

# Postoperative Sensitivity Associated with Low Shrinkage versus Conventional Composites

Vladimir Ivanović<sup>1</sup>, Tatjana Savić-Stanković<sup>1</sup>, Branislav Karadžić<sup>1</sup>, Jugoslav Ilić<sup>1</sup>, Ario Santini<sup>2</sup>, Katarina Beljić-Ivanović<sup>1</sup>

<sup>1</sup>Department of Restorative Dentistry and Endodontics, Faculty of Dental Medicine, University of Belgrade, Belgrade, Serbia;

<sup>2</sup>Edinburgh Dental Institute, University of Edinburgh, Lauriston Place, Edinburgh, United Kingdom

## SUMMARY

**Introduction** Postoperative sensitivity in restorative dentistry can be related to preparation trauma, dentin adhesives' ability to seal open dentinal tubules, deformation of restorations under occlusal stresses and microleakage.

**Objective** The study assessed possible reduction in postoperative sensitivity with low shrinkage compared to conventional composites using different bonding agents and the influence of the operator skill on the incidence of postoperative sensitivity.

**Methods** Nine hundred and sixty permanent premolars and molars with primary carious lesions from patients 21 to 40 years old were used. Cavities 2 to 3 mm deep and with margins in enamel were prepared by four operators. Two operators had five years (A and B) and two had over 20 years (C and D) of clinical experience. Teeth were divided into eight groups each contained 120 restorations: (1) Els<sup>®</sup>+James-2 (original formula), (2) Els<sup>®</sup>+James-2 (new formula), (3) Els<sup>®</sup>+Excite, (4) InTenSe<sup>®</sup>+James-2 (original formula), (5) InTenSe<sup>®</sup>+James-2 (new formula), (6) InTenSe<sup>®</sup>+Excite, (7) Tetric Ceram<sup>®</sup>+Excite, and (8) Point 4<sup>®</sup>+OptiBond Solo Plus. At 14 days postoperatively, two independent operators, who did not take part in the clinical procedure, assessed postoperative teeth sensitivity using special questionnaires. Data were analyzed using non-parametric chi-square, Mann-Whitney and ANOVA tests.

**Results** Group 8 showed significantly higher score than the other groups. Less postoperative sensitivity was reported with two low-shrinkage composites (groups 2, 3, and 5) but with no significant difference. There was no statistical difference between groups 1, 2, 3, 4, 5, 6 and 7. Operator A had the highest postoperative sensitivity score compared to the other three.

**Conclusion** Conventional composite material Point 4<sup>®</sup> with its bonding agent caused significantly more postoperative sensitivity than low shrinkage composites combined with different adhesives. Operator skill influenced the incidence of postoperative sensitivity.

**Keywords:** dental materials; sensitivity; composite resin; shrinkage; adhesion; operator skill

## INTRODUCTION

Tooth colored restorations, such as resin based composites (RBC) are the material of choice today for most dental patients. The major disadvantages associated with conventional RBC restorations are polymerization shrinkage and contraction stresses [1]. When the contraction stresses exceed the adhesive force of composite to the tooth substrate, marginal gap formation and micro leakage occur [2]. However, polymerization contraction stress is only present when the shrinking materials are bonded and compressed towards opposite cavity walls during their adaptation, and is influenced by many factors including cavity size and configuration (C-factor), type of composite and light intensity [3]. Many clinical problems encountered with RBCs are caused by inadequate dimensional stability [1, 2].

Composites with a high modulus of elasticity or rapid polymerization exhibit high contraction stress, whereas flowable composites of low modulus of elasticity usually have lower contraction stress [4]. Reduced contraction stress can also be achieved by the use of

incremental placement techniques, though the results of several reports are at variance regarding the merit of these methods [4, 5]. Polymerization shrinkage can have a negative effect on the clinical performance of a resin based composite. Considerable force, i.e. contraction stress, is applied to the adhesive bond during composite curing. If the adhesive cannot withstand this force then a gap will occur and can lead to marginal discoloration and postoperative sensitivity [6].

