Assessment of Two Resin Nanocomposite Applied in Minimal Invasive Treatment of Dental Restorations

In vivo study

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The purpose of this study was to analyze in vivo composite restorations performed with two hybrid resins. The study in vivo was conducted on a longitudinal type clinical group of 38 patients aged 16-64 years, randomly selected. Conduct the study was in compliance with ADA guideline. Subjects were made a number (No) of 99 dental cavities which have been restored using two composite resins as an enamel substitute and as a dentin substitute a modified glass ionomer resin. The restorations were divided into 2 groups depending on materials used. The cavities were mechanic prepared in accordance with the modern treatment principles of carious lesions. Restoration assessment was done using modified Ryge criteria. Statistical data processing was done with software for Windows SPSS13.00 with $p \leq 0.05$. There have been significant statistically differences between the original color analysis criterion $\chi^2 = 8.986$, $df = 1$, $p \leq 0.05$ and finally $\chi^2 = 6.476$, $df = 1$, $p \leq 0.05$ and for postoperative sensitivity $p \leq 0.05$. There are differences between groups which still changes color perfect with fluctuated score between clinical and clinical acceptability restorations which were kept on appropriate conditions.

Keywords: frontal restoration, hybrid composite, Ryge criteria, scanning electron microscopy

Long-term success of restorations is attributed to various factors which can be grouped into three categories: patient, clinician and restoration materials. We can't say that only one of these factors may be responsible for clinical success of restorations because the causes of failure are diverse. Factors related to patient access to the lesion represented by its cooperation, restoration size, food hygiene, individual preventive practices, environmental oral conditions, bruxism, and gum consumption. Factors related to the clinician are: clinical experience, in-depth knowledge of handling and operator procedures. Factors related to restorative materials are handling of material which can produce large differences in the performance of restoration, the rate of abrasion, the layer of restoration and interface with tooth. Manufacturers have made significant progress to reduce the microleakage, introducing the practice of materials with a higher power of accession and a lower polymerization shrinkage, but the microleakage is still the main reason for clinical failures in particular the use of the strong light cured source [1-3]. The purpose of this study was to analyze in vivo of composite restorations performed with two hybrid dental resins.

Experimental part

The null hypothesis of this study was that there are differences between the types of materials used in dental restorations and the tested hypothesis was that after three years of study the scores of the evaluation Ryge are different. Selection of patients was done randomly after clinical examination. 38 subjects were included in the study 16-64 years old. Criteria for inclusion were: vital teeth with dental caries lesions, without significant medical antecedents or allergies to products used, available for assessment. Criteria for exclusion were followed: patients with significant medical antecedents or allergies to products used, non-cooperating, non-availability of assessment; teeth with signs of inflammation or endodontic treatment; malocclusions teeth. Longitudinal clinical study was designed and conducted according to instructions (as amended) regarding ADA Guide for Materials Bioadeshives Clinical Protocol (January 1994). All patients in the study were informed about the purpose of study. Restoration of lesions was done according to their topography and in agreement with the manufacturer's instructions on the clinical protocol for use of materials.

Selection of material for restoration was randomly done (table 1) and restorations are applied according to manufacturer's instructions. Restoration materials were cement resin modified glass ionomer (RMGI) Vitremer ™(3M ESPE™) nano hybrid composite Filtek Supreme (3M ESPE) ceramic hybrid composite particles, Ceram X (Dentsply De Trey), orthophosphoric acid 37% enamel-dentin adhesives, Adper Prompt L-Pop (3M ESPE) and Prime & Bond NT (Dentsply De Trey), halogen light source 3M.The reason of applying a liner RMGI -Vitremer – (3M ESPE) was as a restorative resin composite volumetric polymerization shrinkage reduces average of 41% [4]. Clinical option was motivated by reducing of micro leakage, setting time and material behavior, RMGI to mineralized tissues (behavior cohesion). Cavity preparation was done conform the modern principles of treatment of carious lesions by mechanical treatment with diamond burs (no. 330, 329, 245, 271, 272).

We made finishing, and beveling of enamel surface to optimize the shape of adhesion, although studies show that enamel preparation method does not affect power adhesive systems to V and VI generation [5]. In the cavities we have first achieved and then applying the adhesive matrix to promote the better adhesion material to restore the dental structure [6].

