Analysis by optic microscopy of class II cavities in laminate restoration

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Summary

The aim of this study is to analyze different materials applied in class II cavities of human extracted teeth, using optic microscopy. Materials and methods: This is an in vitro study realized on 80 teeth restorations through the sandwich-open technique. As restoration resin we used modified glass ionomer, compomer, giomer, and cermet, composite. Comparative analyses were realized with SPSS 13.0 programmer. Results: Maximal values of the hybrid layer depth were obtained by group 3 with modified resin glass ionomer resin: respectively 2.61 ± 0.26 μm. The total adhesive system has a stronger adhesion versus self-etching primer system $p \leq 0.05$. The depth of the hybrid layer obtained in this study is not very high but it is similar to results from other studies. If we take into account correlation studies (method) between the presence of the microleakage and the strength of adhesion, we could hope that this will be a successful method in the long run, since the hybrid layer will be able to seal the dental infrastructure. Conclusion: The sealing with dentinal threshold is difficult to realize at the interface, because the prismatic enamel is missing and it is indispensable to use a material with chemical adherence mechanism, like resin modified glass ionomer, compomer or giomer

Keywords: hybridization, hybrid layer, sandwich-open restoration.

Introduction

The widening palette of dental materials causes sometimes difficulties in the choice of an optimal material in the correlation with the clinical situation; the prognostic will be reserved if we quantify clinical parameters. The marginal sealing is a major problem. Therefore, in this study we propose to test different bioadhesive materials for which we can follow a better alternative for a good intrication of the dentinal structure, namely, by using the laminate technique [1].

Objective

The aim of this study is to analyze different materials using optic microscopy, as on the class II cavities on the dental human extracted teeth.

Materials and Methods

This study was realized in vitro and included 80 teeth (molar and premolar), extracted from periodontal or orthodontic reasons. Standard second class cavities were prepared, having cylindrical shape.

The teeth were divided into eight groups, and were restored according to the manufacturer's indication. The materials tested are presented into *Table 1*.

After restoration, the teeth were thermo-cycled (5-55º; 500 cycles) according to the protocol described by Gulitz [2] and then the samples were conserved in bottles with isotonic solution for maximum 48 hours until the samples were prepared for optic microscopy. The teeth were longitudinally sectioned in 2 halves. The two halves were polished under water-spray, using low speed.

Table 1. Restoration modalities by groups of materials used

Group	Material type		Frequency
	Dentin restoration	Enamel restoration	
1[9]	Compomer - Dyract Flow [2 with 4]	Composite resin - Filtek Supreme 1 cu H3PO4 [3 with 5]	10
2 [9]	Compomer - Dyract Flow [2 with 6]	Composite resin - Filtek Supreme [1 with 5]	10
3 [9]	RMGI - Vitremer [1]	Composite resin - Filtek Supreme [1 with 5]	10
4 [9]	Cermet - Miracle Mix [1 with 8]	Composite resin - Filtek Suprem [1 with 5]	10
5 [9]	Compomer Dyract AP [2 with 6]	Composite resin - Filtek Suprem [1 with 6]	10
6 [9]	Compomer - Dyract Flow [2 with 6]	Composite resin - Ceram X [2 with 6]	10
7 [9]	Compomer Dyract AP [2 with 5]	Giomer - Beautiful [5]	10
8 [9]	Composit X-flow [2 with 6]	Composite resin - Filtek Supreme [1 with 5]	10
	Total		80

[1]3M ESPE
[2]Dentsply DeTrey
[3]H_3PO_4 37%
[4]Prime & Bond NT (Dentsply De Trey)
[5]Adper Prompt el Pop (3M ESPE)
[6] Xeno III (Dentsply De Trey)
[7]RMGI -resin modified glass ionomer
[8]polyacrilic acid10%
[9]Photoactivation by halogen source

The sectioned surface was conditioned with 37% phosphoric acid for 10 sec. Then the teeth were washed with distilled water and dried with air-spray. The samples were kept in their bottle for maximum 24 hours until they were impregnated with a solution (Congo red, isopropilic alcohol 5%, distilled water 5%) and then examined with an Optical Microscope, (Epival Inter Phaco Kalzeiss-Jena), magnification by 400.

Results

The analysis of the hybrid layer depth in the study groups was realized by measuring the depth in three points and than by averaging each sample. The measures were realized in millimeters and than the results were transformed in micrometers. This modality was realized by other authors [3].