"Low shrinkage" composites in general are conventional composites, the reduction in shrinkage being achieved by optimizing monomers and fillers in various ways. Six newer low shrinkage composites were shown to have significantly less polymerization shrinkage than conventional composites [7], though gingival microleakage was not prevented by the use of a low shrinkage composite compared to a control, when cured by a high intensity light [8]. Also, there was no significant difference in post-gel shrinkage between the control light (400 mW/cm<sup>2</sup>) and all-pulse or soft-start polymerization regimes [9], nor did low shrinkage composites represent an improvement in terms

## Correspondence to:

Vladimir IVANOVIĆ  
Department of Restorative  
Dentistry and Endodontics  
Faculty of Dental Medicine  
Rankeova 4, 11000 Belgrade  
Serbia

[vladaivanovic@hotmail.com](mailto:vladaivanovic@hotmail.com)

of reducing contraction stress or microleakage compared to conventional materials [10].

A clinical problem related to contraction stress is postoperative sensitivity [11]. Sensitivity can be related to preparation trauma, deformation of restorations under occlusal stresses and bacterial microleakage [11, 12]. A recent study has suggested that neither the visco-elastic behavior of two light curable RBCs nor the light curing regime affected the developed stress levels and concluded that differences in modulus of elasticity and polymerization of the material, rather than irradiance, determine the stress level developed during light curing [13]. Furthermore, according to a recent literature review, postoperative sensitivity appears to be more related to the dentine adhesives' ability to seal open dentinal tubules rather than to the effects of polymerization shrinkage on cuspal deflections and marginal adaptation [14].

Operator skill and experience might also be a factor in the clinical outcome and success of any restoration [15]. There are only a few in-vivo studies which have evaluated the success of composite restorations. Moreover, these studies were conducted on relatively small numbers of both patients and teeth [16, 17, 18].

## OBJECTIVE

The aim of the present study was to assess if there is a reduction in postoperative sensitivity with low shrinkage composites compared to conventional composites using different bonding agents, and to investigate the influence of the operator skill on the incidence of postoperative sensitivity.

The null hypothesis is that there is no reduction in clinical sensitivity with low shrinkage composites compared to conventional composites irrespective of the bonding agent used and the operator individual skill.

## METHODS

Nine hundred and sixty permanent premolar and molar teeth (patients' age ranged 21–40 years), affected by primary carious lesions were included in the study. The protocol was presented to and approved by The Ethical Com-

mittee of the School of Dentistry, University of Belgrade. Exclusion criteria were: pregnancy, acute and chronic systemic diseases, immune-compromised patients, allergy to material ingredients, pulp and/or periapical pathosis. All patients were fully informed of the involved clinical procedures, and gave their written consent to be involved in the study. The cavities were either mesially or distally situated. All teeth were in full physiological contact with both the adjacent and antagonist teeth. MO (mesio-occlusal) or DO (distal-occlusal) cavities corresponding fully to generally accepted adhesive cavity preparation rules were prepared according to the literature [19, 20, 21].

The occlusal aspect was opened using a round high speed diamond bur ISO 012 or 014, type F 0002 (Dentsply/Maillefer, Ballaigues, Switzerland) with copious water spray. The proximal extension of the cavity margin was always within sound enamel and all preparations with gingival walls out with enamel were excluded from the study.

Depending on the cavity dimensions, carious dentine was removed using tungsten carbide burs, size ISO 014 to 018, type E 0123, (Dentsply/Maillefer, Ballaigues, Switzerland) in a low speed hand piece at 300–500 rpm. Preparations were terminated when on probing the cavity floor dentine showed a hardness equivalent to that of surrounding dentine. Only teeth with both occlusal and proximal cavity depth of 2 mm but not greater than 3 mm into dentine were included in the study. These dimensions were confirmed using a periodontal probe. All enamel margins were bevelled with a flame-cylindrical diamond finishing bur, type F0245 (Dentsply/Maillefer, Ballaigues, Switzerland). No cavity toilette was performed.

The prepared cavities were randomly allocated a number from 1 to 960, using a computer generated sequence system, resulting in the random allocation of adhesive resin based composite combinations (ARBCCs). Tables 1 and 2 list the adhesives and RBCs used in the study. Table 3 lists the eight ARBCCs applied in class II restorations assessed for postoperative sensitivity.

