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# Assessment and Evaluation of Hydrochloric Acid Microabrasion on Enamel and its Effect on Microleakage of Anterior Restorations

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**الخلاصة**

**الاهداف**: تهدف الدراسة اللى تقييم تأثير حامض الهايدروكلوريك على كشط السن الدقيق ولتقييم استعمال انواع مختلفة من الحشوات الراتنجية ولدراسة تأثير الخزن(تأخير عمل الحشوة)على التناضح المجهري للحشوات الراتنجية بعد الكشط الدقيق وقبل عمل الحشوة. **المواد وطرق العمل**: اربعون سن ضاحك قلعت من اجل التقويم استعملت وذلك بعمل كشط دقيق وحشوات راتنجية لها بأوقات مختلفة حسيب المجاميع الموجودة بالدراسة, تم عمل حفر للحشوات على السطحين الشدقي واللغوي من الاسنان والتي تم ترميمها بحشوة راتنجية من نوع هجين دقيق او حشوة راتنجية من نوع السيراميك النانوي, ثم عوملت الاسنان بالتعريض الحراري, وطليت بطبقتين من طلاء الاظافر وتم تقطيعها طوليا باتجاه شدقي لغوي وتم تقييم تناضح الاسنان المجهري باستعمال اختراق الصبغة التقليدية. **النتائج**: اقل تناضح مجهري لوحظ في الاسنان التي لم تتعرض الى الكشط الدقيق , التناضح المجهري ازداد بعد الكشط الدقيق وبدون فروقات معنوية بالنسبة لجهة الحشوة الاطباقية لنوعي الحشوات المستخدمة, بينما كان هناك فرق معنوي لحشوة السيراميك للجهة العنقية من الحشوة الراتنجية. لم يكن هناك فرق بالتناضح المجهري باختلاف اوقات عمل الحشوة بعد الكشط الدقيق ولم يكن هناك فرق معنوي للتناضح المجهري بالاعتماد على نوعية المواد المستعملة. **الاستنتاجات**: باخذ قيود هذه الدراسة في المختبر ازداد التناضح المجهري بعد الكشط الدقيق وبدون اي تاثير على زمن وضع الحشوة, التناضح المجهري كان اعلى بالجهة العنقية من الحشوة لكل المجاميع وبدون فروقات بالنسبة للمواد المستعملة.

## ABSTRACT

**Aims**: was to evaluate the effect of microabrasion on teeth, to determine the effect of using 2 types of composite resins and influence of storage time on microleakage of composite restorations after microabrasion before making a restoration. Materials and Methods: Forty premolar teeth extracted were used, the teeth were microabrased and composite restorations were made at certain times after microabrasion according to the different groups of the study, a standard cavity was prepared on the two surfaces of the teeth that were restored with either a microhybrid or nanoceramic composite restoration, the teeth were subjected to thermocycling, and sectioned buccolingually longitudinally. Marginal leakage was evaluated using a dye penetration method. Results: Least microleakage scores were observed when the teeth were restored without microabrasion, microleakage increased after microabrasion with no statistically significant difference for the occlusal site for both materials, while a significant difference was seen in favor of Tetric N ceram at the cervical sites. No difference in microleakage scores were observed regardless of the time of restoration after microabrasion, there was no significant difference in microleakage scores depending on the type of the material .Conclusion: given the limitations of this study, there was an increase in levels of microleakage after microabrasion of teeth, regardless of the time of application of the restoration, microleakage was higher in gingival margins in all the groups, and no significant difference in microleakage scores depending on the type of material at the occlusal margin.

**Keywords**: Fluorosis, Microabrasion, Composite Restorations, Hydrochloric acid

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## INTRODUCTION

Discoloration of the teeth is frequently seen in the general population [(1)]. Young individuals are obsessed with their physical appearance and many attractive smiles are troubled by some type of simple defect that can be corrected easily, either on an individual tooth or on all teeth [(2)].There has been an increase in the number of people seeking treatment for dental stains. Hence; the dentist must be ready to manage these patients.

Stains could have an extrinsic or intrinsic etiology, identification of the type of stain and its etiology are important because it dictates how the dentist can manage the condition [(3)]. Bleaching and enamel microabrasion are considered as conservative methods used for removing or improving discolorations limited to the enamel layer [(4,5)].

Dental fluorosis is the most common indication for enamel microabrasion as fluorosis produces opaque white areas or yellow to dark brown discolorations with porosities on the enamel surface[(6)], microabrasion procedure should be considered the first optional line of management [(7)].

