SEM EVALUATION OF THE HYBRID LAYER IN MECHANICAL AND KINETIC PREPARED CAVITIES, RESTORED WITH GIOMER

Irina Maftei[1], Iulia Cătălina Săveanu[1], Oana Dragoş[2], Ioan Dănilă[1]

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

[2]Scientific Researcher, National Research and Development Institute for Technical Physics IFT, Iaşi, Romania

***Corresponding author:** *Irina Maftei, Assist. Prof, PhD,*
Faculty of Dental Medicine
University of Medicine and Pharmacy "Grigore T. Popa" - Iasi, Romania
16, Universitatii Street, 700115
Email: irina_bamboi@yahoo

ABSTRACT

Using restorative materials obtained by nanotechnology allows maximum penetration of the dental structures with maximum bond strength both by infiltration and adhesion. The purpose of this study was to analyze with SEM the hybrid layer in enamel and dentin, for the occlusal cavities prepared mechanically and with laser, and filled with giomer. **Method** The study included 10 human molars and premolars that were extracted for orthodontic or periodontal reasons, which were divided into two equal groups N = 5, each with two equal sub-groups: Group A - cavities in enamel A1 and dentin A2, prepared with laser (WaterlaseMD-Biolase) with MG6-MZ6 peaks, 30% water, 60% air with a power of 5.5 W at 20 Hz for enamel and 3W at 15 Hz for dentine; group B- enamel cavities B1 and dentin cavities B2, both high and low speed mechanical preparations with diamond cylindrical drills and no. 1 globular carbide drills. The materials used were Giomer Beautifil (Shofu), orthophosphoric acid 37%, and dental bonding agent Adper Single Bond Plus (3M ESPE). The materials were placed in a single layer and photo activated with source halogen (3M), cut lengthwise(diamond), polished, conditioned (H3PO4-35% -4s), stored(48 h), analyzed by SEM (VEGAIITESCAN and JEOLJSM 6390[a]), SPSS 14.00 statistically analyzed (ANOVA, $p \leq 0.05$). **Results** Hybrid layer analysis showed differences between groups, the average size of the SH being for Gr.A1= 5.18 mm, Gr.A2 = 15.81 mm, Gr.B1=4.24 mm, Gr.B2 = 5.83 mm. There were statistically significant differences between them at $p \leq 0.05$, in favour of the samples prepared with laser and examined at the dentin. **Conclusions** Regardless of the group we studied, adhesion to enamel and dentin of the giomer proved optimal in terms of quality. The advantage in what HL size is concerned belonged to the LASER preparations in dentin.

Key words: LASER, SEM, GIOMER

INTRODUCTION

Currently, European dental practice tends to approach painless, minimally invasive treatment methods. Therefore the European trends are general implementation of such a treatment, the very wide range of devices of this type of preparation showing that it tends to replace the drills during procedures.

Using restorative materials obtained by nanotechnology allows maximum penetration of the dental structures with maximum bond strength both by infiltration and adhesion.

The purpose of this study was to analyze with SEM the hybrid layer in enamel and

dentin, for the occlusal cavities prepared mechanically and with laser, and filled with giomer.

MATERIAL AND METHOD

The study included 10 human molars and premolars that were extracted for orthodontic or periodontal reasons, which were divided into two equal groups N = 5, each with two equal sub- groups:

- group A - cavities in enamel A1 and dentin A2, prepared with laser (WaterlaseMD - Biolase) with MG6- MZ6 peaks, 30% water, 60% air with a power of 5.5 W at 20 Hz for enamel and 3W at 15 Hz for dentine.
- group B - enamel cavities B1 and dentin cavities B2, both high and low speed mechanical preparations.

Permission was obtained from an institutional ethical committee of University of Medicine and Pharmacy "Gr. T. Popa" Iasi and the subjects gave written, informed consent.

The restorative materials used were Giomer Beautifil (Shofu), orthophosphoric acid 37%, and dental bonding agent Adper Single Bond Plus (3M ESPE). For photo activation we used a halogen source (3M ESPE).

After extraction the teeth were brushed with a non-fluorinated, abrasive paste and rinsed with water. We prepared rectangular occlusal cavities with rounded internal and external angles to a depth of 2.5 mm. For the mechanical preparation we used diamond cylindrical drills and no. 1 globular carbide drills at high and low speed. For the laser preparation we used zirconium and sapphire tips MZ6, MG6. Drills were operated inside a pattern in order to obtain approximately equal cavities.