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Gr	Material		N	Cumulative percent
	Dentinal substitute	Enamel substitute		
1	RMGI* – Vitremer**	Composite resin- Filtek Supreme (3MESPE)¤	79	22.4
2	RMGI* – Vitremer**	Composite resin - Ceram X ***	23	71.7
*RMGI – resin modified glass ionomer, **(3M ESPE) , ¤¤ ***(Dentsply DeTrey)				

Table1
DISTRIBUTION OF MATERIALS USED BY GROUPS, THE ABSOLUTE (N) AND RELATIVE FREQUENCIES

Criterion	*Score*	**Definition**
Color	0	Undetectable visual
	A	Without detectable visual difference
	B	Color difference at acceptable
	C	Unacceptable color difference
Marginal color	A	Without marginal discoloration
	B1	Less than 50% of edges are discolored
	B2	More than 50% of edges are discolored
	C	Discoloration penetrated along the edges
Marginal adaptation	A1	Restoration is continuous with the tooth
	A2	Defect marginally detectable on palpation
	B	Space visible in the probe can penetrate
	C	Space visible – exposure of the dentine or basic material.
Morphological form	A	Restore restores the contours of anatomical
	B	Restoration is not respecting the anatomical shape
	C	Restoration is under level of occlusion- exposure of the dentine or basic material.
Restoration surfaces	A	Surface smooth as dental tissues
	B	Less smooth surface without roughness.
	C	Rough surface

Table 2
RYGE MODIFIED CRITERIA FOR ASSESSMENT RESTORATIONS

Evaluation of clinical parameters was made conform to Ryge criteria presented in table 2. The evaluation was performed at 21 days, 6 months, 12 months, 24 months and 36 months. At each assessment were recorded in the record of assessment criteria of restorations, with sensitivity for each restoration. Statistical data processing was performed with SPSS 13.00 setting a threshold of statistical signified, $p \leq 0\ 05$.

Results and discussions

Comparative analysis of color criterion results revealed the significant differences statistically for Gr.2 CX-V initial assessment (fig.1-A). Restorations made in the Gr.1 FS-V had initially only 36.70% (29) ScA, rest fillings tend to ideal, with a view to assessing restorations from 36 months to receive 64.55% ScA (51) . Gr.2 to CX-V received ScA 34.78% (8) of cases in assessing the initial 36 months showing 4.34% (1) ScA. The ceramic X restorations (Dentsply DeTrey) proved to be superior in terms of color criteria (fig.1-B). The differences were statistically significant $\chi^2 = 8.986$ initially, $\chi^2 = 6.476$ at the final assessment for a degree of freedom df = 1, $p \leq 0.05$. The level of significance $p \leq 0.05$ shows that the relationship was statistically significant correlation of average intensity for Ceramic X composite resin restorations with both the initial assessment and final evaluation. Analyses of marginal staining, marginal adaptation, marginal contour and surface restoration were put in evidence that there are differences between the two groups but were not statistically significant. Also the analysis of marginal staining revealed that the Gr.1TS-V is a decreasing proportion of ScA in favor of the B1 ScB1 finally being present in approximately 24% of cases (fig. 1-C) and the Gr 2 CX-V there is a decrease in the proportion of those with ScA for final percentage ScB1 7 / 23 = 30.4% (fig.1-D).