Cavities were restored in the following manner. In all groups a total etch technique (TE) was applied. A 35% phosphoric acid gel (Microcid Etchant Gel, Saremco, Rebstein, Switzerland) was applied to enamel for 30 seconds, and to dentine for 15 seconds, then thoroughly rinsed off with water for 15 seconds and subsequently dried with a gentle oil-free airflow for 2 seconds, taking care not to

**Table 1.** Adhesive agents

Adhesive	Manufacturer	Composition	Mode of application
<i>James-2</i> (original formula)	SAREMCO, Rebstein, Switzerland	Acetone solvent, Hydroxyethylmethacrylate, Urethanemethacrylate, Polyalkenoate methacrylized (20%), Hydroxypropylmethacrylate, Glycerinedimetharylate, Catalysts, Inhibitors	Active condition. 20 s; polymerization 20s
<i>James-2</i> (new formula)	SAREMCO, Rebstein, Switzerland	Hydroxyethylmethacrylate, Urethanemethacrylate, Polyalkenoate methacrylized (5%), Hydroxypropylmethacrylate, Glycerinedimetharylate, Catalysts, Inhibitors	Active condition. 20 s; polymerization 20s
<i>Excite</i>	VIVADENT, Schaan, Liechtenstein	Ethanol 25%; Phosphonic acid acrylate; HEMA + Bis-GMA + Dimethacrylate: 73.6%; High dispersed silica 0.5%; Catalysts and Stabilizers 0.9%	Active condition. 10 s; polymerization 10s
<i>OptiBond Solo Plus</i>	KERR Corporation, Orange, USA	Ethyl alcohol 20-25%, Alkyl dimethacrylate resins, Barium aluminoborsilicate, glass, Fumed silica (SiO <sub>2</sub> ), Sodium hexafluorosilicate	Active condition. 15 s; polymerization 20s

**Table 2.** Resin based composite materials

Composite	Manufacturer	Composition	Properties – manufacturer's results
<i>Els extra low shrinkage</i> <sup>®</sup>	SAREMCO, Rebstein, Switzerland	Bariumaluminiumborosilicate, (3methacryloxypropyl) trimethoxysilane, BisGMA BisEMA Catalysts, Inhibitors, Pigments	Young's modulus 5.1 GPa; polymer. contr. 2.1 vol%; shrinkage stress 4.2 MPa
<i>Tetric Ceram</i> <sup>®</sup>	VIVADENT, Schaan, Liechtenstein	Bis-GMA,UDMA,TEGDMA, Ba-glass, Ytterbium trifluoride, Ba-Al-F-Si glass, SiO <sub>2</sub> , spheroidal oxide 79 w%	Young's modulus 8.9 GPa; polym. contr. 3.2 vol%; shrinkage stress 12.8 MPa
<i>InTenSe</i> <sup>®</sup>	VIVADENT, Schaan, Liechtenstein	Dimethacrylates, Ba-glass, Ytterbium trifluoride, Copolymer 82.2 w%	Young's modulus 7.6 GPa; polym. contr. 2.7 vol%; shrinkage stress 8.8 MPa
<i>Point 4</i> <sup>®</sup>	KERR Corporation, Orange, USA	Bis-GMA, TEGDMA, EBDMA, EDMAB, HEMA, Barium aluminoborosilicate, Nanosilica, Fumed silica 76 w%	Young's modulus 8.9 GPa; polym. contr. 3.4 vol%; shrinkage stress 11.9 MPa

**Table 3.** Combinations of adhesive agents and RBC materials applied in class II restorations

No	Adhesive agent	Composite material
1.	James-2 (original formula) +	Els <sup>®</sup>
2.	James-2 (new formula) +	Els <sup>®</sup>
3.	Excite +	Els <sup>®</sup>
4.	James-2 (original formula) +	InTenSe <sup>®</sup>
5.	James-2 (new formula) +	InTenSe <sup>®</sup>
6.	Excite +	InTenSe <sup>®</sup>
7.	Excite +	Tetric Ceram <sup>®</sup>
8.	OptiBond Solo Plus +	Point 4 <sup>®</sup>