Aims of the study were to evaluate the effect of hydrochloric acid microabrasion on teeth, to determine the effect of using different types of composite resins (microhybrid and nano-ceramic) on microleakage after microabrasion, and to determine the influence of storage time on microleakage of composite restorations after microabrasion before making a restoration.

## MATERIALS AND METHODS

The study was approved by Research Ethics Committee board (University of Mosul, College of Dentistry, REC reference No. POP/Ib.20/10/20).

Forty extracted upper human premolar teeth for Orthodontic reasons were collected cleaned and polished, they will be examined so that they were free from cracks and caries or fluorosis. The teeth were applied in 0.1 % thymol until the time of use. The teeth were divided in to the following groups:

**Group One: Restorations applied on the tooth surfaces without microabrasion (Control Group 10 teeth)**

Buccal cavity preparations were restored with Shade A3 Tetric N ceram (Ivoclar vivadent Germany) while the lingual cavities were restored with Shade A3 Hybrisun which is a universal microhybrid (Mega-Physik D76437 Restatt Germany) for all the other groups.

**Group Two: Restorations made immediately after microabrasion (10 teeth)**

Cavities were made and filled with the two types of composite materials as in the first group immediately after performing microabrasion.

**Group Three: Restorations made after three days of microabrasion (10 teeth)**

Cavities were made and filled with the two types of composites after three days of microabrasion, immediately after the

microabrasion they were stored in distilled water until they were restored.

**Group Four: Restorations made after seven days of microabrasion (10 teeth)**

Also in this group, microabrasion was performed to the teeth, they were then stored in distilled water for seven days then cavities prepared and restored as in the previous groups.

The protocol for the work was as follows:

**Microabrasion Procedure:**

For performing the microabrasion to the teeth, 6.6% hydrochloric acid slurry that contains silicon carbide microparticles (Opalustre, Ultradent U.S.A) was used the acid was applied from the syringe with 1.00mm thickness to the labial surfaces. A handpiece was then used at a slow RPM rate, with the rubber cups (Products Dentaires S.A. Switzerland) directly on the enamel surfaces for up to 60 seconds figure(1) as described by the manufacturer without shaving .

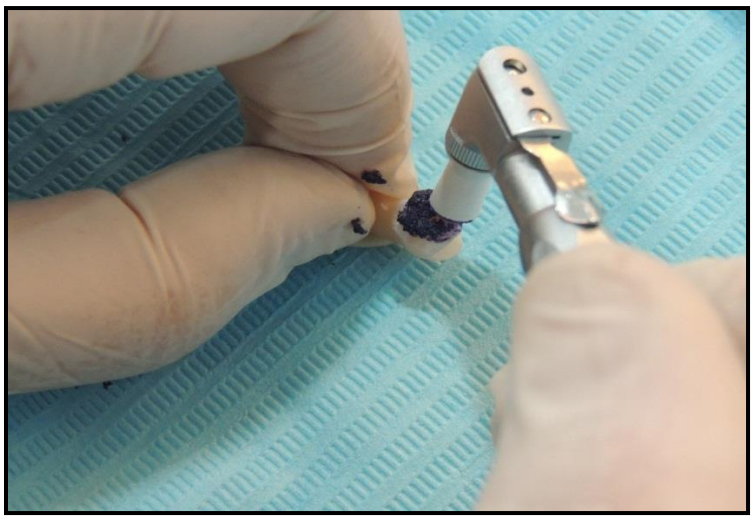

**Figure (1):** Microabrasion of Teeth

**Restorative Procedure:**

After microabrasion for the immediate restoration group a standard class V cavity (mesiodistal width of 4mm, occlusogingival length of 3mm was prepared with a use of a mechanical pencil on the surfaces of the teeth, depth of cavity 2mm) [8], then using a high speed diamond flat end fissure bur (Dia Dent, Korea ) with water as a coolant in the middle third of the buccal and lingual surfaces of the premolars, cavity dimensions during work were constantly checked by a vernia, the diamond bur was changed every fifth preparation, the other groups that were subjected to microabrasion were stored in distilled water until the time of restoring them, for the cavity restoration, the enamel surface was first etched with 37% phosphoric acid gel for 15 seconds (Alpha dent U.S.A), rinsed for 15 seconds and dried, a bonding agent

was then applied homogeneously with a disposable brush tip (Southern Dental Industries, Australia) to the entire cavity walls, excess adhesive was removed by a mild air flow from the triple syringe and then light cured for 20 seconds with an LED light (WMD China), that was checked with a curing radiometer and was found to have an output of 1200 mW/cm, the cavities were then restored with either type of filling material (either Tetric N ceram or Hybrisun ).The other groups were microabraded in the same method.