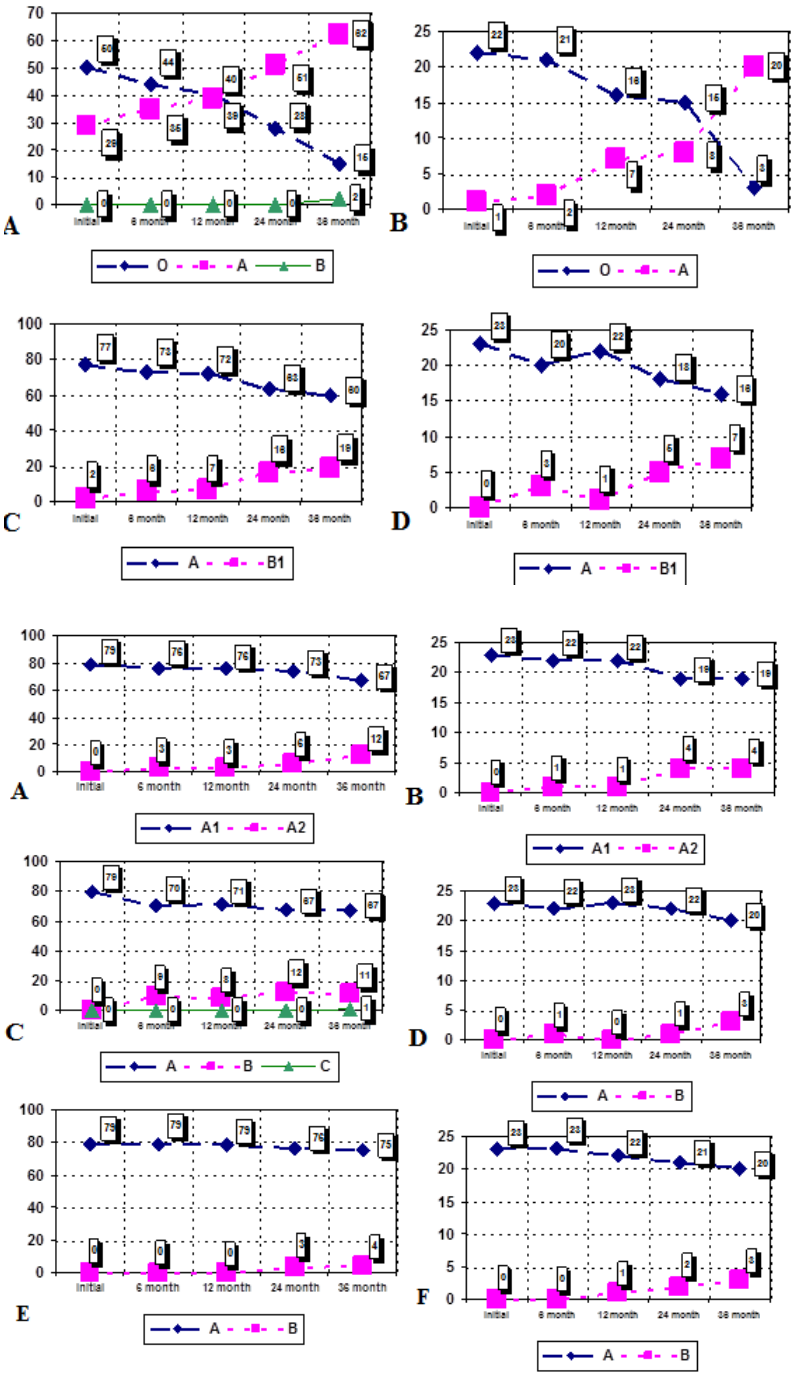

Fig. 1. Distribution of scores -absolute frequency: A- Color Gr.1. (FS-V); B- Color Gr.2.(CX-V); C- Marginal staining Gr.1.FS-V; D - Marginal staining Gr.2CX-V

Fig. 2. Distribution of scores- absolute frequency A-Marginal adaptation Gr.1.FS-V; B-Marginal adaptation Gr.2CX-V; C-Marginally contour - Gr.1.FS-V, D - Marginally contour - Gr.2CX-V; E-Surface restoration -Gr.1.FS-V; F-Surface restoration - Gr.2CX-V

Regarding to the marginal adaptation the analysis criterion revealed that the Gr.1TS-V is a decrease for ScA1 and ScA2 - but not increased, finally reaching a 15% (12) Sc A2 (fig.2-A). Gr.2 CX-V presented a fall ScA1 for ScA2 - but not sharp, is finally reaching a rate of 17.4% (4) Sc A2 (fig.2-B).

Analysis showed marginal contour criterion Gr.1TS-V at a loss for the ScA, ScB - but not increase, eventually reaching a rate of 13.9% (11) ScB respectively 1.1% (1) Sc C (fig 2-C). At GR2-CX-V level was decreased in favor of ScA (fig.2-D). Analysis of surface restoration showed a decrease for ScA and ScB in 5% (4) in the Gr.1 SF-V (fig. 2-E) and a decrease for ScA, ScB 13.04% (3) the Gr.2CX-V (fig.2-F). The sensitivity at Gr.1FS-V it is in percentage of 21.5%. In assessing of the 12 months no patient has shown sensitivity. Gr.2CX-V at baseline there was a rate of 9.5% (2), after one year sensitivity no longer present in any of the patients. Postoperative complications occurred initially at Gr.1FS-V 1.3% (1) but after three years of the restoration was clinically manifested as a complication that required endodontic treatment. The rate complications at 36 months were 2.6%. Gr.2CX-V level was found to emerge in any evaluation of postoperative complications. We applied resin modified glass ionomer under the layer of resin composite for improve the mineralized of dentin because this material contain fluoride which is responsible for remineralization of the teeth. We analyzed the composition of Vitremer (3MESPE) by Energy-dispersive X-ray spectroscopy (EDS) EDS and the results are presented in the table 3.

Also, we analyzed the interface between Vitremer and dental hard tissue structure by Scanning Electron Microscopy. There is a continue hybrid layer at level of the enamel (fig. 3 A) and also at level of dentin (fig. 3 B).