The cavities were filled with a hybrid material- resin modified glass ionomer - by applying a single layer of material and respecting the manufacturer's instructions. The fillings were photo activated with a halogen source.

Samples were cut lengthwise with diamond discs, washed with 90 ^{0} alcohol and the resulting sections were processed and polished with paper discs, gums and abrasive pastes of decreasing grain. After polishing the sections were washed with distilled water for 2 minutes. The samples were subjected to a surface demineralization with 35% H3PO4 for 4 seconds to remove the smear layer and again washed for 2 minutes with distilled water. Prepared teeth were stored in vials with saline until the analysis (within 48 hours) [6].

Analysis of samples was performed by scanning electron microscopy VEGAIITESCAN and JEOLJSM 6390ª. Statistical data processing was performed with SPSS 14.0 and Microsoft Excel for Windows at an established statistical significance level of $p \leq 0, 05$. Comparative analysis was performed using the ANOVA test.

RESULTS

Hybrid layer analysis showed differences between groups, the average size of the SH being for Gr.A1= 5.18 mm, Gr.A2 = 15.81 mm, Gr.B1=4.24 mm, Gr.B2 = 5.83 mm (Table I, II).

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
GR.A1 - L-BEAUTIFUL-S	5	5,18	2,41	1,07	2,18	8,17	1,92	7,76
GR.A2 - L-BEAUTIFUL-D	5	15,81	1,01	,45	14,55	17,07	14,67	16,87
GR.B1 -M-BEAUTIFUL-S	5	4,24	1,33	,59	2,58	5,89	2,82	5,77
GR.B2 -M-BEAUTIFUL-D	5	5,83	2,25	1,00	3,03	8,63	3,34	8,95
Total	20	7,76	5,09	1,13	5,38	10,15	1,92	16,87

Table I. HL average size. Descriptive statistics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	438,4	3	146,14	42,63	,000
Within Groups	54,84	16	3,42		
Total	493,27	19			

Table II. Anova test

Variations in hybrid layer size were highlighted both between groups and within the same group in each sample (Table III).

Ultra structural analysis of the hybrid layer size for the four groups revealed statistically significant differences between them at $p \leq 0.05$, in favour of the samples prepared with laser and examined at the dentin (Fig. 1).

(I) GRUPURILE STUDIATE	(J) GRUPURILE STUDIATE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
GR.A1 - L-BEAUTIFUL-S	GR.A1 - L-BEAUTIFUL-D	-10,63	1,17	,00	-14,16	-7,11
	GR.B1 -M-BEAUTIFUL-S	,940	1,17	1,00	-2,58	4,45
	GR.B2 -M-BEAUTIFUL-D	-,65	1,17091	1,00	-4,17	2,86
GR.A1 - L-BEAUTIFUL-D	GR.A1 - L-BEAUTIFUL-S	10,63	1,17	,00	7,11	14,16
GR.B1 -M-BEAUTIFUL-S	11,57	1,17	,00	8,05	15,10	
GR.B2 -M-BEAUTIFUL-D	9,98	1,17	,00	6,46	13,50	
GR.B1 -M-BEAUTIFUL-S	GR.A1 - L-BEAUTIFUL-S	-,94	1,17	1,00	-4,46	2,58
	GR.A1 - L-BEAUTIFUL-D	-11,57	1,17	,00	-15,10	-8,05
	GR.B2 -M-BEAUTIFUL-D	-1,59	1,17	1,00	-5,11	1,92
GR.B2 -M-BEAUTIFUL-D	GR.A1 - L-BEAUTIFUL-S	,654	1,17	1,00	-2,86	4,17
GR.A1 - L-BEAUTIFUL-D	-9,98	1,11	,00	-13,50	-6,46	
GR.B1 -M-BEAUTIFUL-S	1,59	1,17	1,00	-1,92	5,11	