All cavities were prepared and restored by the same operator.

**Dye Penetration Test:**

After all the groups were restored, the teeth were subjected to manual thermocycling between 5 and 55℃, with a dwell time of 15 seconds [(9)]. The teeth were then coated with a double layer of nail varnish (except for the area of the restoration),the apices of the teeth were sealed with cold cure acrylic resin to prevent dye penetration through the canals and immersed in 0.2% metheylen blue for 24 hours [(10)], then embedded in a block of clear acrylic resin(Dentarum, Germany) and sectioned with dissecting disks longitudinally using a One-slice cutting technique through the center of both the restorations.

Marginal leakage was evaluated using a conventional dye penetration method. The dye penetration was quantified for both the occlusal and the cervical margins of the restorations. The degree of dye penetration was then graded at 40X magnification with a dissecting microscope (Altay, Italy), evaluation of leakage was made with a 3-point severity scale as described by Yaicin *et al* 2006 [(11)].

| Score | Criteria |
|---|---|
| **0** | No Microleakage, No dye penetration |
| **1** | Dye penetration up to one-third of the cavity wall |
| **2** | Dye penetration more than one-third but less than two thirds of the cavity wall |
| **3** | Dye penetration more than two-thirds of the cavity wall |

**Statistical Analysis**

An SPSS 18 program was used to analyze the data, frequency and percentage of dye penetration were calculated. Non-parametric tests, Kruskal Wallis was used to compare for all the groups and Mann-Whitney was used to compare between two groups, the results were considered significant when $P \leq 0.05$ .

## RESULTS

Table (1) displays the frequency of dye penetration scores in terms of the two materials at the occlusal and cervical sites before and after microabrasion. The results

showed that the control group that was restored without microabrasion showed the least leakage scores regardless of the material type with either no ( score zero) or little microleakage (score one). After microabrasion, there was an increase in the frequency and the severity of the microleakage reached score three.

**Table (1):** Frequency and Percentage Distribution of Microleakage Scores for Both Materials at Both Sites for all the Groups**.**

| No. | Groups | Site | Material | Frequency of Microleakage Scores | | | | Percentage of Microleakage Scores | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **0** | **1** | **2** | **3** | **0** | **1** | **2** | **3** |
| 1 | Control | Occlussal | Tetric | 10 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| | | | Hybrisun | 8 | 2 | 0 | 0 | 80 | 20 | 0 | 0 |
| | | Cervical | Tetric | 6 | 4 | 0 | 0 | 60 | 40 | 0 | 0 |
| | | | Hybrisun | 4 | 5 | 1 | 0 | 40 | 50 | 10 | 0 |
| 2 | Immediate Restoration after Microabrasion | Occlussal | Tetric | 6 | 2 | 2 | 0 | 60 | 20 | 20 | 0 |
| | | | Hybrisun | 4 | 2 | 4 | 0 | 40 | 20 | 40 | 0 |
| | | Cervical | Tetric | 1 | 1 | 4 | 4 | 10 | 10 | 40 | 40 |
| | | | Hybrisun | 1 | 0 | 1 | 8 | 10 | 0 | 10 | 80 |
| 3 | 3Day After Microabrasion then Restoration | Occlussal | Tetric | 6 | 1 | 1 | 0 | 60 | 40 | 0 | 0 |
| | | | Hybrisun | 3 | 7 | 0 | 0 | 30 | 70 | 0 | 0 |
| | | Cervical | Tetric | 3 | 1 | 3 | 3 | 30 | 10 | 30 | 30 |
| | | | Hybrisun | 1 | 0 | 5 | 4 | 10 | 0 | 50 | 40 |
| 4 | 7 Day After Microabrasion then Restoration | Occlussal | Tetric | 6 | 4 | 0 | 0 | 60 | 40 | 0 | 0 |
| | | | Hybrisun | 4 | 3 | 2 | 1 | 40 | 30 | 20 | 10 |
| | | Cervical | Tetric | 2 | 2 | 4 | 2 | 20 | 20 | 40 | 20 |
| | | | Hybrisun | 1 | 0 | 2 | 7 | 10 | 0 | 20 | 70 |

Figures (2 & 3) show the percentage of microleakage scores at the occlusal and cervical site for both materials, least microleakage scores were found in the controls depending upon type of the material, after microabrasion ,there was an increase in microleakage scores (i.e score 3) at the cervical region for both materials regardless of the time of applying the restoration after microabrasion.

