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The evaluation of Smart Dentin Replacement (SDR), a year observation study

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Summary

Introduction

The size of composite material layer used for restoring hard tissues of a tooth is connected with polymerisation stress, which varies between 2.5% and 3.5% of the volume in most composite materials. The value rises with the increase in the portion of the composite material. Thus, there is a necessity of using the technique of layers, which can be time consuming in case of extended cavities of hard tissues. The composite material SureFil Smart Dentin Replacement (SDR) Flow turned to be an alternative and seems to be a great turning point in the conservative dentistry.

Aim of the study

The aim of the study was the evaluation of flowable composite material SDR as the base layer during one year observation.

Material and methods

Post-operative sensitivity was evaluated during initial studies after the treatment. During further periodic examinations class II fillings were evaluated as for contact points between neighboring teeth and the presence or absence of gingivitis. All the fillings were evaluated as for secondary caries occurrence. After the treatment, parameters of the experimental material work were compared to traditional composite materials.

Results

Initial clinical examinations revealed post-operative sensitivity in approximately $\frac{1}{4}$ of patients next day and 3 days after the filling was completed. The number decreased significantly 7 days after the treatment and decreased to 5% of the patients. The clinical evaluation of contact points showed normal – 100% restoration of contact points in various time intervals. We did not observe any inflammatory condition due to filling overhang or allergic reaction of the gingiva in contact with SDR. The symptoms of secondary caries, confirmed with clinical and radiological examinations, were detected in 7 (4+3) fillings in the period of 12 months of the observation. Clinical condition after 6 months showed 5% of restoration failure while after 12 months it was 7%.

Conclusions

The results of own studies show high effectiveness and safety of SDR use as the 4mm base layer for fillings of cavities class I and II at least one year after conservative treatment (layer application) or during one-year-observation.

Key words: composite materials, post-operative sensitivity, secondary caries, contact points, gingival coefficient

Introduction

The evolution of composite materials is aimed at meeting esthetic requirements of the filling. Besides permanent and esthetic restoration of the tooth, also fast, comfortable and easy treatment is expected. Most clinicians recommend a 2mm layer of a composite placed in a single layer due to the limitation of hardening depth and polymerisation shrinkage of the composite material (1,2). The size of the layer is also connected with polymerisation shrinkage which varies between 2.5% and 3.5% of the volume. The value rises with the increase in the portion of the composite material (2).

Therefore, the technique of layer application, which can be time consuming in case of big cavities of hard tissues, seems to be a must.

According to present studies, the polymerisation stress is definitively lower (3-4fold) during SDR polymerisation when 4-mm-layer is applied (3,4,5). SDR technology is based on a unique chemical structure of the organic phase which includes a polymerisation modulator. A component- urethane dimetacrylate resin is a kind of a monomer which controls the course of polymerisation by being a so called chemical ‘soft start’. A polymerisation network is formed in a more straight and slower way. Shrinkage tension can be limited to a great extent (5,6).

Moreover, SDR has similar physical properties to traditional composites, such as susceptibility, surface roughness, shine, and shade. It is a particularly useful feature while restoring hard tissue defects on contact surfaces (2). The base material seems to be a great turning point in the conservative dentistry.

Aim of the study

The aim of the study was the clinical evaluation of flowable composite material SDR as the base layer during a year observation.

Material and methods

The study material consisted of 60 patients qualified after clinical and radiological examinations for the conservative treatment of deep caries of the posterior mandibular and maxillary teeth with the invasive method. The group revealed 12 cavities of class I and 48 cavities of class II according to Black’s classification (4,7,8).

All cavities were treated with the self-etching system XENO V (DENTSPLY) for 15 seconds and then with the polymerized system for 10 seconds. The next stage was to apply SureFil® SDR™ Posterior Bulk Fill Flowable Base (DENTSPLY). The material was applied in 4-mm-layers up to enamel-dentine link with the use of a single compula of 0.13ml applicator for intraoral application according to manufacturer’s instruction.

The mastication surface was restored with the use of the microhybride composite of low shrinkage tension (DENTSPLY) or with the composite material EsthetX® HD High Definition

Micro Matrix restorative (DENTSPLY). In all clinical cases, due to diagnosed deep caries, either hardening hydroxide-calcium preparation Life (KERR) or Dycal (DENTSPLY) were applied to the cavity wall. In case of cavities class II, the contact point was appropriately restored thanks to the use of high quality system of anatomic partial matrices.

In extended hard tissues defects of class II cavities, besides clinical evaluation, rough models of class II fillings were performed. The models were checked for the possibility of broadening the contact point.

The fillings were processed and polished using the Enhance[®] Finishing System and diamond rubbers PoGo[®] One Step Diamond Micro-Polisher (DENTSPLY).

On preliminary examinations – the next day, 3 and 7 days after the procedure, the post-operative sensitivity was evaluated (Table 1).