Table 2. Descriptive quantitative analysis by groups

	N	Media	Standard error	Sig.	95% Confidence interval by the medies	
					Inferior limit	Superior limit
Group 1	10	1.8300	.17029	.05385	1.7082	1.9518
Group 2	10	.9000	.13333	.04216	.8046	.9954
Group 3	10	2.6100	.26013	.08226	2.4239	2.7961
Group 4	10	.7800	.07888	.02494	.7236	.8364
Group 5	10	1.3600	.15776	.04989	1.2471	1.4729
Group 6	10	2.0900	.15239	.04819	1.9810	2.1990
Group 7	10	2.2000	.17638	.05578	2.0738	2.3262
Group 8	10	.2950	.14991	.04740	.1878	.4022
Total	80	1.5081	.77367	.08650	1.3360	1.6803

Diagram 1. Variation of the average value of a hybrid layer depth into the groups.

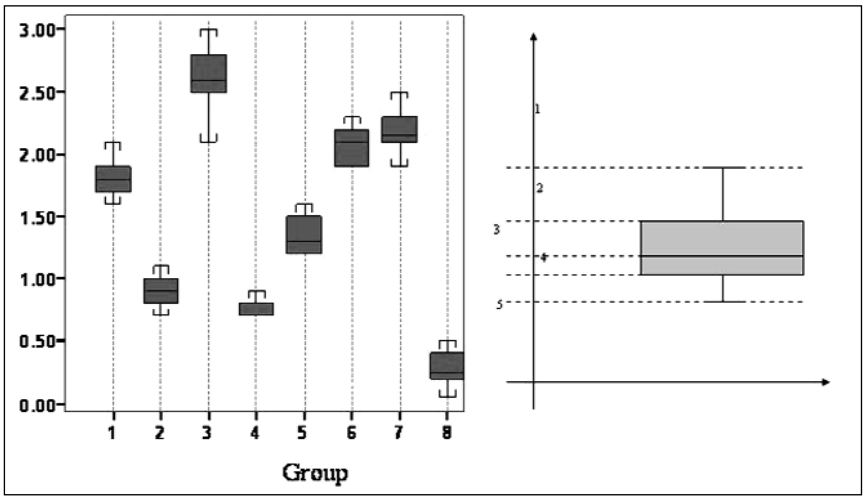


Table 3. Quantitative analysis by groups

Levene Statistic	df1	df2	Sig.
1.479	7	72	.188

Table 4. ANOVA

	Sum of square	df	Medium of square	F	Sig.
Inter-groups	45.286	7	6.469	232.754	**.000**
Intra-groups	2.001	72	.028		
Total	47.287	79			

We can observe higher difference value between groups.

The results by the *AN*alysis *O*f *VA*riance tests show that there is a significant difference between the groups $p \leq 0.05$ (*Tables 1-5*). The results show that there is significant statistical difference between group 1 and 2 $p \leq 0.05$. Group 1 with H_3PO_4 35% etching obtained a better value, with an average depth of the hybrid layer of 1.83 ± 0.17 μm (*Figure 1*) compared with group 2, with 0.9 ± 0.13 μm depth (*Figure 2*). However there are many studies [4,5,6] regarding the adhesion at the dentin, one study showing a hybrid layer of at least 1.8-2.0 μm [7,8]. The maximal value of the depth of hybrid layer was obtained by group 3 – with modified resin glass ionomer (*Figure 3*), which realized a maximal infiltration of 2.61 ± 0.26 μm (*Diagram 2*).

Group 4 (Miracle Mix-Filtek Supreme) obtained a lower hybrid layer of 0.78 μm. (*Figure 4*)

Group 5 (Dyract AP-Filtek Supreme) obtained a hybrid layer of 1.36 μm. (*Figure 5*)

Group 6 (Dyract flow-CeramX) obtained a depth infiltration of 2.09 ± 0.15 μm. (*Figure 6*)

Group number 7 (Dyract AP-Beautiful) obtained good results with a hybrid layer depth average of 2.2 ± 0.17 μm. Other studies show that the depth of the hybrid layer is 23.5 ± 10.8 μm [7,8,9].