dehydrate the tooth surfaces. The adhesive agent was immediately applied with a disposable brush according to the manufacturer's instructions so as to thoroughly wet all etched surfaces. Adhesive was left undisturbed for the allocated time after which excessive solvent was removed with a blast of air from a syringe (Table 1). The adhesive was cured using a light curing unit Astralis 7 (Ivoclar-Vivadent, Schaan, Liechtenstein) for 20 seconds at 500 mW/cm<sup>2</sup>. The RBCs (Table 2) were placed using a modified incremental layering technique [22]. The proximal portion of the cavity was always restored first. Each increment was placed and condensed from the joint angle between one of the lateral and the gingival wall towards the opposite lateral wall, up to the level of the dentino-enamel junction (DEJ), after which another increment was placed, condensed and shaped to fill the resultant space. The same procedure was repeated to fill the occlusal portion of the cavity. Final increments were placed in the same manner until full anatomical form was achieved. Each increment was cured for 40 seconds using a light curing unit on a soft start and pulse polymerization mode (Astralis 7) with an initial intensity of 500 mW/cm<sup>2</sup> increasing to 800-1000 mW/cm<sup>2</sup>. The light tip was maintained at constant distance of 1cm from the RBC surface. The intensity of the light curing unit was monitored by a Demetron Radiometer (Demetron Kerr, Dansbury, CT, USA) and was always within the proscribed intensity limits for both adhesives and RBCs polymerization.

The occlusal contacts were checked with Hanel 80 µm articulating paper (Roeko, Langenau, Germany), and the morphology contoured with tungsten carbide finishing burs (Kerr, Sybron, Minnesota, USA). In all groups, wet grinding and polishing was carried out using coarse, medium, fine and ultra-fine Sof-Lex finishing discs (3M ESPE, St. Pauls, USA), and silicone polishers (Composite

Polish Kit, Diotech, Heerbrugg, Switzerland). Finishing burs were replaced after every 20 restorations, silicone polishers after 10 restorations, and polishing discs after every restoration.

Four staff members A, B, C, and D, from the Department of Restorative Odontology and Endodontics, School of Dental Medicine, Belgrade University, participated in the study. Two operators (A and B) were qualified for no more than five years, the other two (C and D) were senior staff members, each with over twenty years of clinical and teaching experience. Each operator was instructed to complete 30 restorations for each ARBCC. Only restorations which corresponded to the protocol were included in the study resulting in 120 per ARBCC and 240 per operator, a total of 960 restorations.

An assessment questionnaire, consisting of two parts, was used (Appendix). Part I logged patient's details and the ARBCC, and was filled in by the operator at the time of placement of the restoration. This was given an ID number which was duplicated in Part II of the questionnaire used by the assessors. Patients were recalled after fourteen days. At this visit, to avoid bias the Part II Assessment Questionnaire was completed by the two independent assessors, both senior staff members (one senior lecturer and Director of the Biomaterial Research at postgraduate studies, and another senior clinical lecturer). The assessors were neither involved in placing restorations nor had any knowledge of the operator who placed the restorations or the material combination.

Data were statistically analyzed using non-parametric chi-square ( $\chi^2$ ), Mann-Whitney (M-W) and ANOVA tests.

## RESULTS

Age, sex, tooth type, and cavity location had no effect on the prevalence of the postoperative sensitivity ( $\chi^2$ -test:  $p > 0.05$  in all cases).

Postoperative sensitivity was recorded in 101 (10.52%) of total 960 restorations (Table 4). Spontaneous pain was not reported in any of the sensitive teeth, all teeth showing multiple episodes of postoperative sensitivity provoked by the external stimuli.

Sensitivity was reported to have commenced immediately after anesthesia wore off in four teeth, within three to five hours postoperatively in 94 teeth, and after one to two

