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# THE EFFECT OF THERMOCYCLING ON MICROLEAKAGE OF SELF ETCH ADHESIVE: A FLUID FILTRATION STUDY

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## ABSTRACT:

**Aim**: The aim of the study was to evaluate the effect of thermocycling on microleakage of self etch adhesive using fluid filtration model.

**Materials And Method**: 50 human extracted mandibular molars were used in this study, flat dentin surfaces were obtained by removing enamel using 80 grit silicone carbide paper ,class I cavities were prepared approximately 1.5mm in depth and 4mm in width and were restored using single bond universal adhesive and Filtex Z250 composite resin , the teeth were sectioned horizontally to obtain dentin disc .The specimens were randomly divided into 5 groups : group I – no thermocycling was done (control),Group II- 500 cycles ,group III- 1000 cycles ,group IV -1500 cycles and group V -2000 cycles respectively .The microleakage was evaluated using fluid filtration model.

**Results:** Group V showed the highest amount of microleakage ($4.31X10^{-6}$ ) followed by Group IV ($2.41X10^{-6}$)and group I.II III showed the least microleakage with no significant difference .

**Conclusion:** Thermocycling increases the microleakage of self etch adhesives.

**Keywords:** Thermocycling, Self etch adhesive, Filtex Z250, fluid filtration model.

## INTRODUCTION:

Over the last years there has been tremendous increase in the use of composite resin restoration due to an increase concern of aesthetics amongst people.There have been various innovations in the materials and techniques that sophisticate the restorative treatment procedures particularly in terms of enhancing the clinical success of treatment. The development of adhesive system is constantly evolving, claiming advantages over their predecessors. Etch and rinse adhesive are considered technique sensitive and time consuming. This system of adhesives is largely replaced by self etch due to reduce clinical steps and time effectiveness. Adhesives play a crucial role in bonding the restoration to tooth structure. Secondary caries is a major cause for the failure of restorations. Bacterial by products particularly the acidic components may infiltrate not only the bonding interface, but also the tooth tissue at the periphery, creating a demineralised zone at the margins, and thus rapidly promote caries progression. In this regard, it has been suggested that an increased resistance of the tooth-resin interface to acid may effectively reduce the progression of secondary caries.[1-4]

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Thermocycling is a process of subjecting specimens to different temperature so as to simulate the intraoral temperature changes. It has been reported that thermocycling induces degradation at tooth restoration interfaces due to the difference in the coefficient of thermal expansion of tooth and composite resin. There are few studies evaluating the influence of thermocycling on adhesives.

There are numerous methods for microleakage assessment including from the most commonly used ones i.e., dye penetration, dye extraction to various others like electrochemical , radioactive isotopes ,bacterial penetration method etc however all these methods posses inherent drawbacks and some of them are not clinically relevant .Fluid filtration model was introduced by Pashley et al , the concept of this model was based on the principle of applying constant air pressure on the fluid , the leakage was measured on the means of bubble displacement , this method is considered was one of the reliable method for microleakage testing .Thus in an attempt to study microleakage with an reliable method fluid filtration model was constructed for this study purpose .[5-8]

Hence, the aim of the study was to evaluate the effect of thermocycling on microleakage and to test the null hypothesis that there is no significant difference in microleakage with and without thermocycling using fluid filtration model.

## MATERIALS AND METHODS:

50 extracted mandibular molars stored in 1% chloramine solution were used. Flat dentin surface was obtained by removing enamel with and diamond disc followed by 80 grit silicon carbide paper under running water, so that all the margins of the cavity are in dentin. Class I cavities were prepared on the flat dentin surface using a diamond bur (no .2 ) attached to airotor. The cavity dimensions were 2 mm in depth and 2 mm in width, dimensions were standardised using a periodontal probe. Single bond universal adhesive (3M ESPE) was applied according to manufacturer's instructions and light cured for 10 sec, following which the cavity was restored using Filtex Z250 (3M ESPE ) which was placed in three increments and each increment was light cured for 40 sec using a quartz tungsten halogen (QTH) light curing unit with 650mW/cm² intensity. Using a diamond disc the teeth were horizontally sectioned to obtain a dentin disc approximately 2mm in height and 4 mm in width. The specimens were stored in distilled water at 37 $^{o}$C for 1 week.

