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Clinical and Experimental Evaluation of the Effectiveness of «Soft-Start» Polymerization in Dental Composite Restoration

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Abstract

The clinical and experimental efficiency of the soft-start polymerization technique in composite restorations was studied. In this study, 57 patients between 30 and 44 years of age with secondary caries had 158 restorations done using the photo-composite material Filtek Z250. The restorations performed were distinguished into two groups, the basis of the photo-polymerization method of employed (conventional polymerization technique and «soft-start» polymerization technique). The objects of the study also included the specimens of 18 extracted teeth. The analysis of the data indicates that employing the «soft-start» polymerization technique provides better integration of the composite material to the hard tissues of the tooth. This conclusion was best demonstrated in cases where the dentin was a connecting link in the chain «substrate-hybrid layer-composite». IJBM 2012; 2(3):242-245.
Key words: *composite materials, dental restoration, «soft-start» polymerization.*

Introduction

Modern dental composite materials facilitate making restorations easier, with impeccable aesthetic results. The new-generation composites stand out because of their mechanical strength, hardness and color stability. The field of the composite materials application is in a state of constant growth. Therefore, today it is possible to create durable direct restorations of the front teeth, as well the chewing teeth, using modern composite materials [1, 2].

People choose cosmetic restorations. For these reason, the direct cosmetic restoration of posterior teeth has become a vital and important part of the dental profession and one of the fastest growing areas of dentistry. Reconstruction of an anatomical tooth form is quite a complex operation that requires great expertise. Light-cured composite materials produce a high aesthetic effect [3, 4]. Therefore, modern composite materials provide an opportunity to build extensive reconstruction for the coronal portion of the posterior teeth [5, 6].

Hybrid composites, due to the high flexural strength and resistance to abrasion, allow for the creation of durable restoration of the anatomical form of the front teeth and extended cavities of classes I, II per Black's classification. Longevity of the composite restorations is determined mainly by their tightness and durability [7, 8]. However, polymer shrinkage remains a very real problem, despite the improvement in the quality of the filling materials and technologies of photo-polymerization [9, 10].

The most significant lack of the modern adhesive systems is their limited stability in vivo. The main manifestations of unsuccessful operation composite fillings are filling fallout and the violation of their marginal fit [11, 12]. Improving the quality of the biomaterial integration to the tooth may hold the key to long life of the clinical composite restorations [13, 14]. However, prevention of undesirable side effects, such as polymer shrinkage and the formation of marginal gap, is not always possible [15-17].

Method of «Soft-Start» polymerization was quite a recent entry into dental practice to reduce the shrinkage stress of composite restorations [18, 19]. «Soft-start» technology will prove to be a useful tool in improving the marginal integration of biomaterials to the hard dental

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tissues, and therefore, to the integrity and durability of the composite restorations.

The purpose of this study is the clinical and experimental justification of the efficiency of the soft-start polymerization technique in composite restorations.

Material and Methods

In this study, 57 patients between 30 and 44 years of age with secondary caries had 158 restorations done using the photo-composite material Filtek Z250. All patients gave informed written consent. The restorations performed were distinguished into two groups, the basis of the photo-polymerization method of employed. The 1st group included the restorations performed according to the conventional polymerization (CP) technique, whereas the 2nd group included the restorations performed according to the «soft-start» polymerization (SSP) technique. In total, 76 restorations were performed in the 1st group (34 by Class I and 42 by Class II) and 82 restorations were done in the 2nd group (38 by Class I and 44 by Class II).

To check tooth sensitivity, the Visual Analog Scale (VAS) was used. Sensitivity to the standard cold stimulus was performed preoperatively, and at 2 and 12 weeks, post the composite restoration. To minimize subjectivity of this study, two additional specialists were involved.

The objects of the study also included the specimens of 18 extracted teeth, which were cleaned prior to remove calcified plaques and dental scurf. Cavities, 3 mm in diameter and 2 mm in depth were prepared on all the teeth. Preparation was performed using a turbine handpiece with diamond burs and abundant water supply. The centers of the cavities thus formed were localized at the boundary of the enamel-cement compound.

After the preparation, all 18 cavities were acid etched with 34% orthophosphoric acid gel for 15 seconds. After 10 seconds, the teeth were washed in running water, excess moisture was removed from the cavities and the adhesive was applied. Next, the cavities were filled with composite material. Based on the planned intervention, two groups were distinguished. In the 1st group, photo-polymerization was conducted according to the conventional method, in 9 specimens; in the 2nd group, the photo-polymerization was performed in line with the «Soft-Start» method, in 9 specimens. To restore the defects, light-cured composite Filtek Z250 was used. Photo-polymerization was performed using a light emitting diode (LED).

After staging the composite fillings, all the specimens were thermocycled for 500 cycles between 5 and 55°C; the apical holes of the teeth were sealed with heated sticky wax and covered with two layers of nail varnish, leaving 1 mm around the restorations. Then, the teeth were stored in 2% methylene blue, washed under running water and longitudinal sectioning was done through the center of the restorations (Fig.1, 2).

Evaluation of the dye penetration depth was performed employing a stereomicroscope (Nikon Eclips E600, Tokyo, Japan) at ×20 magnification and scored on a nonparametric scale from 0 to 4, as follows:

- 0 - no microleakage,
- 1 - microleakage less than 1/3 of the cavity wall,
- 2 - microleakage less than 2/3 of the cavity wall,
- 3 - microleakage spreading along the entire wall of the carious cavity.
- 4 - microleakage, spreading to the bottom of the carious cavity.

Blind scoring all the interfaces and the mean score was recorded by two investigators.

