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Preheating effect on polymerization shrinkage of composites Restoration (in vitro comparative study)

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Abstract Background: this vitro study aims to evaluate and compare the effect of preheating on polymerization shrinkage among three different filler size composites which include Filtektm Z250 micro hybrid, Z250xt Nano hybrid and nanocomposite Z350xt. in Class II cavity preparation. Materials and methods: 72 maxillary 3rd molars with class II cavities preparations. according to material used the samples were divided into three groups: group A (FiltekZ250 micro hybrid). Group B(Z250xt Nano hybrid). Group C (nanocomposite Z350xt), each group were divided according to temperature of composite into 2 subgroups of 12 teeth: Group A1 composite restoration at room temperature(24±1˚C), A2 composite restoration at preheated temperature(55±1˚C). polymerization shrinkage was estimated after immersion in 2% methylene blue for 24 hrs. Results: the least score of polymerization shrinkage were in Group B(Z250xt Nano hybrid) and Group C (Z350xt nanocomposite) especially in occlusal margin. While Group A(Z250 micro hybrid) had greater scores of shrinkage in cervical margin. Conclusions: Generally, preheating decreased polymerization shrinkage in all groups of composites, but Preheating decreased the polymerization shrinkage effectively in Group A (Z250 micro hybrid) more than Group B (Z250xt Nano hybrid) and Group C (Z350xt nanocomposite) polymerization shrinkage. The scores of polymerization shrinkage varied with different material, margin and temperature for all groups.

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Keywords: *Polymerization shrinkage; preheating.*

1. INTRODUCTION

Direct composite restorations became more popular than conventional amalgam restorations [1] due to Increased esthetic demands and the side effects of mercury in amalgam. The most important features which are responsible for clinical success of the composite restorations are polymerization and degree of conversion of the composite[2]. low viscosity composite (flowable composites) is easier to use, while high viscosity composites are very difficult to adapt well to cavity preparations and may cause unnecessary voids. High polymerization shrinkage is considered the most determining factor for success of direct resin composite restoration among many factors which affect the viscosity of resin [3]. During polymerization process, the pre gel phase changes to a post gel phase. In the post gel stage, the resin has partially set and has no more internal and interfacial stresses (plastic deformation) to compensate for any volumetric shrinkage while during the pre-gel stage, the resin can reorganize themselves without elaborating more internal and interfacial stresses to compensate the volumetric shrinkage [3].

Configuration factor (C-factor) is the ratio of unbonded to bonded surface which makes changing in the polymerization shrinkage of the restoration. So, tensile stresses are elaborated at the resin tooth interface and causes pulling of the material away from the tooth surfaces [4]. In the pre gel stage, only free surfaces of a restoration are consider as a margin for plastic deformation. So, clinically to decrease the polymerization shrinkage by decreasing the C-factor[5]. Recently, due to low viscosity composite ability to increases adaptation and decreases micro-leakage along the restoration tooth interface, low viscosity composites used more widely. Many efforts have been made like using flowable composites, chemical and laser treatments of dentin, reinforcing fibers [6]. Preheating of composite resins before photopolymerization causing increased the degree of conversion by decreasing viscosity and increase flowability. more highly cross-linked polymer network made by increasing both the radical and monomer mobility. In higher temperature [7], mechanical and physical properties of the composite are increased due to increase in conversion, in addition, a better surface hardness and greater depth of cure by pre-warming composites [8].

2. MATERIALS AND METHODS

72 human upper 3rd molar teeth prepared in this research taked from many health centers extracted from patients with age range from 22-35 years, these teeth were stored for a maximum of three months in distilled water at room temperature, before samples were used in the study and put it in sterilized H2O within all parts of the research to avoid dehydration of the

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samples[10]. To decrease disturbing variables [11] only good samples * without cracks* when used fiber _optic light curing device and occlusal anatomy ,nearly similar size of crown when examined by caliper(digital) to examine the bucco-lingually , mesio-distally area and ICD for each sample [12] A restoration template was prepared; Artificial (acrylic) Tooth maxillary second molar located in resin (self–cure acrylic) in box made from metal material with 10x14 cm dimensions, then drilled a space for a sample(in acrylic templet) . Fix the sample (in touch with each other) by a screw. The space for the examined tooth was fully -fill with light body of poly methyl siloxane material before putting a sample to enhance the P.d.L action. The examined sample located in acrylic template after that prepared cavity [13] Modified dental surveyor used to standardized the cavity preparations of specimens, then applied the sample on the table of surveyor horizontally, used modified arm of surveyor mesio-distally to prepare (MO) cavity by high speed hand-piece, with diamond flat fissure bur and every 4 cavities bur was replaced by a new 1 (for high cutting efficiency), Class II cavity prepared mesially for each sample with 2.9mm width, 3.5-4.5mm (axial height) above the CEJ (1mm), and 2.5mm depth , Thich of marginal ridge 2.5mm , after that all preparations were cleaned with water for thirty seconds and dried with cotton for fifteen second before Appling of composite[14]. Three groups of Samples ,24 teeth in each of them(Group a: samples are filled by Z250 micro -hybrid universal, Group b: samples are filled by Z250^{xt} Nano- hybrid Group c: samples are filled by nano-composite) ; then these group divided to two from 12 teeth (a1 and a2 are filled by Z250 micro -hybrid but a1;{at (23±1˚C)} a2: {at (55±1˚C)}; b1 and b2 samples are filled by Z250^{xt} Nano- hybrid but a1{at (23±1˚C)} b2 {at (55±1˚C)}. c1and c2; samples are filled by Z350^{xt} nano-composite but c1 {at (23±1˚C)} and C2: {at (55±1˚C)}

Etching material (37% phosphoric- acid) put on the samples cavities for 15 seconds, cleaned (by water) for fifteen seconds and after that dried for fifteen seconds with cotton , after that scotch Bond(bonding agent) applied 2layer for ten seconds to permit evaporation of solvent then cured (10 seconds). digital radiometer was used before every single use of curing(checking intensity of curing device). Band with matrix { located all around sample for all samples and then used wedges in interproximal area[10]. all restoration groups filled by 2 mm composite layers, after that cured for twenty second for all layer of composite at room temperature and at heating temp. The composite put and cured directly (control samples), heating device used at temperature(55±1˚C) to heat the other groups. Sensor rod made from metal used to check the temp. of composite until reached (55±1˚C), then preheated composite applied to the cavity immediately after taking it out from the heating unit. bur No.170 used to remove the excess materials, disk system (TOR VM Russian Dental Manufacturing compony) used for finishing and polishing.

