

An *in vitro* microleakage study on a new dental amalgam alloy

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ABSTRACT

This study was done to evaluate the microleakage of a new dental amalgam alloy called Al-Rafidain and compare it with an already experimented and known alloy called Degussa by using the dye penetration technique (0.5% methylene blue) after (10) days of storage, results of microleakage revealed no significant difference between restorations of the Degussa alloy and that of Al-Rafidain alloy.

Key Words : Microleakage , amalgam, Degussa alloy.

الخلاصة

الغرض من هذه الدراسة هي مقارنة التسرب المجهرى بين نوع جديد من انواع السبيكة الملمغمية معروفة باسم الرافدين ومقارنته بسبيكة الملمغمية معروفة ومجربة مخبرياً ومستخدمة عالمياً في عيادات اطباء الاسنان. استخدمت طريقة نفوذ الصبغة (0.5% الميثالين الازرق) لمعرفة كمية التسرب المجهرى واطهرت النتائج تشابه كبير بين النوعين.

INTRODUCTION

Dental amalgam remains the most widely used restorative material for both primary and permanent teeth, despite the great advancement of new products. Among the advantages are ease of handling, low cost, excellent physical properties and good clinical results for over 150 years⁽¹⁾.

Conventional amalgam alloy undergoes corrosion and the resulting products have a tendency to improve the sealing at the interface⁽²⁾.

Because amalgam does not bond to tooth structure, an interfacial space remains when an amalgam restoration is placed. This space quickly fills with pulpal / dentinal fluid in response to positive pressure in the pulp and capillary action. Temperature changes can alter the size of this space (owing to difference in thermal expansion coefficients between amalgam and tooth structure) as well as the volume of fluid that occupies the space. These effects can produce pressure changes in the pulp that can stimulate nerves to produce pain. When the interfacial space is relatively large, this effect is exacerbated.

The term "Microleakage" has been used to describe the flow of fluid, bacteria and other components into the interfacial space. Several methods have been used to quantitate this flow's magnitude⁽³⁾.

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MATERIALS AND METHOD

Twenty extracted human premolars were collected and stored in tap water, after scaling and polishing them, all teeth were free from cracks and caries.

Class V cavity preparations (approximately $3.0 \times 2.0 \times 1.5$ mm) were prepared in the middle third of every tooth on each of the buccal and lingual surfaces of each tooth, by a tungsten carbide fissure bur No. 009 (Meisinger Germany) with a high-speed hand-piece using air/water spray.

Following these procedures, the samples were divided into two groups Group A₁: Conventional amalgam restorations (Using Degussa alloy). group A₂: Conventional amalgam restorations (using Al-Rafidain alloy). Both types of alloys are of conventional lathe-cut type, fine grain that has a maximum thickness of (37) μ m and non-zinc containing. Manufacturer's instructions were accomplished for each alloy. An electrical amalgamator was used. Condensation of the amalgam was performed manually using a consider with a (1) mm in diameter tip, each cavity was filled with three increments, each increment was condensed by five thrusts, the condenser's direction was vertically along the cavity wall. The excess amalgam was removed, a burnisher with light circular movements around the margins was performed and then carved by a carver, the teeth were then stored in normal physiological saline at (37) °C in the incubator for (10) days.

All teeth were thermocycle in distilled water (5 °C and 55 °C, 500 cycles, 30 seconds, immersion time).

Root surfaces were sealed with an autopolymerizing epoxy resin (Qualye Dental, Dominion Way, Worthing West Sussex, ENGLAND). Other tooth surfaces were painted with (2) coats of finger-nail polish, to within (1.0) mm of the restoration margins. The teeth were immersed in (0.5%) methylene blue (pH = 7.2) for (4) hours and then rinsed with water and air dried.

The samples were sectioned from the buccal to the lingual surface using a carboril disc in a low-speed hand-piece.

Slides from all samples at $\times 30$ magnification were used for microleakage evaluation by (2) calibrated examiners. Microleakage scores were based on the degree of dye penetration according to Reticf⁽⁴⁾ 0 = no leakage; 1 = leakage extending to the dentinoenamel junction; (2) leakage extending to the axial wall of the preparation; 3 = leakage extending along the axial wall of the preparation.

Statistical Analysis was performed by two methods, the first method was the (t-test) and the second was the Wilcoxon-Mann-Whitney test.

RESULTS

By comparing the microleakage between both types of alloys (A₁ = Degussa and A₂ = Al-Rafidain alloys), using 20 separate samples for each type of alloy.

The data was analyzed by two methods: The first method was by the (t-test) the results were as follow:

Alloy Type	Number of Samples	Mean	Standard Deviation	Standard Error	Calculated t	Tabulated t
A1	20	1.500	1.100	0.246	0.407	1.680
A2	20	1.350	1.225	0.274		

At the 5% probability ($\alpha = 0.05$) this reveals that although leakage is present in both groups (The control group A1 and the experimental group A2) there is no significant difference between them.

The second method was done by the Wilcoxon-Mann-Whitney test⁽⁵⁾, in order to test the ranks between the mean and standard deviation for both types (Figures 1 and 2), also results indicated no significant difference between both alloys.