Other studies have obtained the following results: marginal adaptation of restorations to class IV and V has made with composite Filtek Supreme (3M ESPE) received alpha score in 98% of baseline and 6 months from completion of restorations, marginal staining alpha initially received a score of 80% of cases, 18% B and 2% scor C score for the 6 months to 82% assessment score A score B 6%, 12% score C. All other criteria received a score of 100% [7].

Element	(keV)	Mass%	Error%	Atom%	Cation
C	0.277	34.05	0.21	45.52	13.9096
0	0.525	32.71	0.28	32.83	41.8202
F	0.677	8.81	0.33	7.45	3.5544
Na	1.041	1.46	0,16	1,02	2.2232
Al	1.486	10.57	0.11	6.29	17.0258
Si	1.739	10.34	0.13	5.91	17.0801
P	2.013	1.28	0.13	0.66	2.5154
Ca	3.690	0.79	0.17	0.32	1.8712
Total		100.00		100.00	

Table 3
EDS ANALYSIS OF TEMPLATE FILLED WITH VI (3MESPE)

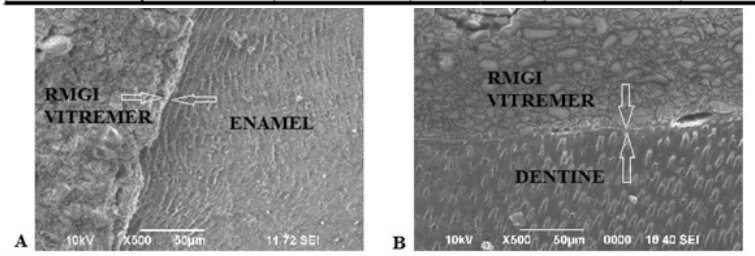

Fig. 3. Top-view SEM x500 photomicrographs magnification of the template filled with Vitremer (3MESPE) A- interface material - enamel, B- interface material - dentin

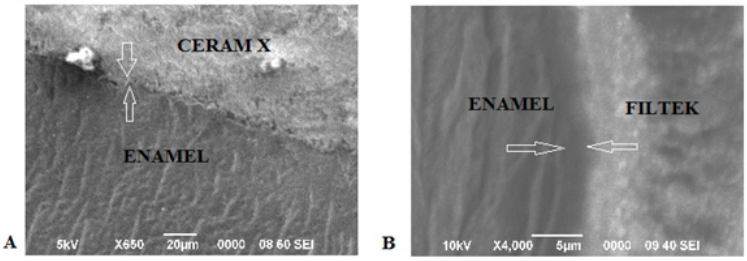

Fig. 4. Top-view SEM photomicrographs magnification of the template filled with Ceram X A- interface material - enamel, and with Filtek B- interface material - dentin

Other studies [8] made with Phil Aclite a hybrid composite restoration flowable, Bisco, USA indicate that the retention rate is 61 vs. 75% for hybrids. The scores obtained in hybrid composites restorations of Class V at 24 months were 79.5% and 20.5% score B criterion anatomically shaped, score 54.9%, 44.3% score 0.7% B and C score for marginal adaptation criterion, 74.8% scor A, 25.2% score B for criterion color. The dentinal tubules were sealing with Adper Prompt L-Pop (3M ESPE), which decreases the permeability of the dentin appearance, shown in the other studies, 55% (39-70) for the dentine pulp under pressure, with 77 % (68-83) for the dry dentin and with 41% (27-65) for the wet dentine [9,10]. The fracture restorations was not found in this study but has been highlighted in other studies, emphasizing that the most powerful light cured sources made a higher hardness and a greater restoration resistance to impact. So, after two years from completion of class I and II restorations made with Z100 were observed fewer cases of marginal fractures in high-intensity 1000mW/cm2 – 40 s than 300mW/cm2 50 s [11]. Results achieved long-term clinical trials show that the restoration success largely depends on the material, the dental composition adjacent wall restoration and can prevent marginal leakage [12-15]. The characteristics of the morphology of the materials and the interface were systematically investigated by SEM, AFM, Optical Microscopy (MO), Energy-dispersive X-ray spectroscopy (EDS) and other different methods [16-28]. We tested the materials uses in this study by SEM for following the interface between teeth and resins materials and the both materials are a good infiltration and uniform layer [25, 26] aspect visible in figures 4.

Conclusions

With the limitations of the present in vitro study, it may be concluded that there are differences between groups but anyway still fluctuate between ideal clinical score and clinical acceptability the restorations have been kept further under appropriate conditions. Most of the differences statistically significant were obtained by analyzing color criterion, generally the diacrylic hybrid composite resin with ceramic particles showing the best scores.

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