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"Comparison of the Effect of Topical Fluorides on Glass Ionomer Cements. An in-Vitro Study"

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***Abstract**: The purpose this invitro study was to compare the effect of application of two topical fluoride agents, **Kidodent–mouth rinse** and **Kidodent –toothpaste** on the surface roughness and micro hardness of two different glass ionomer cements Ketac^{TM} Molar (Conventional GIC) and Ketac^{TM} N 100 (Resin modified light cured GIC).Thirty specimens were prepared from each glass ionomer restorative material and stored in artificial saliva for 24 hours. Specimens of Ketac^{TM} Molar were divided into 3 groups of 10 each: G**roup A_1** : with Kido Dent - Mouth Rinse, G**roup B_1:** with Kido Dent- Tooth paste, G**roup C_1**: Base line for **micro hardness test.** Also specimens of Ketac^{TM} N 100 were divided into 3 groups of 10 each: G**roup A_2** : with Kido Dent - Mouth Rinse, G**roup B_2**: with Kido Dent- Tooth paste, G**roup C_2**: Base line for **microhardness test.** Surface roughness measurements (Ra) were performed on untreated specimens initially as base line data and after subjecting to their respective topical fluoride treatments. The mean roughness values for all specimens were measured using **surface profilometer**.For micro-hardness testing,10 Specimens of **Group C_1** and **C_2,** of each glass ionomer cement were divided in to two groups of 5 each, one group treated with Kidodent mouthrinse and other group with Kidodent toothpaste which were subjected to micro hardness test before surface treatment and after surface treatment with Topical fluorides.Statistically significant increase in surface roughness and increased reduction in microhardness was seen in case of Ketac ^{TM} Molar ,when compared to that of Ketac^{TM} N 100.In both the groups, glass ionomer cements treated with Kidodent mouth rinse showed slight increase in surface roughness and reduction in micro hardness in comparison to Kidodent toothpaste.*

***Keywords:** Glass ionomer cements,Surface profilometer, Topical fluorides*

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I. Introduction

In Peadiatric dentistry, GIC are used for a variety of procedures including occlusal, proximal, labial, lingual, preventive and tunnel restorations and cementation of stainless steel crowns and orthodontic bands[1]. Glass ionomer based restorative materials have the ability of releasing fluoride ions inherently and also acquiring further fluoride ions following exposure to fluoridated products such as gels, varnishes, dentifrices and solutions which makes it possible to act as a rechargeable fluoride release system during recurring cariogenic challenges[2]. In the process of application of topical fluoride gels and solutions like sodium fluoride (NaF) stannous fluoride (SnF2) and acidulated phosphate fluoride (APF) the cement surface may be significantly altered, especially when etched with phosphoric acid and due to the high reactivity of fluoride agents. This is of clinical significance because fluorides are routinely used as a preventive strategy in dentistry[3].

Cehreli et al proved that the Glass ionomer based restorative materials when exposed to fluoride gels develop surface roughness and lead to structural alterations, dependent on the composition and pH of Fluoride agents used. This inturn leads to increased plaque accumulation, Secondary caries, Surface discolouration and fatigue failure[4] . In the process of application of topical fluoride gels and solutions like sodium fluoride (NaF) stannous fluoride (SnF2) and acidulated phosphate fluoride (APF) the cement surface may be significantly altered causing surface roughness[5].

Therefore, patients with glass ionomer restorations and their modifications, who receive topical fluoride treatments, could be at a risk of increased surface roughness and decreased surface hardness which may produce erosion and eventual degradation of the material thereby significantly shortening the life span of such restorations[6].

II. Materials And Methods

Total 60 glass ionomer specimens of 4 mm diameter x 2 mm height were made,30 each from conventional GIC (Ketac^{TM} Molar) and resin modified light cured GIC (Ketac^{TM} N 100) were prepared by placing glass ionomer cement in to split-ring stainless steel mould. The material was pressed between Mylar strips supported by microscopic slides on either side to remove the excess material. The Conventional glass ionomer was allowed to set at room temperature for 15 minutes. The Resin modified Glass ionomers was cured for 40 seconds as per manufacturers instructions on either side using a 3M curing light. Finishing procedures were not incorporated as surfaces were cured against matrix, which resulted in a satisfactory finish. All the specimens were stored in artificial saliva for 24 hours prior to testing.The artificial saliva was prepared according to the chemical constituents given by Shellis in 1978 with a pH of 7[7].

