thirds urea, and hydrogen peroxide can be considered its active ingredient. The hydrogen peroxide content in Opalescence Quick is therefore much lower than that in Opalescence Xtra. Also Opalescence Quick has more complicated steps of break down to free radicals than Opalescence Xtra.[29]

F2000 fluoride concentration was not increased by bleaching. This result was in agreement with Lee, *et al*., 2002 who concluded that hydrogen peroxide has a similar effect on the fluoride release from compomers compared to the case of distilled water.[30]

CONCLUSIONS

All glass ionomer materials possess high rate of fluoride release. Opalescence Xtra (OX) increased fluoride release from conventional and resin-modified glass ionomers in the first week while the effect faded by time. Opalescence Quick (OQ) had no significant effect on the fluoride release of the three materials. Time had significant effect on fluoride release from all the materials.

REFERENCES

1. Heymann HO. Tooth whitening: Facts and fallacies. Br Dent J 2005;198:514.
2. Yengopal V, Mickenautsch S. Caries-preventive effect of resin-modified glass-ionomer cement (RM-GIC) versus composite resin: A quantitative systematic review. Eur Arch Paediatr Dent 2011;12:5-14.
3. Attin T, Hannig C, Wiegand A, Attin R. Effect of bleaching on restorative materials and restorations-a systematic review. Dent Mater 2004;20:852-61.
4. Atali PY, Bülent F, Topba I. The effect of different bleaching methods on the surface roughness and hardness of resin composites. J Dent Oral Hyg 2011;3:10-7.
5. Dishman MV, Covey DA, Baughan LW. The effects of peroxide bleaching on composite to enamel bond strength. Dent Mater 1994;10:33-6.
6. Garcia-Godoy F, Garcia-Godoy A, Garcia-Godoy F. Effect of bleaching gels on the surface roughness, hardness and micro morphology of composites. Gen Dent 2002;50:247-50.
7. Hannig C, Duong S, Becker K, Brunner E, Kahler E, Attin T. Effect of bleaching on subsurface microhardness of composite and a polyacid modified composite. Dent Mater 2007;23:198-203.
8. Eliades G, Kakaboura A, Palagaias G. Acid-base reaction and fluoride release profiles in visible light-cured polyacid-modified composite restorative. Dent Mater 1998;14:57-63.
9. Attar N, Turgut MD. Fluoride release and uptake capacities of fluoride-releasing restorative materials. Oper Dent 2003;28:395-402.
10. Itota T, Carrick TE, Rusby S, Al-Naimi OT, Yoshiyama M, McCabe JF. Determination of fluoride ions released from resin-based dental materials using ion-selective electrode and ion chromatograph. J Dent 2004;32:117-22.
11. Lee SY, Dong DR, Huang HM, Shih YH. Fluoride ion diffusion from a glass-ionomer cement. J Oral Rehab 2000;27:576-86.
12. Chan WD, Yang L, Wan W, Rizkalla AS. Fluoride release from dental cements and composites: A mechanistic study. Dent Mater 2006;22:366-73.

13. Dionysopoulos P, Kotsanos A, Pataridou A. Fluoride release and uptake by four new fluoride releasing restorative materials. J Oral Rehab 2003;30:866-72.
14. El Mallakh BF, Sarkar NK. Fluoride release from glass ionomer cements in deionized water and artificial saliva. Dent Mater 1990;6:118-22.
15. Pamir T, Tezel H, Ozata F, Celik A. Fluoride release from esthetic restorative materials with and without adhesive. Quintessence Int 2006;37:145-50.
16. Yap AU, Wattanapayungkul P. Effects of in-office tooth whiteners on the hardness of tooth-colored restoratives. Oper Dent 2002;27:137-41.
17. Price RT, Sedarous M, Hiltz GS. The PH of tooth whitening products. J Can Dent Assoc 2000;66:421-6.
18. Türker SB, Biskin T. The effect of bleaching agents on the microhardness of dental aesthetic restorative materials. J Oral Rehabil 2002;29:657-61.
19. Ulukapi H, Benderli Y, Ulukapi I. Effect of pre- and post-operative bleaching on marginal leakage of amalgam and composite restorations. Quintessence Int 2003;34:505-8.
20. Robertello FJ, Coffey JP, Lynde TA, King P. Fluoride release of glass ionomer-based luting cements *in vitro*. J Prosthet Dent 1999;82:172-6.
21. Nicholson JW, Croll T. Glass ionomer cements in restorative dentistry. Quintessence Int 1997;28:705-14.
22. Bodanezi A, de Bittencourt ME, Bodanezi RV, Zottis T, Munhoz EA, Carlini B Jr. Surface Modifications on Aesthetically Restored Teeth following Home Bleaching with 16% Peroxide Carbamide. Eur J Dent 2011;5:157-62.
23. Rattacaso RM, da Fonseca Roberti Garcia L, Aguilar FG, Consani S, de Carvalho Panzeri Pires-de-Souza F. Bleaching agent action on color stability, surface roughness and microhardness of composites submitted to accelerated artificial aging. Eur J Dent 2011;5:143-9.
24. Bertacchini SM, Abate PF, Blank A, Baglieto MF, Macchi RL. Solubility and fluoride release in ionomers and compomers. Quintessence Int 1999;30:193-7.
25. Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials-fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater 2007;23:343-62.
26. Xu X, Burgess JO. Compressive strength, fluoride release and recharge of fluoride-releasing materials. Biomaterials 2003;24:2451-61.
27. Attin T, Buchalla W, Siewert C, Hellwig E. Fluoride release/uptake of polyacid-modified resin composites (compomers) in neutral and acidic buffer solutions. J Oral Rehabil 1999;26:388-93.
28. Robertello FJ, Meares WA, Gunsolley JC, Baughan LW. Effect of peroxide bleaches on fluoride release of dental materials. Am J Dent 1997;10:264-7.
29. Haywood VB, Leech T, Heymann HO, Crumpler D, Bruggers K. Nightguard vital bleaching: Effects on enamel surface texture and diffusion. Quintessence Int 1990;21:801-4.
30. Lee JH, Kim HI, Kim KH, Kwon YH. Effect of bleaching agents on the fluoride release and microhardness of dental materials. J Biomed Mater Res 2002;63:535-41.

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