All teeth were stored for a minimum of 24 hours at room temperature in distilled water[7]. Thermocycling procedure done by cycling the samples five hundreds cycles between two customized water baths. Mechanical load cycling were subjected to all the samples by using a customized device by subjected all teeth to 50,000 cycles of fifty N (obtained by using 5 kg weight), this force was applied intermittently[12]. the apices of the teeth sealed by Blue wax then the samples painted with 2 coats of finger nail varnish, to prevent dye penetration leaving a 1 mm margin around the cavity, then 2% methylene-blue solution used to soak the samples for 24 hour at room temperature. after removal of the specimens from the dye solution, a slurry pumice and rubber cup used to remove the outer layer of dye[13]. dental surveyor used during placing the root with the long axis of the tooth in chemically cured acrylic resin. Then longitudinal section made in the sample mesio-distally. Stereomicroscope used to evaluate and detect polymerization shrinkage in the restored sectioned teeth, which determined through methylene-blue penetration was scored according to standardized criteria (0 to 4)at tooth- composite interface : (occlusally) 0: no dye leak , then dye leak 1: less than half of distal wall, 2: full length of distal wall 3: the half of pulpal floor ,4: more than the pulpal floor. cervically 0: No dye leak , then dye leak 1: less half than the cervical wall,2: full length of cervical wall,3: more than half length of the axial wall ,4: full the axial wall.[14]

3. RESULTS

Statistical analysis for all data of this research done by SPSS (version20) which consists of

1. Descriptive statistics represent by bar chart from tables and graphic and have Arithmetic mean, (SD), Minimum and Maximum value, since microleakage in group a is higher than group B and group C with highly significant in total p=0.008 at (23±1˚C) p = 0.002 since p<0.02 while is not significant at (p=0.556)at (55±1˚C) occlusally and Descriptive statistics of Group a are higher than Group B and Group C cervically . Cervical microleakage in group a then group Band less microleakage was found in Group C with highly significant in total (p=0.002) at 23±1˚C (p=0.000) since p<0.01 ,While is not significant at(55±1˚C) (p=0. 454).

2.Inferential statistics represented by Kruskal Wallis test (to calculate the significant difference between groups) and Mann Whitney U test to calculate comparisons among groups}.

since in Mann witney U test, the total microleakage results are not significant except between group a and group C is highly significant p=0.009 p<0.02, and significant at (23±1˚C)

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between group a and group B (p=0.06) p<0.06 , between group a and group C (p=0.028) p<0.02 is highly significant.

2- In cervical margin by Kruskall Wallis and Mann Whitney U tests.

At 23±1˚C microleakage is (highly significant) between groups since p<0.02 except that between Group B and Group C is not significant(p=1.00) 23±1˚C since p>0.05 .

3-Totaly difference between temp.the descriptive statistics (mean rank, mean and median) of groups at 23±1˚C are more than heated groups occlusally mean of Z350 at 23±1˚C is less than heated groups. Microleakage score totally and depend on materials affected at 23±1˚C than that of heated temp., despite of that it was non-significant for all samples and totally p>0.06, except Group A which is highly significant (p=0.008) since p<0.02.

4-The difference of micro leakage between temp. cervically totally and depend on materials using Mann Whitney U tests.

Totally difference between temp. the descriptive statistics, mean rank, of groups 23±1˚C are more than eheated composite groups cervically except (mean rank) of Z250xt at 23±1˚C is less than heated groups, while median , mean have mimic data for both temp. except in Z250 at 23±1˚C are more than heated subgroup.

4. DISCUSSION

As shown in this study, preheated composite (at 55°C) had minimum polymerization shrinkage in Z250 composite compared with same material at 23±1˚C , in contract polymerization shrinkage in both Z250xt and Z350XT not significantly different with same materials at 23±1˚C [15], The Z250 was highly effected because of arranged of composite monomers above each other which permit high cavity wall wettability [16]. High percent of temperature lost after two minutes so the heating composite must apply as soon as possible within 15 second[7]. Due to elastic deformation of preheated composite, curing must be immediately, composite return to its original shape while cooling and move faster far from the tooth surface [14]. So thermal contraction (elastic deformation) will raised by high temperature above 60°C this lead to raised polymerization shrinkage significantly[15]. when temperatures are not changed there is little shrinkage occlusally if compared with cervical margin, because of highly bonded composite to enamel, and the other reason the highest vertical dimensions cervically and this lead to more composite shrinkage. [14,15,16].

5. CONCLUSION

In this in vitro study: The highest result observed in Z250 micro-hybrid cervically. While lowest in Z250^{xt} Nano-hybrid and Z350^{xt} nano-composite occlusally. Generally, micro leakage decreased by preheating in all groups of composites; Preheating decreased micro leakage effectively in Z250 micro-hybrid, While, Z250^{xt} Nano-hybrid and Z350^{xt} nanocomposite micro leakage not effected by preheating significantly.

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