Specimens of Ketac^{TM} Molar were divided into 3 groups of 10 each, GROUP A_1 (10): with Kido Dent – MouthRinse, GROUP B_1(10) : with KidoDent Toothpaste, GROUP C_1 (10) : Baseline for **MICROHARDNESS TEST.**

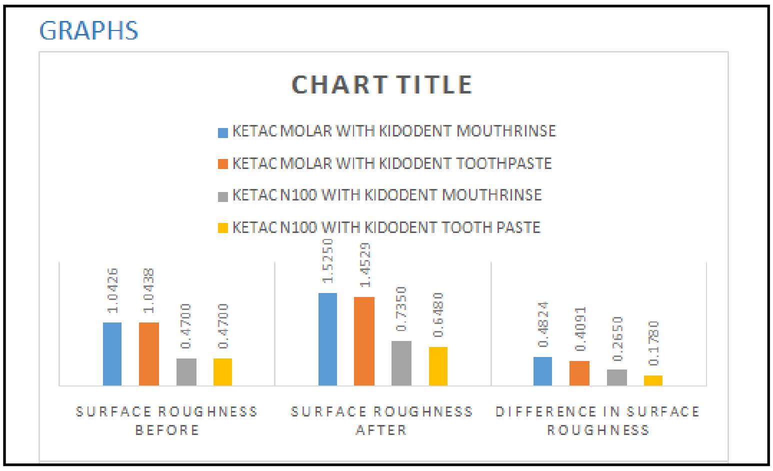
Surface roughness of specimens of group A_1,A_2 and group B_1,B_2 was tested prior to their respective topical fluoride treatments using **Surface profilometer**. To measure the roughness profile value, the diamond stylus is moved across the surface under a constant load of 3.9µm.The instrument is calibrated using a standard reference specimen, and then set to travel at a speed of 0.1mm/s with a range of 600um during testing. This procedure was repeated 3 times for each specimen and the average values were considered to be the surface roughness value. After initial surface roughness recording the specimens are subjected to their respective topical Fluoride treatments.

For G**roup A_1** and **A_2**, **Kido Dent - Mouth Rinse** was applied with cotton roll applicators and allowed it to dry on specimen for 4 minutes. For G**roup B_1**and **B_2**, **Kido Dent - Tooth paste** were applied with cotton roll applicators for 4 min each. All the specimens were rinsed with deionized water, then blot dried and evaluated for changes in surface roughness using profilometer.10 Specimens of **Group C_1** and **Group C_2** were subjected to micro hardness test and were divided in to two groups of 5 each, one group treated with kidodent mouth rinse and other group with kidodent tooth paste for 4 minutes each, which were again subjected to micro hardness test. The specimens were placed on the stage of the tester and stabilized. The area to be intended was observed through an optical viewing system of testing machine. The Vickers diamond intender was positioned on first specimen and testing parameter of 100 gm for 15 s was entered and the test was carried out in automated sequence. The average microhardness of materials was measured from 2 indentations.

III. Results

Data was entered in MS – Excel sheet .The mean surface roughness and Surface Microhardness values were calculated and subjected to statistical analysis. One way ANOVA was used for multiple comparisons followed by paired T test for pair wise comparisons. In all cases there was increase in Surface roughness. Ketac^{TM} Molar showed statistically significant increase in the surface roughness after treatment with with Kidodent mouthrinse (NaF) and Kidodent toothpaste (Sodium monofluorophosphate) with $p<0.01$. Ketac^{TM} N100 shows increase in surface roughness after treatment with Kidodent mouthrinse (NaF) and Kidodent toothpaste (Sodium monofluorophosphate) but not as significant when compared to Ketac ^{TM} Molar.