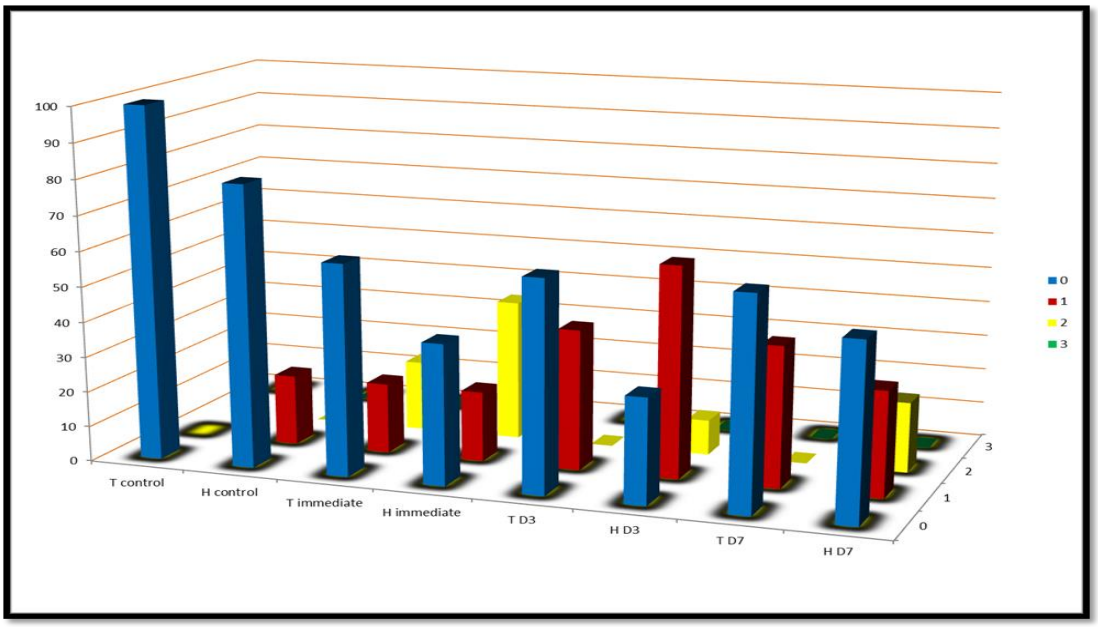


**Figure (2):** Percentage of Microleakage Scores For Both Materials at Different Times Occlusally , T=Tetric , H=Hybrisun , D3= Day Three, D7= Day Seven