Table 5. Comparative analysis between the groups

	(I) Group	(J) Group	Different by average (I-J)	Standard errors	Sig.	95% Confidence interval by average	
						Inferior Limit	Superior Limit
Bonferroni	Group 1	Group 2	.93000(*)		.000	.6881	1.1719
		Group 3	-.78000(*)	.07456	.000	-1.0219	-.5381
		Group 4	1.05000(*)	.07456	.000	.8081	1.2919
		Group 5	.47000(*)	.07456	.000	.2281	.7119
		Group 6	-.26000(*)	.07456	.023	-.5019	-.0181
		Group 7	-.37000(*)	.07456	.000	-.6119	-.1281
		Group 8	1.53500(*)	.07456	.000	1.2931	1.7769
	Group 2	Group 3	-1.71000(*)	.07456	.000	-1.9519	-1.4681
		Group 4	.12000	.07456	1.000	-.1219	.3619
		Group 5	-.46000(*)	.07456	.000	-.7019	-.2181
		Group 6	-1.19000(*)	.07456	.000	-1.4319	-.9481
		Group 7	-1.30000(*)	.07456	.000	-1.5419	-1.0581
		Group 8	.60500(*)	.07456	.000	.3631	.8469
	Group 3	Group 4	1.83000(*)	.07456	.000	1.5881	2.0719
		Group 5	1.25000(*)	.07456	.000	1.0081	1.4919
		Group 6	.52000(*)	.07456	.000	.2781	.7619
		Group 7	.41000(*)	.07456	.000	.1681	.6519
		Group 8	2.31500(*)	.07456	.000	2.0731	2.5569
	Group 4	Group 5	-.58000(*)	.07456	.000	-.8219	-.3381
		Group 6	-1.31000(*)	.07456	.000	-1.5519	-1.0681
		Group 7	-1.42000(*)	.07456	.000	-1.6619	-1.1781
		Group 8	.48500(*)	.07456	.000	.2431	.7269
	Group 5	Group 6	-.73000(*)	.07456	.000	-.9719	-.4881
		Group 7	-.84000(*)	.07456	.000	-1.0819	-.5981
		Group 8	1.06500(*)	.07456	.000	.8231	1.3069
	Group 6	Group 7	-.11000	.07456	1.000	-.3519	.1319
		Group 8	1.79500(*)	.07456	.000	1.5531	2.0369
	Group 7	Group 8	1.90500(*)	.07456	.000	1.6631	2.1469

* Mean difference is significant at $\alpha = 0.05$

Figure 1. The aspect of the interface between composite and enamel in group 1. We can observe perfect intrication of composite in the enamel infrastructure, with good hybrid layer (H_3PO_4 35% and Prime & BondNT, Dentsply DeTrey). (X 400).

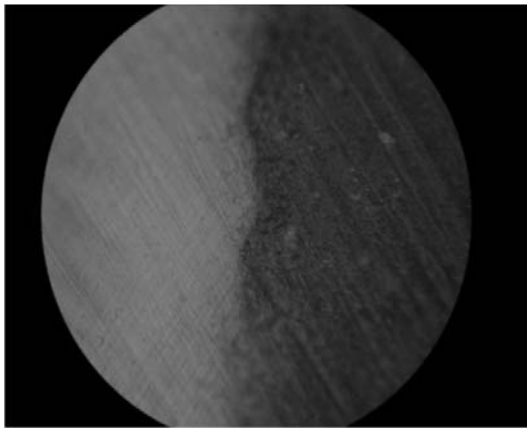


Figure 2. The aspect of the interface between dentin and compomer (Xeno III) (transversal section). We can see a hybrid layer 3 μm in depth (X 400).

