COMPARATIVE EVALUATION OF THE HYBRID LAYER IN LATERAL PREVENTIVE RESTORATIONS

Irina Maftei[1], Iulia Cătălina Săveanu[2], Oana Dragoş[3], Carina Balcoş[4], Ioan Dănilă[5]

[1]PhD student, Department of Oral- Dental Prevention, Faculty of Dental Medicine, "Gr. T. Popa" University of Medicine and Pharmacy, Iaşi, Romania

[2]Assist. Prof. Department of Oral- Dental Prevention, Faculty of Dental Medicine, "Gr. T. Popa" University of Medicine and Pharmacy, Iaşi, Romania

[3]Scientific Researcher, National Research and Development Institute for Technical Phisics IFT, Iaşi

[4]Jr. Assist. Department of Oral- Dental Prevention, Faculty of Dental Medicine, "Gr. T. Popa" University of Medicine and Pharmacy, Iaşi, Romania

[5]Prof., Department of Oral- Dental Prevention, Faculty of Dental Medicine, "Gr. T. Popa" University of Medicine and Pharmacy, Iaşi, Romania

ABSTRACT

The purpose of this study was the OM = optical microscopy analysis of the dentinal HL=hybrid layer of two materials with metal alloy particles used in minimally invasive cavity preparations. The study included 10 human premolars and molars, extracted for orthodontic or periodontal reasons. The extracted teeth were used in the study after obtaining a informed consent from the patients, in compliance with the protocol approved by the ethics committee of UMF Gr.T.Popa Iasi. Samples were divided randomly into two equal groups (N = 5): GR.1 (N = 5), GR2 (N = 5). Minimally invasive occlusal cavities were made using a mechanical preparation. We used cylindrical diamond burrs and carbide globular no. 1 burrs. The restorative materials used were: PAA=PolyAcrylic Acid, SE = 3M ™ Scotchbond Etch ™, dental adhesive ASBP = Adper Single Bond Plus (3M ESPE), glass-ionomer with metal alloy particles MM = MIRACLE MIX (3M ESPE) and non gamma 2 amalgam A=ANA2000. The analyzed groups were: GR.1:(5)PAA;MM and GR.2:(5)SE™;ASBP;A. Materials were used according to the manufacturer's instructions, the resulting samples were thermo cycled 500 cycles (5 0 -55 0), sectioned, viewed by OM=ZEISS–AXIO-CAM-MRC5 and statistically analysed (ANOVA, $p \leq 0.05$). Statistical data processing was performed with Microsoft Excel and SPSS 14.0, $p \leq 0, 05$. The results obtained by quantitative analysis of the HL indicate that there are differences ($p \leq 0.05$) between groups in favour of the samples filled with amalgam 10.37 (± 2.62). Conclusions: The restoration material and the use of a dentinal adhesive dimensionally influence the HL size.

Key words: amalgam, hybrid layer, glass-ionomer.

The research was supported by the CNCSIS grant budget nr.2669 in 2008- IDEI competition- exploratory research projects.

INTRODUCTION

Broadening the range of materials continues to make it difficult sometimes for the practitioner to choose the optimal and viable solution, restoration prognosis often being reserved if one quantifies a number of clinical parameters.

One of them would be the topography of the lesion. In occlusal caries we must focus on a wear-resistant material. When physiognomic demands are low we can opt for a wear-resistant material such as glass-ionomer with metal alloy particles or amalgam, the choice depending on the

patient's caries risk and the biological properties of the material.

In the past, amalgam use cleared the test of time, but the need to sacrifice tooth substance for a retentive cavity design gradually made composite restorative materials more desirable. But due to high polymerization shrinkage, subsequent marginal leaching and low resistance to wear, in certain situations composite resins recommendation is made with reluctance.

Introduction of metal alloy glass-ionomers responds to imperatives related to resistance to wear (higher then composite resins and lower then amalgam) and to the polymerization contraction (very low). In addition, metal alloy glass-ionomers show a thermal expansion coefficient similar to the dental hard tissues and induce a certain degree of mineralization of the surrounding hard tissues by slowly releasing fluoride.

Because restoration sustainability in time, in favourable conditions, is a basic goal and good wear properties are known, we wanted to test two metal alloy dental materials and to pursue options that could be best in terms of hybrid layer quality for these materials.