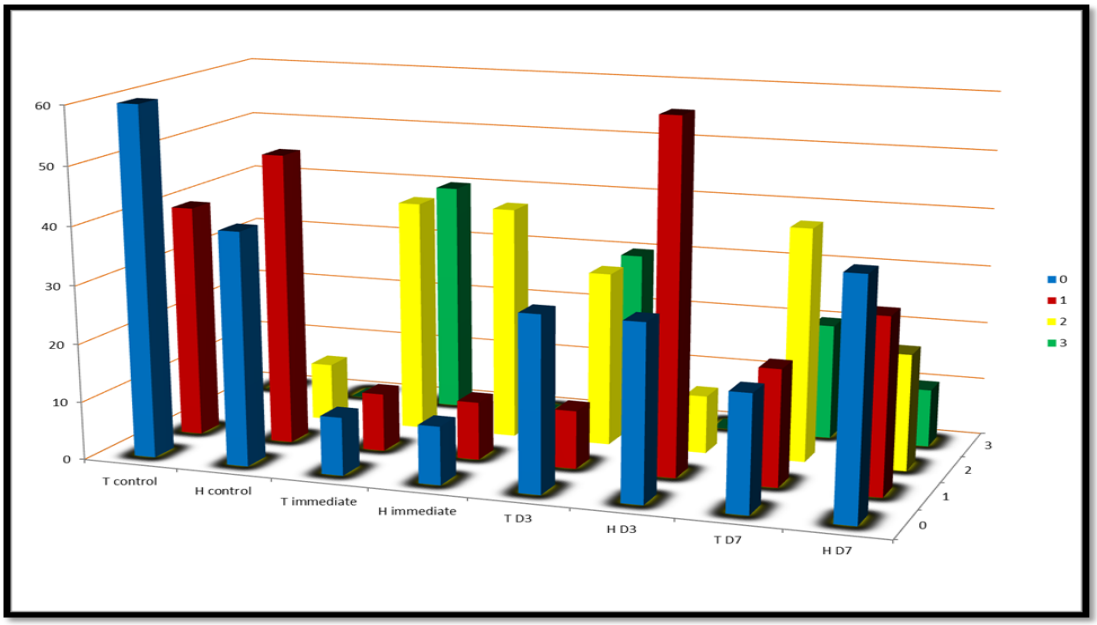


**Figure (3):** Percentage of Microleakage Scores For Both Materials at Different Times Cervically., T=Tetric , H=Hybrisun , D3= Day Three, D7= Day Seven

Table (2) displays the comparison of the microleakge score between the groups for both materials at both sites, a highly statistically difference was found in the occlusal for Tetric- N ceram for both sites a significant difference was found in the cervical of Hybrisun, while occlusal of Hybrisun exhibited no significant difference.

**Table (2):** Comparison of Microleakage Scores For all the Group

| Material | Site | Chi-Square | Degree of Freedom | P Value |
|---|---|---|---|---|
| **Tetric N ceram** | Oclussal | 23.228 | 3 | 0.000** |
| | Cervical | 11.707 | 3 | 0.008** |
| **Hybrisun** | Oclussal | 6.225 | 3 | 0.101 |
| | Cervical | 18.023 | 3 | 0.000** |

Kruskal – Wallis , **P ≤ 0.00 Highly Statistically Significant

Table (3) illustrates the comparison of the microleakage scores between the groups restored with Tetric N- Ceram at the occlusal and cervical sites, a significant difference was observed between the control group and the groups that were restored immediately, after three and seven days for the occulsal site, while a highly statistically significant difference was observed between the control group and the group that were restored immediately, and groups that were restored after three and seven days for the cervical site. No significant difference was observed in the restoration that was done immediately after microabrasion versus the delay of three and seven days after the microabrasion for both sites before applying the restoration (i.e. occlusally and cervically).

**Table (3):** Comparison of the Microleakage Scores Between the Groups Restored with Tetric N- Ceram( Nanocomposite) For the Occlusal and Cervical Site

| No. | Groups | Site Occlussal Material Tetric Nceram | | Site Cervical Material Tetric N ceram | |
|---|---|---|---|---|---|
| | | Z Value | P Value | Z Value | P Value |
| **1** | Control Versus Immediate Restoration After Microabrasion | -2.166 | 0.03* | -3.218 | 0.001** |
| **2** | Control versus 3Day After Microabrasion then Restoration | -2.179 | 0.029* | -2.165 | 0.030* |
| **3** | Control Versus 7 Day After Microabrasion then Restoration | -2.179 | 0.029* | -2.54٧ | 0.011* |
| **4** | Immediate Restoration After Microabrasion Versus 3Day After Microabrasion then Restoration | -0.347 | 0.728 | -1.326 | 0.185 |
| **5** | Immediate Restoration After Microabrasion Versus 7 Day After Microabrasion then Restoration | -0.347 | 0.728 | -1.417 | 0.157 |

Mann-Whitney Test. ** P≤0.00 Highly Significant , * P≤0.05 Statistically Significant

Table (4) depicts the comparison of the microleakage scores between the groups restored with Hybrisun for both the occlusal and cervical site, again the same picture of results for the previous material are presented here, a significant difference was observed between the control group and the groups that were restored immediately, after three and seven days for the occulsal site, while a highly statistically significant difference was observed between the control group and the groups that were restored immediately, after three and seven days for the cervical site. No significant difference was observed in the restoration that was done immediately after microabrasion versus the delay of three and seven days after the microabrasion before making the restoration for both sites (i.e. occlusally and cervically).