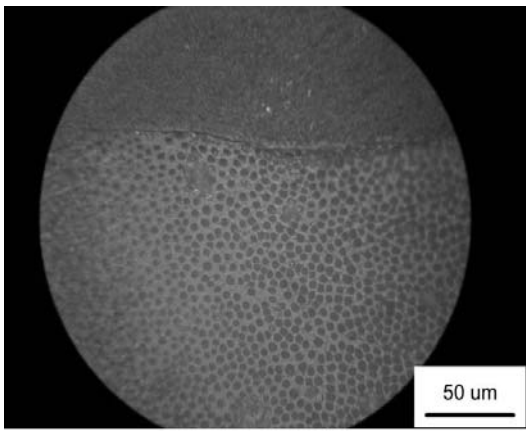


Diagram 2. The average of a hybrid layer into the groups

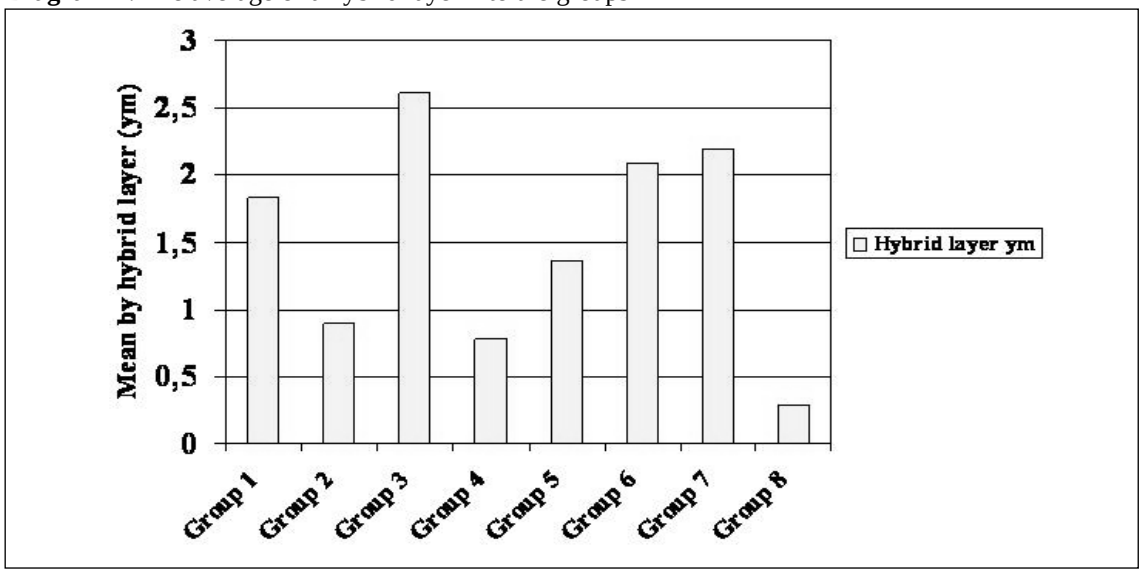


Figure 3. RMGI-composit interface in group 3. We can see good adaptation between materials (X 400).

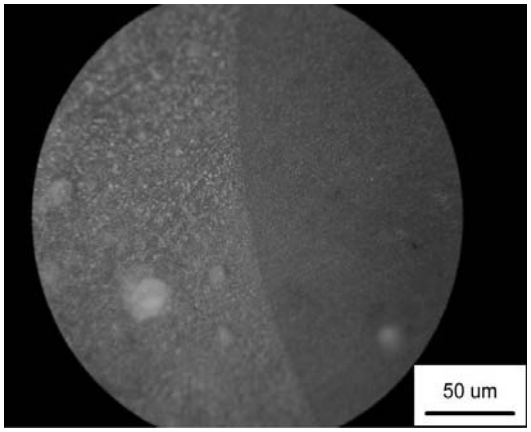


Figure 4. Cermet-dentin interface (transversal section) in group 4. We can see a constant hybrid layer, 12 μm in depth (X 400)

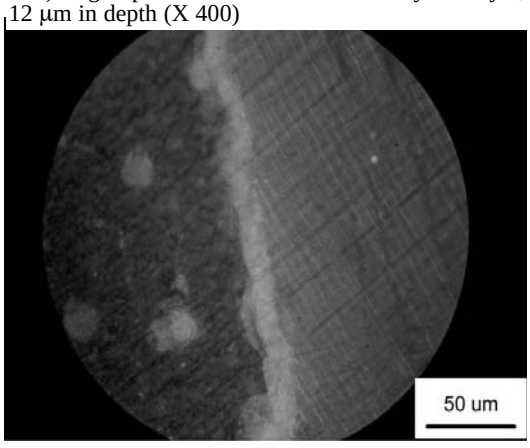
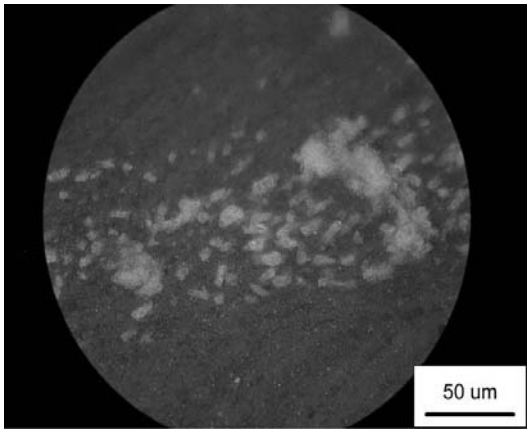


Figure 5. Compomer-dentin interface aspect in group 5. We can observe good intrication of the material (X 400).



In contrast, another study [10] shows that the depth of the hybrid layer at the dentin level was 0.5 μm, this fact suggesting that the depth of the hybrid layer is different when affecting the dental tissue.

Group 8 (X-flow-Filtek) has the smallest depth of the hybrid layer at the dentin, respectively 0.29 ± 0.14 μm (*Figure 8*).