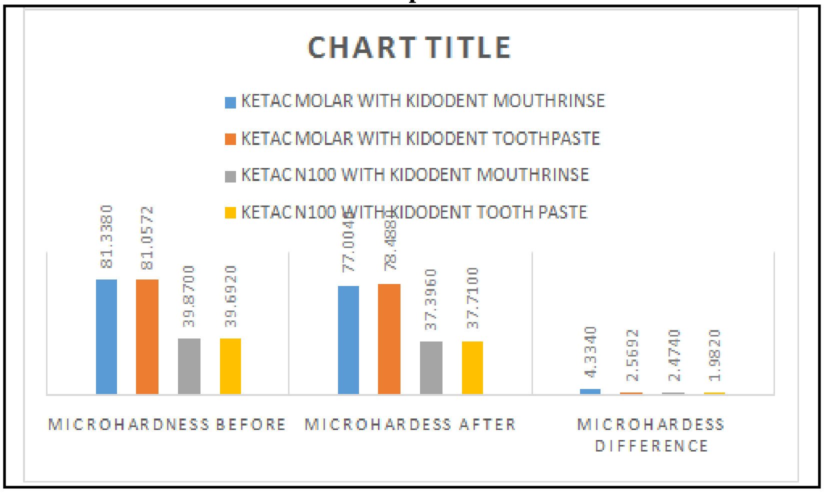
Graph: 1



Graph:1 : Shows effect of Topical fluorides(Kidodent mouth rinse and Kidodent tooth paste) on surface roughness of GICs(Ketac^{TM} Molar and Ketac^{TM} N 100) tested. (Difference between pre and post treatment values).

There was increased difference in Surface roughness in all the groups after surface treatment with topical fluorides ,which is shown in descending order**, Ketac ^{TM} Molar treated with Kidodent mouthrinse > Ketac^{TM} Molar treated with Kidodent toothpaste > Ketac^{TM} N100 treated with Kidodent mouthrinse > Ketac^{TM} N100 treated with Kidodent toothpaste**.Statistically significant increase in surface roughness was seen in case of ketac^{TM} Molar treated with topical fluorides,when compared to that of Ketac^{TM} N 100.In both the groups, Glass ionomer cements treated with Kidodent mouth rinse shows slight increase in surface roughness ,when compared to those treated with Kidodent toothpaste.

Graph:2



Graph:2 Shows effect of Topical fluorides (Kidodent mouth rinse and Kidodent tooth paste) on Microhardness of Glass ionomer cements(Ketac^{TM} Molar and Ketac^{TM} N 100) tested.(Difference between pre and post treatment values).

As the Surface roughness increases Microhardness decreases. There is decrease in Microhardness in all the groups after surface treatment with topical fluorides ,which is shown in ascending order, **Ketac^{TM} Molars treated with Kidodent mouthrinse < Ketac^{TM} Molars treated with Kidodent toothpaste < Ketac^{TM} N100 treated with Kidodent mouthrinse < Ketac^{TM} N100 treated with Kidodent toothpaste.** Increased reduction in microhardness was seen in case of Ketac^{TM} Molar treated with topical fluorides ,when compared to Ketac^{TM} N 100.In both the groups,GICs treated with kidodent mouthrinse shows slight decrease in microhardness,when compared to those treated with kidodent tooth paste.

IV. Discussion

Conventional glass ionomer used in this study was GIC Ketac^{TM} Molar, which constitutes of powder Ca,La,Al fluorosilicate glass and liquid containing Polycarboxylic acid and Tartaric acid, which is preserved with benzoic acid. Resin modified light cured glass ionomer contains aqueous component De-ionized water, Methacrylate component blend including HEMA, Polyalkenoic acid component , Filler components , Nanomers, and Nanoclusters.Topical fluorides used in this study were mouthrinse constituting of NaF 0.05% ,Xylitol 5% and Triclosan .03%. and tooth paste containing 0.038% Sodium monofluorophosphate.The study involves 3 parameters:

- Comparitive evaluation of the Effect of Topical fluoride agents on **surface roughness** of Glass Ionomer cements