**Table 4.** Analysis of the incidence of postoperative pain with respect to RBCA system

Material			Pain					
			Not present		Present		Total	
			N	%	N	%	N	%
Els + James 2 (orig)	1	N	108	90	12	10	120	100
		%	12.57		11.88		12.5	
Els + James 2 (new)	2	N	113	94.17	7	5.83	120	100
		%	13.15		6.93		12.5	
Els + Excite	3	N	113	94.17	7	5.83	120	100
		%	13.15		6.93		12.5	
InTenSe + James 2 (orig)	4	N	108	90	12	10	120	100
		%	12.57		11.88		12.5	
InTenSe + James 2 (new)	5	N	112	93.33	8	6.67	120	100
		%	13.04		7.92		12.5	
InTenSe+Excite	6	N	111	92.5	9	7.5	120	100
		%	12.92		8.91		12.5	
TetCer + Excite	7	N	107	89.17	13	10.83	120	100
		%	12.46		12.87		12.5	
Point 4 + OBSP	8	N	87	72.5	33	27.5	120	100
		%	10.13		32.67		12.5	
Total		N	859	89.48	101	10.52	960	100
		%	100.0		100.0		100.0	

$\chi^2=45.489$ ;  $p=0.001$

days in three teeth. Postoperative sensitivity lasted for one to three days in 98 teeth, and in the remaining three teeth for four to five days. No tooth was sensitive seven days postoperatively, and no case required additional treatment.

Postoperative sensitivity was reported on chewing food in 85 teeth, on both chewing food and clenching teeth in 12 teeth, and on chewing and consuming hot or cold food or drinks in four teeth.

Conventional RBC Point 4 combined with OptiBond Solo Plus, compared to the other seven ARBCCs, gave significantly higher incidence of postoperative sensitivity ( $\chi^2$ -test:  $p<0.001$ ). However, in ARBCCs group 1–7 (Tables 3 and 4) there was no statistically significant difference in the incidence of postoperative pain ( $\chi^2$ -test:  $p>0.05$ ). Least postoperative sensitivity occurred with low shrinkage composite Els, but with significant difference only in regard to Point 4 ( $\chi^2$ -test:  $p<0.001$ ) (Table 4).

Less postoperative sensitivity was found with adhesive agent James 2 – new formula than with James 2 – original formula, combined with low shrinkage RBCs Els and InTenSe, respectively, but with no statistically significant difference ( $\chi^2$ -test:  $p>0.05$ ) (Table 4).

With operator A, significantly higher incidence of postoperative sensitivity was found compared to other three operators (M-W:  $p<0.05$ ) (Table 5).

According to the results of the present study the null hypothesis that there is no reduction in clinical sensitivity with low shrinkage composites compared to conventional composites irrespective of the bonding agent used and operator skill is therefore rejected.

**Table 5.** Incidence of postoperative sensitivity with respect to operators

Operator			
A	B	C	D
39 (16%) <sup>A</sup>	21 (8.7%) <sup>B</sup>	21 (8.7%) <sup>B</sup>	20 (8.3%) <sup>B</sup>

Results with identical superscripts are not significantly different.

## DISCUSSION

A limited number of clinical studies have measured postoperative sensitivity following the placement of RBC [11, 18, 23, 24], and a literature search failed to find any that have focused on postoperative sensitivity caused by low shrinkage versus conventional composites. Low shrinkage composite is expected to be accompanied by high contraction stress and RBCs with both a low shrinkage and low contraction stress should give the least problems with respect to marginal seal and sensitivity [25]. The results of the present study are in agreement with the results of Klevlerlaan and Feilzer [25] as the incidence of postoperative sensitivity was reduced with both the low shrinkage and low contraction stress RBCs (Els and InTenSe) compared to conventional composites.

In the present study an effort was made to eliminate variables as far as possible, though it is exceedingly difficult in any clinical study. A criticism of some previous papers is that they have failed to standardize conditions such as age of the patient, physiological and pathological condition of the tooth, cavity size, and restoration classification. Frequently class I or class II restorations were included either for replacement of existing restorations or for the treatment of the primary carious lesions [18]. A major factor causing dentine sensitivity is hydrodynamic movement of the dentinal fluid [12], which would be expected to be greater in very young teeth affected by a primary carious lesion, and less in very old or sclerotic teeth which had previously been restored. In an attempt to exclude these variables patients in the age range of 21–40 years who had primary carious lesions were arbitrarily chosen for this study.

Cavity configuration (C-factor) plays an important role in the generation of stress related sensitivity due to polymerization contraction [26]. In a previous study class I cavities (C-factor approx. 5) and class II cavities (C-factor

**APPENDIX**

**Part I**

**ASSESSMENT SHEET**

Id No: . . . . .