The samples were randomly divided into 5 groups. Group I – The specimens were stored in deionised water at 37 $^{o}$C. The remaining groups were subjected to thermocycling in deionised water bath at 5$^{o}$-55$^{o}$C ±2$^{o}$C for 15 sec .Group II- 500 cycles of thermocycling, group III- 1000 cycles, group IV – 1500 cycles and group V – 2000 cycles .All the specimens were subjected to fluid filtration model for assessment of microleakage .

**MICROLEAKAGE TESTING:** Microleakage assessment was done using fluid filtration model.

The system as shown in the Figure 1 consists of two sections:

SECTION A: Consists of the tubes, pipes, syringes, micropipette, control faucet, buffer system (Borosil co.) and the tooth sample

SECTION B: Consists of the recorder of the bubble displacement which includes digital SLR camera (Canon1200D) AutoCAD (Autodesk, Inc.)

An bubble was introduced in the micropipette, following which an constant $O_2$ pressure and the micropipette was connected to tooth sample , movement of bubble displacement was recorded using DSLR camera and the microleakage was calculated using Auto CAD and an custom made software and were expressed in terms of µL/min/cm $H_2O$.

## RESULTS:

The highest amount of microleakage was seen in group V ($4.31X10^{-6}$) followed by group VI ($2.41X10^{-6}$ ), group III ($1.31X10^{-6}$),group II ($1.28X10^{-6}$( and the least in group I ($1.23X10^{-6}$)

*STATISTICAL ANALYSIS:*

The statistical analysis was performed using one way ANOVA test. The results were statistical significant as $P<0.05$ as shown in Table 3

## DISCUSSION:

The demand for aesthetics has resulted into newer modifications in adhesive system. Self etch adhesive has gained popularity due to reduced clinical steps and ease in use. Despite of various modifications, dealing with microleakage continues to an important issue causing restorative failure. Microleakage may be consequence of many factors such as polymerisation shrinkage, contamination, failure to adapt composite to the walls but when it comes to microleakage of self etch adhesive the major factor that might hinder bonding if contamination occurs regardless of saliva or blood [6].

Self etch adhesive have gained popularity over the years due to reduced clinical steps that probably will reduce the risk of contamination and therefore reduce microleakage In this study single bond universal adhesive (3M) was used which is a 7th generation bonding agent which is both hydrophilic and hydrophobic in nature thus providing good strength at both wet and dry etched dentin[14,15] .It provides a distinct hybrid layer and resin tags which improves bond strength and hence single bond universal adhesive was selected in this study to evaluate whether if thermocycling affects microleakage .

Microleakage studies are the most common method of detecting bond failure at tooth restoration interface. Thermocycling is most widely accepted method used to simulate the intraoral

conditions, although some researchers consider it questionable method .The reason behind it is the validity and clinical significance of thermocycling method, since the temperature used may not be same as in the oral cavity. In thermocycling method specimens are subjected to thermal cycles that simulate oral condition .However, there is wide range of temperature difference, dwell time and transfer time' .Thus, there is no standardisation of thermocycling method given in the literature .In the present study 5°C-55°C ±2°C and the dwell time 15S was used. Various authors have studied effect of thermocycling on microleakage using different dwell time, a range of 15 s to 2 mins reported in literature .However it is important to note that increasing the dwell time exceeds the real clinical conditions and may reduce the thermal isolation of the material causing brittleness [10,12].

Geurtsen et al 1997 reported an increase in the microleakage of composite restoration after thermocycling using dye penetration test and a dwell time of 30s² .Iwase H et al reported a gradual increase in microleakage after 4 months of thermocycling, they used a dwell time of 2minutes in the study .In the present study microleakage values have increased after 1500 and 2000 thermo cycles respectively. Various microleakage studies have compared thermocycled and non thermocycled groups and observed no statistically significant difference[1,268], in contrast the results of the present study suggests an increase in microleakage of adhesives after 1500 thermo- cycles .It is important to note that the previous studies are performed either using dye penetration or dye extraction method which are no more consider an reliable method for assessment of microleakage .The present study utilises an reliable method for microleakage evaluation i.e. fluid filtration model however the results recorded are two dimensional in nature and does not mimic the exact clinical microleakage , as the method been In Vitro .

## CONCLUSION

Based on the results of this study, it can be concluded:

1) That there is an increase in microleakage of self etch adhesives with increase the number of thermocycles.

2) 2) The null hypothesis is rejected. as there was a significant increase in microleakage of self etch adhesives as the number of thermocycles increased ,

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sensitivity. J Am Dent Assoc 2003;134: 1621-1629.