During subsequent follow-up studies – 1, 6, 12 months after the treatment, class II fillings were evaluated regarding the contact points between the neighboring teeth (Table 2) as well as gingivitis (Table 3). All the fillings were checked for secondary caries. The evaluation criteria used for the parameters according to Dr. John Burgess and Dr. Carlos Muñoz's method (4,7,8) are described below in separate tables.

After the treatment, working parameters of the experimental material and traditional composite materials were compared. The results are presented in Table 5.

Results

The examination group consisted of 60 patients who had 60 fillings class I or II done. All patients underwent the preliminary examination.

The attendance on the follow-up after 1 month and 6 months was 100% and after 12 months it was 94% as 3 patients with class I defects and 1 patient with class II defect failed to come for the examination.

The results concerning criteria of SDR evaluation are presented in Tables 1-4.

Post-treatment sensitivity was observed in approximately ¼ of the examined patients on the next day and 3 days after the filling was completed. The number of patients with enhanced intensity of sensibility decreased to 5% of the patients 7 days after the treatment (Table 1).

The clinical evaluation of the contact point showed proper (100%) restoration in various time intervals (Table 2).

SDR used as the base composite material did not induce any side effects as for parodontal soft tissues after 1 month in 94% of the patients and after 6 months and 12 months –in all cases. There was neither inflammatory condition due to the filling overhang nor allergic reaction of the gingiva during contact with SDR. Inflammatory condition due to bad hygiene was observed

during the follow-up visit 1 month after the treatment only in the region of three teeth, which was 6% of all the observed fillings (Table 3).

Symptoms of secondary caries, stated with both clinical and radiological examinations, were observed in 7 fillings during 12 months of observation; clinical status showed 5% of failure restorations after 6 months while it was 7% after 12 months (Table 4).

Both dentists performing the treatment and those who carry out periodic observations were given the questionnaire concerning clinical evaluation of the fillings treated with SDR and one concerning subjective evaluation of the parameters of working with the experimental material (Table 5).

On a 5-grade scale, SDR turned out to be 'better' or 'significantly better' base material as far as general processing (37 and 30%), working time (36 and 35%) and the use of cannula (40 and 35%) were concerned in comparison to traditional composite material.

A high percentage (40%) in relation to internal adaptation and a positive contact was observed with the parameter 'better' and SDR showed superiority in this range.

Very few negative opinions (1-2%) were observed in relation to 6 features of working with the experimental material.

Discussion

In the conservative dentistry with the use of composite materials, the restoration of hard tissues of a tooth should follow the rules of layer technique, using 2mm of the material at a time. Otherwise, a sudden increase in shrinkage stress in polymerisation can occur. The polymerisation stress, occurring during radiation of traditional composite material, moves producing deformations that can lead to enamel fissures, cusp shift and cusp rupture. A hiatus between the composite and the defect wall may result in post-operative sensitivity, microleakage, or secondary caries. Moreover, if wall bonding is strong enough to prevent the fissure, the stress is concentrated inside the material resulting in micro-fissures inside. There is a high risk of functional failure of the restored tooth (2).

SDR is a composite of lowered shrinkage stress, a one-component material that contains fluorine and aroentgen-contrast (2.2 mmAl, in comparison to enamel -2.0mmAl and dentine 1.0 mmAl) (9).

It reveals many features of a typical flowable composite material, yet it can be placed in 4mm layers simultaneously with minimal polymerisation stress up to enamel-dentine link(2,10).

Contact points may be restored with the use of SDR composite (available in one universal shade resembling B1 in the Vit's scale) and the surface layer with the use of a universal filling composite. It is possible to use SDR with any combining system and any composite to restore the enamel layer (9,11,12). Roggendorf et al. (13) confirmed that internal adaptation of 4mm

layer SDR to the dentine and 2mm portion of conventional composite resin is approximate. According to the studies, it does not have harmful effect as compared to two separate layers of traditional composite. The author stated that such restoration can be successfully applied in the method of an open sandwich.

The experimental composite shows delayed gelling point, which can be compared statistically only to siloran-based composite.

Polymerisation stress is lower even in comparison to nano- and microhybride composites (3).

On the other hand in his studies observed that SDR has low polymerisation stress and effective hardening in the whole 4mm layer and is resistant to fracture and fissure in the perigingival region (12).

According to thorough clinical observation of SDR, the following were observed: contact points restored between teeth in case of class II defects, gingivitis in the neighborhood of the restoration and secondary caries. During the evaluation of presence or absence of sensitivity and its intensity in our study, the patients were asked about various degrees of sensitivity they felt during preliminary studies (the next day, 3 days and 7 days after the treatment). The patients' reaction to cold was also checked. The patients were to subjectively evaluate the presence or absence of sensitivity by checking positive and negative answers.

Post-operative sensitivity occurred in approximately $\frac{1}{4}$ of the patients on the next day and 3 days after the treatment. Patients' subjective evaluation seems to be quite high.

A significant change of this parameter led to decreased patient's pain stimuli one week after the treatment. The problem of post-operative sensitivity also frequently occurs in restoration of hard tissues with traditional composite material. In case of SDR, it is connected with the preparation and filling very big and deep carious lesions. The presence of sensitivity can be connected with hard tissues damage or inappropriate application of etching applicator (2).