Statistical analysis

All of the data was processed according to the variation statistics method using the software Statistica Ver. 7.0. On analysis, the mean and standard deviation were deduced. The difference was considered reliable when $p<0.05$. The Mann-Whitney (U Test) was used to compare the differences between two independent groups (for nonparametric data). For data with normal distribution, inter-group comparisons were performed using Student's t-test. p value less than 0.05 was considered significant.

Results

Clinical evaluation of the degree of tooth sensitivity was assessed preoperatively, and at 2 and 12 weeks after the treatment. The sensitivity of the affected and intact teeth, respectively, was estimated in each case. Based on the results of this study, it was noted that the «soft-start» polymerization technique permitted normalization of the tooth sensitivity much faster than the conventional method. This was best observed in the class II cavities. Perhaps this is due to the low configuration factor cavities (Table 1).

Examination of the histological sections of teeth samples in both groups showed that portions of the composite restorations on the border with enamel were sealed well, showing no significant statistical differences in the degree of dye penetration.

However, an analysis of the data obtained post microscopic examination of the adjacent sections of the composite filling to the dentin surface (Fig.1, 2) showed that the microleakage in the dentinal margins was significantly higher in the samples of the 1st group (Tables 2, 3), amounting to 76.7% of the total number. Also noteworthy is that the dye penetration along the entire length of the wall of the sealed defect was observed in 50% cases of the failed integration.

Sample study of the 2nd group showed high quality adaptation of the biomaterial to the dentin in 88.9% (8 of 9) cases, although only in one case (11.1%) microleakage of less than 1/3 of the sealed wall defect was observed. Therefore, the microleakage at the dentinal margins of SSP was significantly decreased compared with CP ($p=0.015$).

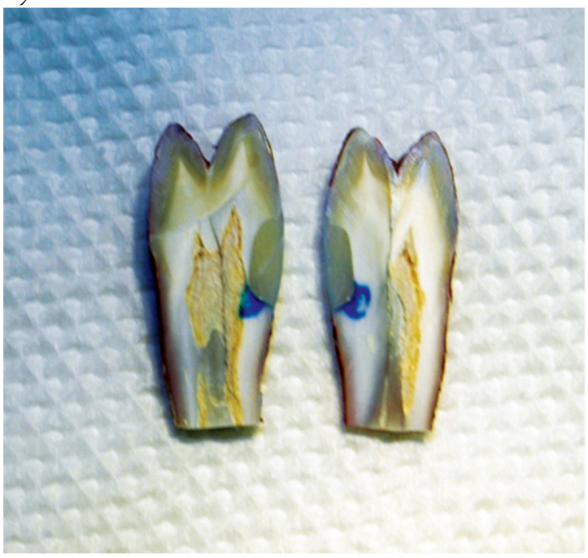
Thus, the analysis of the data indicates that employing the «soft-start» polymerization technique provides better integration of the composite material to the hard tissues of the tooth. This conclusion was best demonstrated in cases where the dentin was a connecting link in the chain «substrate-hybrid layer-composite».

Table 1
Clinical evaluation of the degree of tooth sensitivity before and after treatment (mm)

Test time		Class I			Class II		
		CP (n=34)	p (CP/SSP)	SSP (n=38)	CP (n=42)	p (CP/SSP)	SSP (n=44)
Preoperatively	intact teeth	2.3±7.4	*>0.05*	2.1±5.3	2.8±8.3	*>0.05*	1.8±6.6
	affected teeth	19.4±11.8	*>0.05*	18.2±13.1	14.3±13.8	*>0.05*	16.8±13.7
		p=0.0000		*p=0.0000*	*p=0.0000*		*p=0.0000*
2 weeks after restoration	intact teeth	2.05±6.9	*>0.05*	2.4±6.7	2.1±5.6	*>0.05*	1.6±6.8
	affected teeth	26.8±25.3	*0.0366*	16.05±15.5	15.9±14.7	*0.0282*	9.8±9.99
		p=0.0000		*p=0.0000*	*p=0.0000*		*p=0.0000*
12 weeks after restoration	intact teeth	1.8±7.2	*>0.05*	2.4±5.9	2.4±7.3	*>0.05*	1.6±6.07
	affected teeth	14.1±15.8	*0.0194*	6.6±9.4	5.7±7.4	*0.0453*	2.5±7.2
		p=0.0002		*p=0.0229*	*p=0.0428*		*p>0.05*

Note: *p-value is presented for a two-tailed t-test.*

Figure 1
Quality of the composite integration in the conventional polymerization.



The absence of microleakage the enamel-composite compounds and microleakage on the surface of the dentin-composite interface.

Figure 2
Quality of the composite integration using the "soft-start" polymerization technique.

The absence of microleakage at the enamel-composite compounds and on the surface of the dentin-composite interface.

Table 2
Frequency table of the microleakage scores obtained from the groups

Enamel/Dentinal surface	Enamel margins					Dentinal margins				
Nonparametric scale (score)	0	1	2	3	4	0	1	2	3	4
The polymerization according to the conventional method	7	1	1	0	0	3	1	2	3	0
The polymerization according to the "Soft-Start" method	9	0	0	0	0	8	1	0	0	0

Table 3
Descriptive statistics of the microleakage scores of groups

Groups	N	Min	Max	Median	Mean	SD	p
Enamel margins	conventional method (n=9)	0	2	0	0.33	0.707	0.4414
	"Soft-Start" method (n=9)	0	0	0	0	0	
Dentinal margins	conventional method (n=9)	0	3	1.5	1.38	1.302	0.015
	"Soft-Start" method (n=9)	0	1	0	0.11	0.333	

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