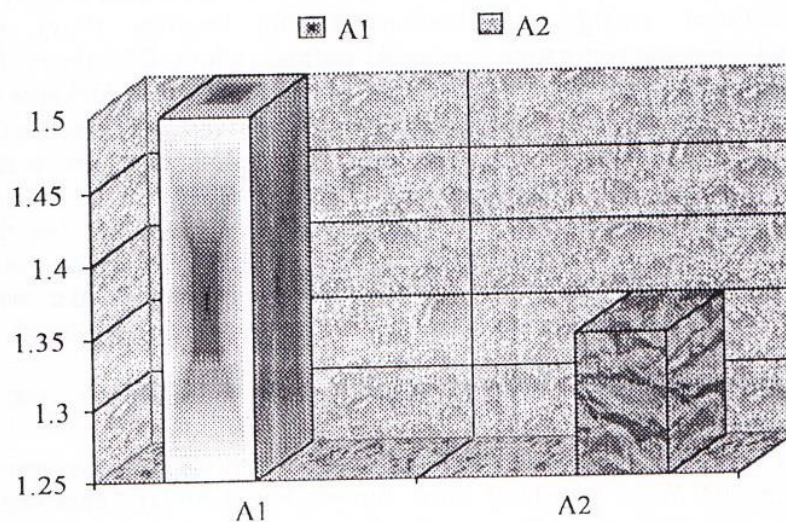


Figure (1): Mean of A1 and A2

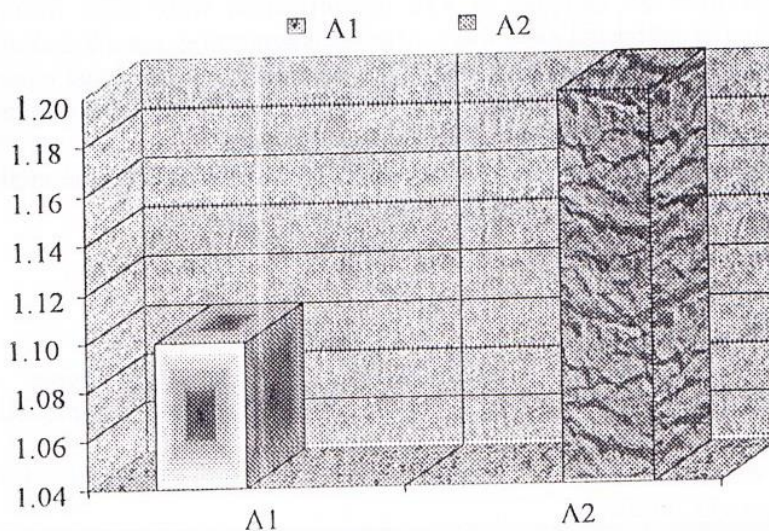


Figure (2): Standard deviation of A1 and A2

A1 = Degussa Alloy
 A2 = Al-Rafidain

DISCUSSION AND CONCLUSION

This *in vitro* study was made with human permanent premolars, the manipulation of both alloys was done similarly to exclude any variations that may happen during the procedure, also taking in consideration the manufactures instructions and recommendations⁽¹⁾.

Class V box type cavities were used since the dentin in the labial or lingual region of the tooth was more likely to be of normal structure with a minimum amount of sclerotic change or secondary dentin formation⁽⁶⁾.

Thermocycling was performed because, variations in temperature can cause expansion and contraction of the restorative material and tooth structure, that may affect microleakage around restorations because of the difference in the coefficient of thermal expansion of the tooth structure and restorative material. The marginal adaptation of the alloy with lathe-cut particles is superior to that of the alloy with spherical or blend particles. The results of this study also supports the findings of Symer and Wing, who said that, in general lathe-cut alloys adapt better to cavity walls than do spherical alloys⁽⁷⁾.

The general tendency for spherical-particle alloys to exhibit greater microleakage values than lathe-cut particle alloys might be explained by the nature of the amalgam surface and it's interface with tooth structure. An examination and these surfaces has shown that spherical-particle alloys have more pronounced surface texture. This texture could reflect the presence of surface channels through which more air or fluids can flow⁽³⁾.

In this study one of the important observations and primary factor that may have caused no significant difference in microleakage between the control group and the experimental group, is the similarity in geometry or shape of the particles.

The next important observation was by Stowell⁽⁹⁾ who showed that when teeth restored with amalgam were left in saliva and others in normal saline, at the end of two weeks those in saliva had leaked less than those in normal saline. They considered that the first two weeks were critical and suggested that a deposit from the saliva had prevented the penetration of radioactive iodine⁽⁹⁾.

Although there was no significant difference in microleakage between both groups, this does not eliminate the fact that microleakage was present, this may be affected by the storage of our groups in normal physiological saline, instead of storing in saliva that may have enhanced obstruction of the tooth restoration interface.

The patency of the dentinal tubules probably would play a defining role in microleakage, factors such as increased patient age and the presence of secondary dentin would reduce patency. All these are considered as modifying factors that can affect microleakage in one way or another.

To summarize the evidence of these investigations, it is clear that by one method of examination or another, many if not most of amalgam restorations are susceptible to penetration at the amalgam-tooth interface. Penetration is greatest soon after insertion, decreases after some weeks and may actually cease. The cause of this reduction may be obstruction of leakage paths by debris or deposits⁽¹⁰⁾.

Also enamel, dentin and amalgam restorative materials all exhibit different coefficients of thermal expansion. These differences may have a significant impact on gap formation and subsequent microleakage⁽¹¹⁾.

Leakage around amalgam restorations has been reduced by varnishes which inhibit early leakage and though they may wash out in time, they are replaced by corrosion products of amalgam that help seal the interface⁽¹²⁾.

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