Pain after eating cold food can occur even for 10 days after the filling. In our study, post-operative sensitivity can be avoided by placing the hardening hydroxide-calcium preparation in the deepest layers of the cavity. After the filling is completed, the surface rebonding can be performed, which prevents transfer of cold stimuli and thus – pain. SDR and contact points restored between teeth in case of class II defects underwent thorough clinical observation.

In some cases, the region of contact point was restored partially or in total with 'base' composite material. Clinical evaluation of the contact point showed normal restoration of the contact point. There was no broadening of contact points in rough models prepared during periodic examinations.

High result of quality check shows high quality of the system of partial matrix and also confirms marginal adaptation of SDR and its self-leveling feature, which allows adaptation to the shape

of prepared cavity walls, fissures and margins of the preparation – the material flows and adapts to the whole surface of the cavity and thus reduces a potential microleakage (7). SDR can be placed in the cavity fast in vast amount without the need of additional manipulation. After a few seconds it forms a uniform base for further application of filling composite. The use of flowable composite material as the base under the composite is not a new idea, whereas the use of flowable material for the marginal adaptation in class II according to Black is innovative (10). The condition of soft tissues in the region of the fillings was normal with deviations, which probably was the result of poor initial hygiene for the first month after the treatment. In our study, a very low percentage of inflammatory condition was observed in the patients. A significant improvement after 6 and 12 months can be directly connected with appropriate instruction of the oral cavity hygiene provided by a dentist and patient's engagement in everyday brushing and additional care procedures.

Secondary caries can be a frequent consequence of ill/bad filling. SDR, regarding indications for use, may be placed in the regions of exposed margins of the filling, i.e. in the regions where secondary caries can occur. Besides clinical examination of the fillings, in certain cases, the RVG picture was taken. There was no carious tissues observed in the region of SDR, which indicates the possibility of marginal leakage along the composite filling restoring the enamel. Slow fluorine release of SDR, which additionally prevents caries development, is also of great importance.

Conclusions

The results of the study showed positive evaluation of SureFil® SDR™ Posterior Bulk Fill Flowable Base. It was also observed by dentists who used this material in class I and II cavities, according to Black (2,10).

The results of own studies show the effectiveness and safety of SDR use as the 4mm base layer for fillings of class I and II cavities during one year observation. It was stated that SDR is neutral for parodontal tissues and allows normal restoration of contact point between neighboring teeth.

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Tables

Table 1. Evaluation of postoperative sensitivity in patients after treatment. The results are presented as a number of subject and in brackets quantity expressed in percentage.

Total number	Next day (%)		After 3 days (%)		After 7 days (%)	
	A	B	A	B	A	B
	44(73)	16(27)	45(74)	15(25)	57(95)	3(5)

A – lack of sensitivity; B – presence of sensitivity

Table 2. Evaluation of contact points in patients after treatment. The results are presented as a number of contact points and in brackets quantity expressed in percentage

Total number	1 month (%)		6 months (%)		12 months (%)	
	A	B	A	B	A	B
	48(100)	0(0)	48(100)	0(0)	47(100)	0(0)

A – optimal value of contact points; B – broadening of interdental space

Table 3. Evaluation of gingival coefficient in patients after treatment

Total number	1 month (%)				6 months (%)				12 months (%)			
	A	B	C	D	A	B	C	D	A	B	C	D
	45(94)	0(0)	0(0)	3(6)	48(100)	0(0)	0(0)	0(0)	48(100)	0(0)	0(0)	0(0)

A – lack of gingivitis; B – gingivitis due to filling overhang; C – gingivitis due to allergy; D – gingivitis due to bad hygiene

Table 4. Evaluation the symptoms of secondary caries in patients after treatment.

Total number	1 month (%)			6 months (%)			12 months (%)		
	A	B	C	A	B	C	A	B	C
	60(100)	0(0)	0(0)	56 (95)	4 (5)	0 (0)	57(93)	3 (7)	0(0)

A – lack of secondary caries; B – secondary caries confirmed with clinical examination; C – secondary caries confirmed with radiological examination

Table 5. Evaluation of parameters of working with experimental material as compared to traditional composite material.

Parameters of work	Subjective evaluation *					
	Significantly better	Better	The same	Worse	Significantly worse	Total
General service	42(30)	52(37)	32(23)	3(2)	0(0)	139(100)
Simplicity of procedure	49(35)	56(40)	32(23)	3(2)	0(0)	140(100)
Internal adaptation	38(27)	56(40)	42(30)	3(2)	0(0)	139(100)
Positive contact formation	38(27)	56(40)	42(30)	3(2)	0(0)	139(100)
Time of procedure	50(35)	51(36)	37(26)	2(1)	0(0)	140(100)
Canule as application mode	48(35)	51(40)	37(27)	1(1)	0(0)	138(100)

*sum of + that corresponds to a single evaluation of a given parameter among 5 subjective evaluations and percentage of each working parameter.