MATERIAL AND METHOD

The study included 10 human premolars and molars, extracted for orthodontic or periodontal reasons. The extracted teeth were used in the study after obtaining an informed consent from the patients, in compliance with the protocol approved by the ethics committee of "Gr. T. Popa" UMPh Iași. After extraction the teeth were immediately cleaned of soft debris with hand scaling instruments, washed with running water and then stored up to 24 hours in saline. The number of sample vials was recorded. Teeth were brushed with a non-fluorinated abrasive paste and then washed with running water. On the occlusal of each tooth we prepared mechanically (M) and minimally invasive cavities with rounded internal and external angles. We used cylindrical diamond burrs and carbide globular no. 1 burrs. Preparation was made at high speed in enamel and low speed in dentine under continuous irrigation with water. The burrs were operated inside a template to obtain cylindrical cavities of approximately equal volume with the following dimensions: 4 mm wide, 2 mm deep.

The samples were randomly divided in two equal groups GR.1 (N = 5), GR2 (N = 5). Each tooth was filled according to the protocol recommended by the manufacturer. The restorative materials used were: PAA=PolyAcrylic Acid, SE = 3M ™ Scotchbond Etch ™, dental adhesive ASBP = Adper Single Bond Plus (3M ESPE), metal alloy glass-ionomer MM = MIRACLE MIX (3M ESPE) and non gamma 2 amalgam A = ANA 2000. The analysed groups were: GR.1:5 (M) PAA; MM and GR 2:5 (M) SE™; ASBP; A.

The resulting samples were thermo cycled 500 cycles between 5 0 and 55 0- 5 minutes at 37 0, 5 seconds at 5 0 then 5 minutes at 37 0 followed by 5 seconds at 55 0- according to a protocol described by Guliz [1]. The prepared teeth were kept in saline vials for 48 hours and then were axially sectioned in half vestibulo-orally. The two halves were polished under water irrigation using discs with decreasing grit at low speeds. The section surface was treated with 37% ortho-phosphoric acid for 10s, washed with distilled water and blown dry. The samples were kept in their vials around 24 hours. Visualisation was performed with an optical microscope (Zeiss-Axio with Axio-CAM MRC 5). Statistical data processing was performed with Microsoft Excel and SPSS 14.0 (Statistical Package for Social Sciences) setting a statistical significance threshold of $p \leq 0,05$. Comparative analysis was performed using the ANOVA test.

RESULTS

Analysis of the hybrid layer in the studied groups consisted of measuring its thickness in three different points for each sample and then achieving the average. The measurements were done in mm and then transformed in µm according to the scale shown in the images. This method of assessment has been used before by other authors in similar studies [2].

Quantitative analysis of the HL size showed an average of 3.28 µm (± 0.69) for GR.1:5 PAA; MM with a minimum of 2.39 µm and a maximum of 4.2µm and 10.37 µm (± 2.62) for GR.2:5 SE™; ASBP; A with a minimum of 7.47 µm and a maximum of 13.93 µm (Table 1).

We tested the equality of variances with the Levene test which resulted positive and applied the variance analysis ANOVA test showing a statistically significant difference p = 0, 015 (Table 2 and 3).

Ultra structural analysis of the hybrid layer size revealed significant statistical differences between groups p ≤ 0.05 (GR.1 MM -D and GR.2 A-D) in favour of the samples restored with amalgam (Fig. 1).

	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max	Between Comp. Variance
					Lower Bound	Upper Bound			
GLASS IONOMER MIRACLE MIX	5	3,282	,690	,308	2,424	4,139	2,39	4,20	
AMALGAM ANA 2000	5	10,37	2,623	1,173	7,114	13,629	7,47	13,93	
Total	10	6,827	4,151	1,312	3,857	9,796	2,39	13,93	
Model *Fixed Effects*			1,918	,606	5,428	8,225			
Random Effects				3,545	-38,216	51,870			24,398

Table 1. Descriptives - Glass Ionomer Miracle Mix-Amalgam Ana 2000

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	125,670	1	125,670	34,150	,000
Within Groups	29,440	8	3,680		
Total	155,110	9			

Table 2. ANOVA - Glass Ionomer Miracle Mix-Amalgam Ana 2000

Levene Statistic	df1	df2	Sig.
9,600	1	8	,015

Table 3. Test of Homogeneity of Variances - Glass Ionomer Miracle Mix-Amalgam Ana 2000