Also, we found that the difference between group 2 (Dyract flow-Filtek Supreme) and 4 (Miracle Mix-Filtek Supreme) is not statistically significant (p=1), respectively we found the same results for group 6 (Dyract flow-CeramX) and 7 (Dyract flow-Beautiful) – namely no statistically significant difference (p=1), (*Table 5*).

Figure 7. Good intrication of the adhesive resin and the giomer in the dentin in group 7 (X400)

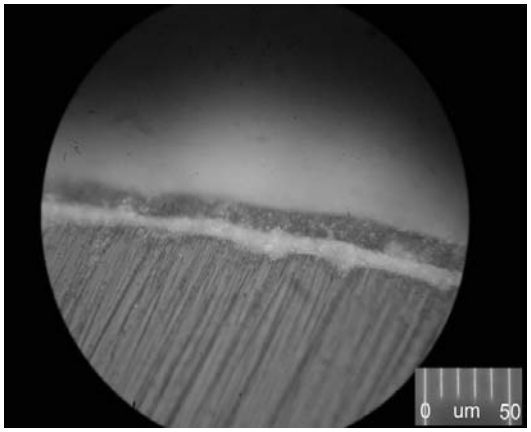
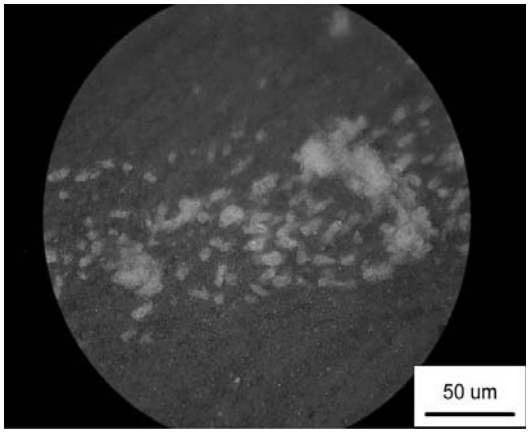


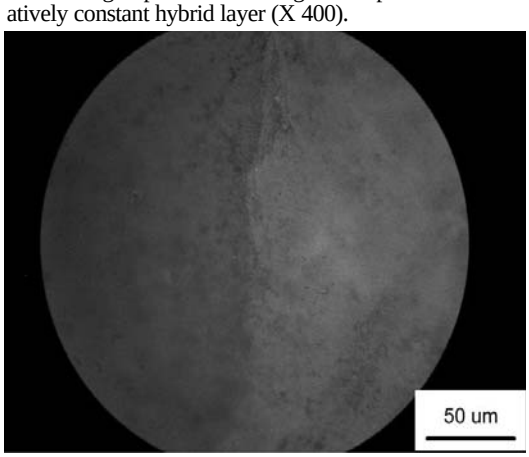
Figure 6. Interface aspect between dentin and composite with ceramics particle. We can observe good intrication of the material (X 400)



Discussion

For a good interaction of the material into the dentine, we propose that the demineralized dentin be removed; however, there is a risk for the pulp tissue. We must respect some criteria. The dentine must be etched with H_3PO_4 37% 15 seconds for removing a smear layer. The application of phosphoric acid in a separate etching step may solubilize intratubular mineral deposits in the affected caries dentin better than weaker acids, thereby contributing to better resin retention. The dentinal substrate must be wet [11]. Excessive drying can determine the collapse of the collagen network and the spaces for adhesion are closed [12].

Figure 8. Interface aspect between composite resin-enamel in group 8. We can see good adaptation with relatively constant hybrid layer (X 400).



It is possible that the original samples present a hybrid layer with 5 μm depth, but after basis and acid exposure they have to measure only 3 μm because 2 μm do not have to be completely infiltrated by the polymerized resin [13].

All the adhesive systems present a higher strength to normal dentin than caries-affected dentine, but the differences were only significant for Prime & Bond NT. [14].

The total adhesive etch yielded higher bond strength than self-etching systems. Significantly lower results were obtained with Prompt el Pop [15].

The depth of the hybrid layer obtained in this study is not higher in other studies. If we take into account correlation studies (method) between the presence of the microleakage and the strength of adhesion, we could hope that this will be a successful method in the long run, since the hybrid layer will be able to seal the dental infrastructure [15]. The laminate restoration with sandwich-open is an alternative solution for depth cavities and in patients with higher caries risk [16].

Conclusions

The sealing at the interface with dentinal threshold is difficult to realize because the prismatic enamel is missing and it is indispensable to use a material with chemical adherence mechanism like resin modified glass ionomer, compomer or giomer.

Pre-polymerized materials are good alternative for this class of restoration.

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