In the present study, Sodium fluoride NaF (.05%) in mouthrinse and Sodium monofluorophosphate (NaMFP) (.O38%) in toothpaste produced statistically significant increase in surface roughness of Ketac^{TM} Molar tested(Graph-1). Akselsen and Rolla suggested that this was due to preferential breakdown of polymer matrix and intact crystals by fluoride ion. Chemically the effect may be characterized by disintegration rather than dissolution[3]. Surface disintegration is caused by a selective attack on the polysalt matrix between the residual glass particles. The polysalt matrix of the set cement is the result of the formation of contact cation–anion ion pairs or complexes between the carboxylic groups of the polyalkenoic acid and metallic ions, especially trivalent aluminium, leached from the glass particles In contact with a NaF solution, the concentration of fluoride in the cement gradually increases so that the fluoride ion can compete with carboxylate groups to form complexes with the Al^{3+} ions. The formation of higher order fluoride complexes $[Al(H_2O)_{6-n}F_n]^{3-n}$ with $n \geqslant 2$ decreases the number of ionic cross-links and site-bounded aluminium causing a gradual disintegration of the polysalt matrix. The extent of chemical erosion then depends not only on the concentration of the fluoride solution but also on the time and frequency of immersion[8].

In our study Surface roughening caused by NaF and NaMFP solution was significantly less for Ketac^{TM} N 100 compared to Ketac^{TM} N 100. This change can be attributed to the type and size of filler particles. Ketac^{TM} N 100 showed lesser surface alterations when compared to conventional glass ionomer cement on application of (.05%) NaF and (.038%) NaMFP. This can be explained by the fact that the matrix of Resin modified light cured glass ionomer cement is obviously not susceptible to degradation by neutral fluoride solutions as the resin glaze provided a greater protection to the light cured glass ionomer surface from the erosive actions of NaF .. Consequently, only a disintegration of the polysalt matrix part occurs. Such selective degradation not only accounts for the observed difference in surface roughening between GIC and RM-GIC, but could also explain the scaly erosion pattern of RM-GIC[9].

- Effect of Topical fluoride agents on **Microhardness** of Glass Ionomer cements.

The results of this study showed that NaF and NaMFP causes reduction (Graph 2) in the surface microhardness values of Ketac^{TM} Molar. Presence of polymerizable monomers could be the reason for greater resistance of light cured resin modified glassionomers to acidic challenge. This was due to surface degradation attributed to increased alkalinity of the NaF during the ion exchange between the glass ionomer and storage solution.NaF may produce dissolution of the restorative materials used[10].

- To evaluate and compare between the effect of two Topical fluoride agents, **KidoDent–MouthRinse** and **KidoDent –Toothpaste** on the surface roughness and Microhardness of GICs.

In this study both the groups, Glass ionomer cements treated with Kidodent mouth rinse (.05%NaF) showed slight increase in surface roughness and reduction in microhardness, when compared to those treated with Kidodent toothpaste (.038% NaMFP).This was similar to the results showed by Billington .He reported the ability of glass ionomer cements (GICs) to take up therapeutic ions, e.g. K^+ and F^-. F^-ions also disrupt the GIC surface. Monofluorophosphate (MFP) ion is a therapeutic alternative to F^-. The glass ionomer surfaces exposed to NaMFP were considerably disrupted though less than those exposed to NaF[11]. When exposed to MFP, GICs behave very similarly when exposed to F^-. When MFP was added to a GIC without F it rendered surface disruption as similar to NaF[12].

The increased surface roughness and decreased microhardness of restorative materials after topical fluoride applications particularly NaF and NaMPF applications have several clinical implications.The increased roughness could become an area to harbour the colonization of S.mutans[6]. Increased plaque formation has been found on conventional glass ionomer cements in situ. This could potentially increase the risk of periodontal disease and dental caries, especially subgingivally, although pathogenicity of the plaque may be low[13]. The increased roughness may be a reflection of the deterioration of the materials. Protection of the glass ionomer restorations by adding fresh cement or resin composite overlays may be considered if the restorations are not replaced[14]. Loss of hardness of the material may contribute to the deterioration of the material in a clinical environment, including loss of anatomical form and discolouration[15].

V. Conclusion

Topical fluorides like Kidodent mouthrinse and Kidodent toothpaste, can cause increase in surface roughness and decrease in microhardness when applied over glass ionomer cements like Ketac^{TM}Molar (Conventional GIC) and Ketac^{TM} N 100 (Resin modified light cured GIC), which may produce erosion and eventual degradation of the material thereby significantly shortening the life span of such restorations.

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