Table III. SH average Bonferroni

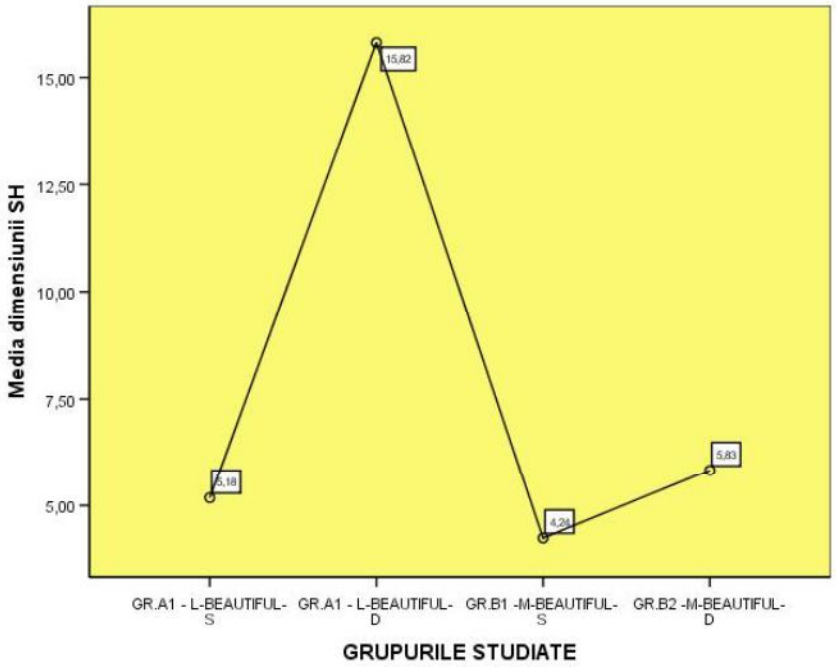

Fig. 1. SH averages

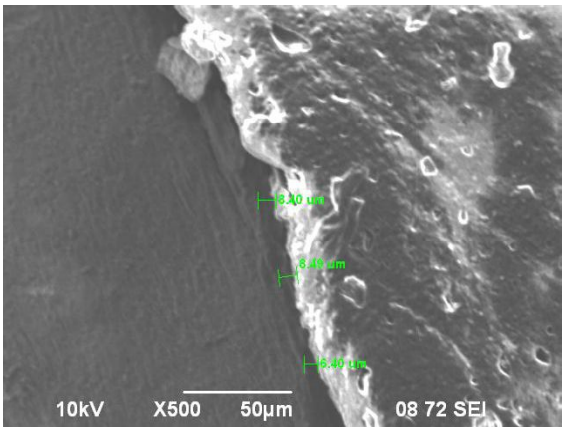

Fig. 2. GROUP A1- LASER-Beautiful-Enamel. Constant HL

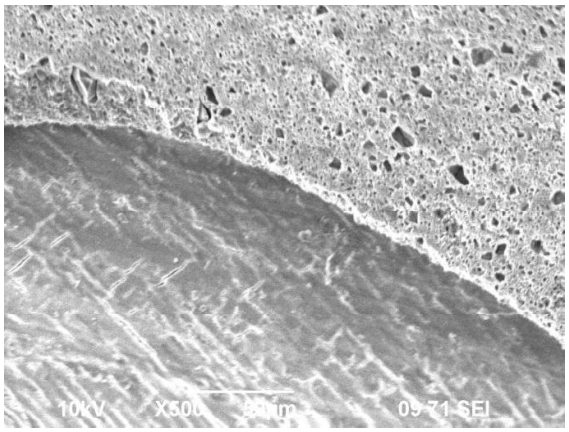

Fig. 3. GROUP A2- LASER-Beautiful-Dentin. Good penetration of the Giomer in dental structure. Increased HL size

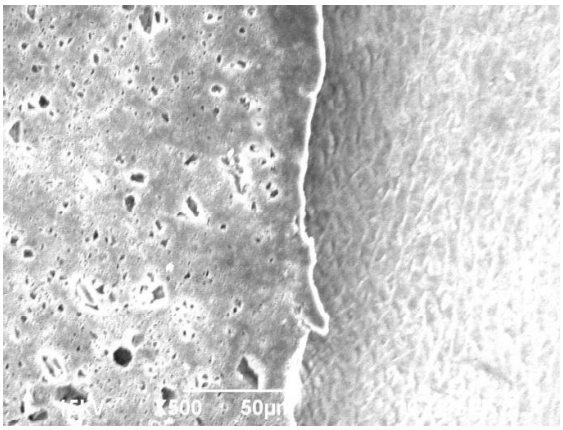

Fig. 4. GROUP B1- Mechanical-Beautiful-Enamel. Constant HL

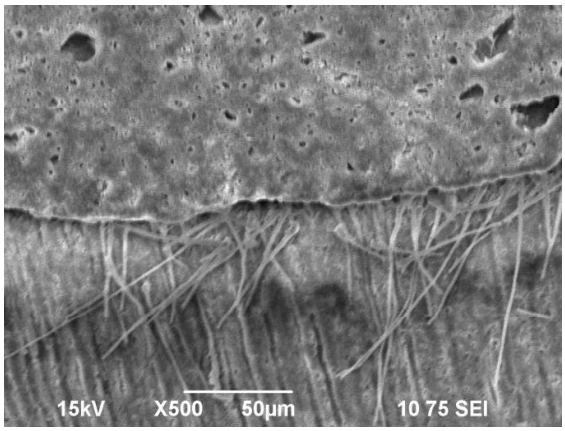

Fig. 5. GROUP B2- Mechanical-Beautiful-Dentin. Constant HL.