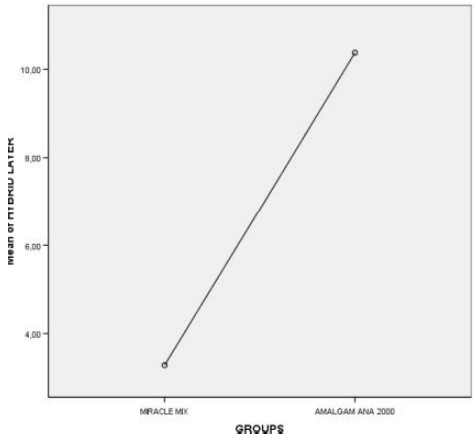

Fig. 1. Average HL size în the studied groups

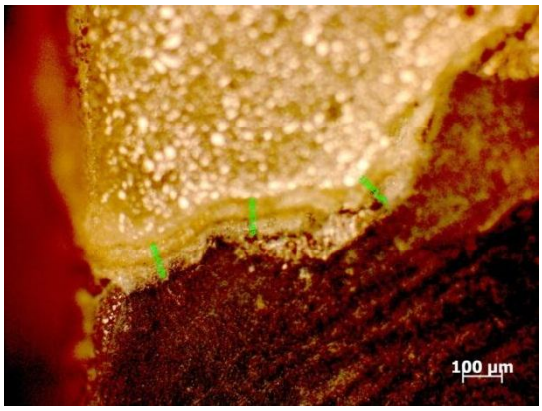

Fig. 2. OM aspect of the Miracle Mix-D interface. It notes the presence of an optimal hybrid layer size, constant along the interface and metal alloy particles that give resistance to wear and to dissolution time

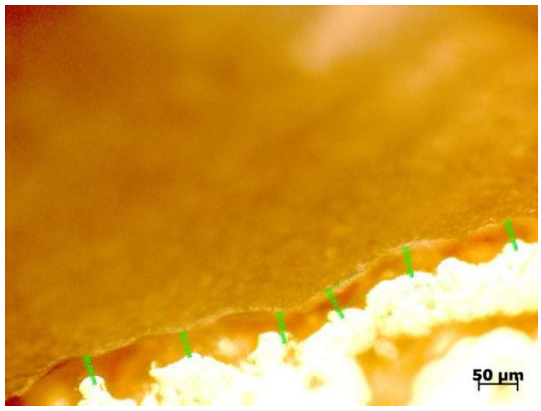

Fig. 3. OM Aspect of the Amalgam ANA 2000-D interface. It notes the presence of a constant, optimal size hybrid layer along the interface but with a certain transparency. This layer could be a result of the dental adhesive used

DISCUSSIONS

Recent studies showed that retention obtained by using amalgam with adhesive system is equal or superior to traditional mechanical retention methods [3]. Optical microscopy of the bonded amalgam-dentin interface revealed in other studies as well as in our own the presence of a optimal and constant HL in all experimental groups [4]. In addition, reducing sensitivity and a more conservative preparation can be obtained when using an adhesive system before applying the amalgam [5, 6].

An optimal adhesion to dentin involves removing all the affected demineralised dentin, which is not always desirable due to a possible interference with the pulp integrity. To have an optimal adhesion to dentin several principles must be respected, namely: dentin must be acid etched with 37% orthophosphoric acid for 15 seconds or weak organic acids (itaconic, maleic, polyacrylic 10%)to remove the detritus layer; etching should be sufficient to demineralise the surface of the dentin, leaving collagen fibres exposed and available for a mechanical link with the resin; the surface should be washed thoroughly to remove any acid trace; the surface must remain moist but not soaked [7].

The hybrid layer provides a sealing and may be a small retention for the resin–dentin bond (a hydrophilic primer and an adhesive agent penetrates about 3 mm around and inside the demineralised dentin on the cavity walls). HL thickness obtained in this study is comparable to that obtained by other studies and considering correlation studies between the presence of micro-fissures and adherence power, we hope that success will be guaranteed as long as the hybrid layer will be able to seal the dental infrastructure [8].

The bond efficiency of glass-ionomers to enamel and dentin depends on: an increased powder - liquid report, smear layer removal and maintaining a hydrate equilibrium.

The use of metal alloy glass-ionomers is a sustainable option when the practitioner is unable to achieve an adequate isolation in patients with medium to high carious risk [9]. Although the size of the hybrid layer was significantly smaller, we recommend the use of metal alloy glass-ionomer MIRACLE MIX (3M ESPE) due to its mineralising properties.

However, when faced with major occlusal stress areas, we recommend the use of amalgam, as it guarantees a good adhesion and a higher resistance to wear.

CONCLUSION

The restoration material and the use of a dentinal adhesive dimensionally influence the HL size.

ACKNOWLEDGEMENTS

The research was supported by the CNCSIS grant budget nr.2669 in 2008- IDEI competition- exploratory research projects.

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