**Table(4):** Comparison of the Microleakage Scores Between the Groups Restored with Hybrisun ( Microhybrid) For the Occlusal and Cervical Site

| No. | Groups | Site Occlussal Material Hybrisun | | Site Cervical Material Hybrisun | |
|---|---|---|---|---|---|
| | | Z Value | P Value | Z Value | P Value |
| 1 | Control Versus Immediate Restoration After Microabrasion | -2.068 | 0.039* | -3.296 | 0.001** |
| 2 | Control versus 3Day After Microabrasion then Restoration | -2.190 | 0.028* | -3.086 | 0.002** |
| 3 | Control Versus 7 Day After Microabrasion then Restoration | -1.982 | 0.047* | -3.296 | 0.001** |
| 4 | Immediate Restoration After Microabrasion Versus 3Day After Microabrasion then Restoration | -0.734 | 0.463 | -1.563 | 0.118 |
| 5 | Immediate Restoration After Microabrasion Versus 7 Day After Microabrasion then Restoration | -0.080 | 0.963 | -0.449 | 0.654 |

Mann-Whitney Test. ** P≤0.00 Highly Significant , * P≤0.05 Statistically Significant

Table (5) illustrates the comparison of the microleakage scores between Tetric N Ceram and Hybrisum According to the occusal and cervical site. In general there was no statistically significant difference between the two types of materials except for the seven-day cervical group in favor of the Tetric N Ceram.

**Table (5):** Comparison of the Microleakage Scores Between Tetric N Ceram and Hybrisum According to the Occusal and Cervical Site

| No. | Groups | Site | Material | Z Value | P Value |
|---|---|---|---|---|---|
| **1** | Control | Occlussal | Tetric Hybrisun | -1.453 | 0.146 |
| | | Cervical | Tetric Hybrisun | -1.023 | 0.306 |
| **2** | Immediate Restoration after Microabrasion | Occlussal | Tetric Hybrisun | -0.989 | 0.323 |
| | | Cervical | Tetric Hybrisun | -0.198 | 0.843 |
| **3** | ٣Day After Microabrasion then Restoration | Occlussal | Tetric Hybrisun | -1.314 | 0.189 |
| | | Cervical | Tetric Hybrisun | -1.043 | 0.297 |
| **4** | 7 Day After Microabrasion then Restoration | Occlussal | Tetric Hybrisun | -1.325 | 0.185 |
| | | Cervical | Tetric Hybrisun | -2.095 | 0.036* |

Mann-Whitney Test.

Figure (4) shows us the various degrees of microleakage observed in the study as seen under the dissecting microscope.