DISCUSSIONS

Erbium core LASER is the elective treatment for affected dentine, as it has a wavelength of 2780nm. The advantage of this wavelength is its higher absorption in water then in hard dental tissue, thus giving the LASER radiation a smaller penetration depth [3].This important property of water absorption is used to reduce and keep the temperature from increasing during the removal of dental tissue [7]. The heat is directed towards the water in the hard dental tissues and when it reaches boiling temperatures it determines micro explosions within the dental hard tissue and the division in small particles [2, 8]. Ablation process is influenced by: laser power, the percentage of water and air used.

Giomers are hybrid restorative materials mainly containing resin and glass-ionomer pre-polymerised particles (PRG - Prereacted Glass-Ionomer – they contain glass ions, amino-silicate fluoride in combination with polyacrylic acid). Adhesion of these materials to the dental substructure is mechanical and it requires etching and application of a primer / bonding agent containing acetone. Polymerization contraction occurs in the plastic phases of the material and is offset by creep, residual stress generated by contraction being diminished.

Compared to the enamel, the dentin offers

less favourable terms for adhesion due to the following factors: heterogeneous chemical composition (collagen, hydroxyapatite), large proportion of organic matter with different surface free energy, the content of the dentinal tubules, the smear layer and increased permeability of dentin in the occlusal area [5]. Studies on giomer (Beautifil, Shofu) restorations in combination with Reactmer - bond adhesive system revealed an average size of about 10 μm for the hybrid layer [8, 6, 1, 4]. Our results confirmed that the enamel is less critical for bonding then dentin by achieving an optimal adhesion. A possible explanation could be the orientation of the enamel prisms in the cavity edges, as they are generally parallel to the surface with which the bonding is performed.

There was no fracture within the restoration material which confirms that the material hardness obtained by S-PRG technology is similar to that of the enamel [9].

High values HL obtained in dentine may be due to the dentinal tubules orientation, therefore the evaluation at the perpendicular dentinal tubules on the bonding surface have determined a HL size almost double then the oblique dentinal tubules [8].

CONCLUSIONS

Our study demonstrated that the sealing of cavities depends more on the penetration ability of the filling material than the type of preparation.

Hybrid layer morphology variations were highlighted between groups but also within the same group in each sample.

Regardless of the group we studied, adhesion to enamel and dentin of the giomer proved optimal in terms of quality. The advantage in what HL size is concerned belonged to the LASER preparations in dentin.

ACKNOWLEDGMENT

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

REFERENCES

1. Macri Soraia, Mariane Goncalves, Tomio Nonaka, Jaime Maia dos Santos, *Scanning Electron Microscopy Evaluation of the Interface of Three Adhesive Systems*. Braz Dent J 2002; 13(1):33-38;
2. Mejàare I, Lingström P, Lagerlöf F, Holm AK, Twetman S. *Effect of combined cariespreventive methods: a systematic review of controlled clinical trials.* Acta Odontol Scand 2004; 62: 163-9. 589-96;
3. Mount GJ, *A new paradigm for operative dentistry*, Australian Dental Journal, 2007;52:(4):264-270;
4. Pasley DH, Horner JA, Brewer PD: *Interactions of conditioners on the dentin surface.* Oper Dent (Suppl) 5; 1992: 137-150;
5. Pasley DH, Pasley EL, Dentin permeability and restorative dentistry. A status report for the American Journal of Dentistry 1991; 4:5-9;
6. Catalina Iulia Saveanu, Danila I, Irina Bamboi, Chiriac H, Oana Dragos: *Evaluarea hibridizarii dentare prin sem în cavitati preparate mechanic si kinetic-laser si restaurate cu giomer.* Revista Romana de Stomatologie 3; 2011:170-175;
7. User Esra, *An evaluation of the bactericidal effect of YSGG laser on Stretococcus mutans*, WCLI Istanbul European Symposium; S210, oral lecture, 11-13 nov. 2004;
8. www. Dekamela.com;
9. www.fotona.si