## TABLES AND FIGURES:

| Material | Manufacturer | Composition |
|---|---|---|
| Single bond universal adhesive | 3M ESPE | MDP phosphate monomer, dimethacrylate resin, HEMA, vitrebond copolymer, filler, ethanol, water, initiators, silane. |
| Filtex Z250 Nanohybrid composite resin | 3M ESPE | UDMA, Bis-EMA ,Bis –GMA, zirconium glass ,colloidal silica |

Table 1: showing the materials used in the study (single bond universal adhesive and Filtex Z250 nanohybrid composite resin

| Material | Group I | Group II | Group III | Group IV | Group V |
|---|---|---|---|---|---|
| Single bond universal adhesive (3M) | $1.23X10^{-6}$ | $1.28X10^{-6}$ | $1.31X10^{-6}$ | $2.41X10^{-6}$ | $4.31X10^{-6}$ |

Table 2: Showing the results of the study, highest microleakage values are seen in group V and the least with group I .

| Groups | Number of samples | Mean | Standard deviation | P Value |
|---|---|---|---|---|
| I | 10 | $1.23X10^{-6}$ | 0.8±1 | |
| II | 10 | $1.28X10^{-6}$ | 0.8±1 | |
| III | 10 | $1.31X10^{-6}$ | 0.9±1 | P<0.05 |
| IV | 10 | $2.41X10^{-6}$ | 1.2±2 | |
| V | 10 | $4.31X10^{-6}$ | 1.8±2 | |

Table 3 : Showing the statistical analysis of the results of study


Fig 1: Showing the fluid filtration model. A-fluid filtration model with digital SLR camera .B. Lateral view. C. AutoCAD system (amount of bubble displacement).

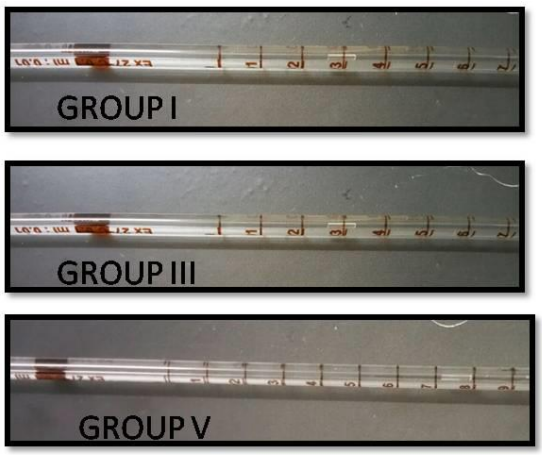
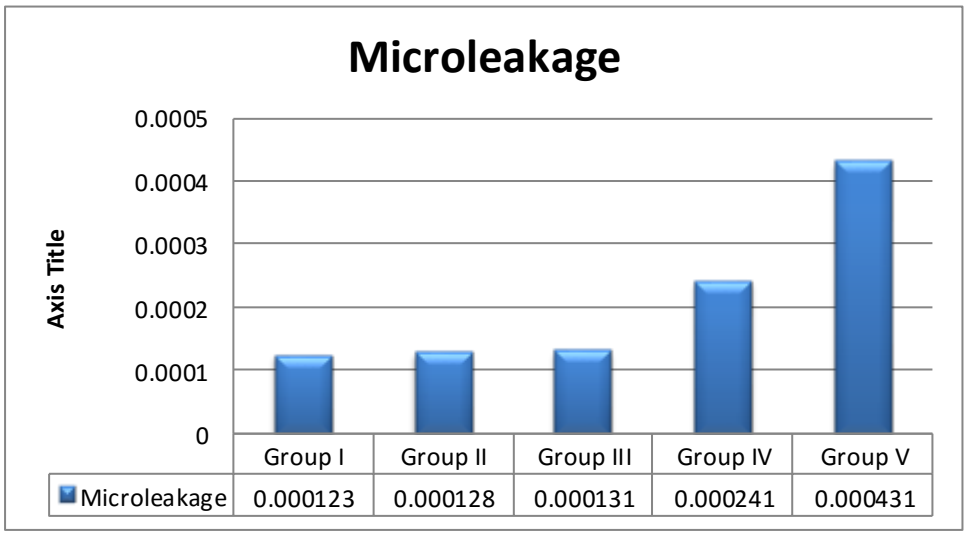



Fig 2: Showing pictures of bubble displacement in the groups (group I ,II ,II I,IV and V respectively)




Graph 1 : Showing the results of the study plotted against graph