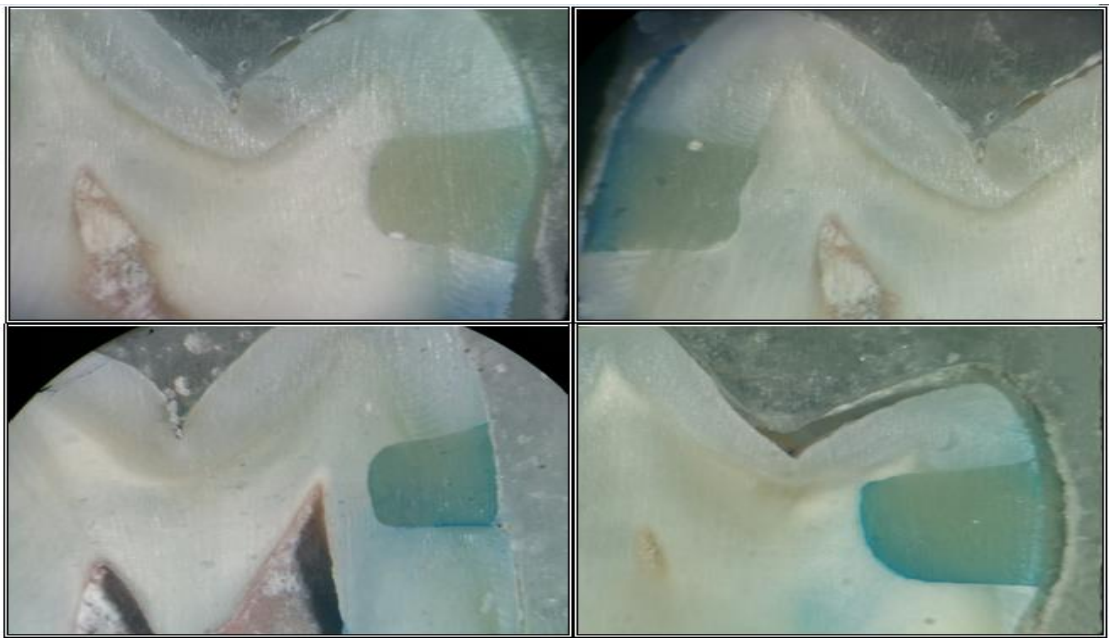

**Figure (4)**: Degrees of Microleakage From Right to Left upper Score zero, 1, lower Score 2,3 .

## DISCUSSION

One of the most challenging aspects of dentistry involves the esthetic resolution of different types of spots present on the dental enamel. Excessive chronic intake of fluorides in amounts that exceed the optimal daily dose of 1 ppm can result in dental fluorosis. Fluorosis of teeth can be restored for functional or aesthetic reasons by composite resin [(12)]. Composite resins have had their properties and characteristics substantially improved since they were introduced in dentistry leading to an excellent acceptance by the dentists [(13)]. Previous studies utilizing microabrasion documented case report studies[(14,15)]. The current invitro study used sound premolar teeth that were microabraded because it was impractical to obtain fluorosed teeth. The current study evaluated the effect of using enamel microabrasion and performing an anterior restoration for esthetic purposes in the treatment of fluorosis [(12)] or in the treatment of caries that have some times been reported to be high in fluoridated areas [(16,17)]. Enamel microabrasion utilizes an acid and agents used to perform abrasion for treatment of different defects present on the enamel such as fluorosis, in the current study Opalustre, which is a 6.6% hydrochloric acid slurry that contains silicon carbide microparticles was used, this provides chemical stain removal along with gentle mechanical abrasion due to the presence of the silica, from a rubber cup. An ideal microabrasion technique should produce insignificant enamel loss, no damage to the pulp or gingival tissues, and satisfactory and permanent results in a short clinical time without no pain or inconvenience to the patient [(18)]. As of today, there are no quantitative methods applicable and valuable for the microleakage determination, thus we have above indicated the amount of microleakage through quantification. Looking at the scores of microlakage, and although all the groups were subjected to thermocycling, which exposes both the restorations and the teeth in vitro to extreme temperatures, such as that can occur in the mouth. It was observed that the control group exhibited no to very limited microleakage depending upon the type of material and site, when microabrasion was induced, there was an increase in the microleakage scores as all the microabraded groups regardless of the time of applying the restoration and type of material, as extensive dye penetration at their seals was observed, this is due to the inability of the resin material to adhere properly to the enamel surface, this might be attributed to the enamel loss from all the abraded surfaces [(19)]. After thermocyling and due to differences in the coefficient of thermal expansion of the filling material and the hard tooth tissue which lead to the formation of a gap at the margins [(20)] interface between the resin and tooth causing leakage of the dye in the formed gap leading to increase of microleakage.

There was an increase in the microleakage groups regardless of the type of material and time of application of the restoration. In contrast to previous studies of dental bleaching that is also considered one of the conservative methods of handling intrinsic staining, waiting after the bleaching procedure and applying a restoration after a delayed time of bleaching, resulted in reduced microleakage scores [21].

Another interesting finding was that there was an increase in the leakage scores in particularly in the cervical area with highly statistically significant difference compared with the occlusal for both types of materials, this might be attributed to that the number of enamel rods are much less than occlusally [22, 23] and also were subjected to microabrasion which resulted in more loss of enamel rods in this area. This comes in line with previous studies of class V microleakage in general that showed statistically significant differences in favor of the occlusal site [8,24] .There are no previous in vitro studies utilizing the same microabrasion methodology to compare our results with.

Another important finding was that there was no significant difference between Tetric N ceram which is a nanocomposite compared with the Hybrisun which is a microhybrid especially in the occlusal site of the cavity. A previous study found nanocomposites had superior properties with better adaptation and less polymerization shrinkage to other types of microhybrid[25].Which might be attributed to the reason that microabrasion resulted in removal of a thin layer of the enamel and may have affected the stricter of the enamel, so there was no effect for the change of the type of material. The current study showed that microabrasion resulted in changes in the superficial enamel tooth structer and remineralization may be needed before making the restoration.

## CONCLUSION

Based on the findings of this study and given the limitations of an in-vitro study, there was an increase in levels of micro-leakage after microabrasion of the teeth, regardless of the time of application of the restoration, microleakage was higher in gingival margins in all the groups, and no significant difference in microleakage scores in nanocomposite compared with the microhybrid. Future studies should evaluate applying the microabrased teeth in artificial saliva or remineralizing agents to determine their effects on the microabrased teeth should be investigated.

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