1) First name . . . . . Family name . . . . .

2) Date of birth . . . . .

3) Male Female (circle appropriate)

4) Tooth restored . . . . .

5) Cavity type: MO DO (circle appropriate)

5) Adesive / Composite combination : . . . . .

Date: . . . . .

Operator

**A, B, C, D** (circle appropriate)

approx. 2) were pooled together [18]. In the present study only class II cavities were used in order to achieve further standardization. Furthermore, cavity depth was standardized by including only cavities which were approximately 2-3 mm deep into dentine, both on occlusal and proximal aspects.

Sensitivity can be related to microleakage. Several studies have shown that when margins are kept entirely in enamel, microleakage occurs very rarely irrespective of the placement technique [5], bevelling [27], total or self-etching technique [28], or light mode [8]. Therefore all cavity margins in this study were confined within sound enamel.

RBC polymerization stress depends, amongst other factors, on chemistry, organic matrix, type of fillers, modulus of elasticity, placement technique, light intensity and light mode. Accepting that all these factors may interfere with polymerization shrinkage and the resulting stresses, manufacturers' instructions were strictly followed exactly with regard to the application and curing of adhesive agents and the curing of RBCs. Incremental placement techniques are generally accepted as reducing contraction stresses [5], and so this technique was used for all restorations. All of the RBCs were placed with a total etch technique (TE). Postoperative sensitivity is maybe associated with TE if monomer diffusion does not completely fill the etched zone. However, recent studies [29, 30] have shown that there was no difference in postoperative sensitivity at two weeks, between TE adhesive and self-etch adhesive and that postoperative sensitivity may depend on the restorative technique rather than on a type of a dentine adhesive [18]. In the present study it was found that the new formula of the adhesive agent James 2, without acetone solvent and with four times less methacrylized polyalkenoate (Table 1), caused less postoperative sensitivity than its original formula (Table 4). This may be attributed to a better diffusivity and dentine sealing ability of James 2 – new formula, and therefore the potential influence of the adhesive agent on the incidence of postoperative sensitivity.

**Part II**

**ASSESSMENT QUESTIONNAIRE**

ID No: . . . . .

1) Did you have postoperative sensitivity: Yes No

If the answer is «NO» do not continue.

2) When did the pain first arise?

a) Immediately after anesthesia wore off

b) After . . . . . hours

c) After . . . . . days

3) For how long did the pain last?

a) Minutes . . . . .

b) Hours . . . . .

c) Days . . . . .

4) Were there single, multiple, or continuous episode? (circle appropriate)

5) Was the pain spontaneous or provoked? (circle appropriate)

6) If provoked, by what stimulus: (circle appropriate)

a) Hot and cold foods

b) Sweet and sour foods

b) Clenching teeth together

c) Chewing food

Date: . . . . .

Name of assessor  
.....

Signature of assessor  
.....

Two conventional RBCs (Tetric Ceram and Point 4) with similar physical properties (Table 2) were chosen as controls, both having high modulus of elasticity, volumetric shrinkage and high contraction stress. It has been shown that there is a high inverse correlation between contraction stress and polymerization shrinkage for many RBCs [25]. An RBC that has both a low contraction stress and low polymerization shrinkage during curing is expected to give the least problems with respect to marginal seal and sensitivity. In the present study the results of Kleverlaan and Feilzer [25] were corroborated because the two low contraction stress and low shrinkage RBCs, Els and InTenS, performed statistically significantly better only than the higher shrinkage and higher contraction stress Point 4, but not than Tetric Ceram. A possible explanation for this finding is that in the clinical design for this study both conventional composites were used with the manufacturer's adhesive agent, only. Since Tetric Ceram and Point 4 have very similar physical properties, it may be speculated that reduced incidence of postoperative sensitivity could be attributed to the adhesive system (Excite vs. OptiBond Solo Plus), in accordance with the views of Sarret [14]. Currently, a further clinical study is being conducted to clarify the role of adhesive agents versus low shrinkage and low contraction stress RBCs.

Cavity preparation and restoration was conducted by four different operators in an attempt to evaluate the

influence of operator's skill on the incidence of postoperative sensitivity. Previous studies have paid minor attention to this variable [18, 23], mainly comparing undergraduate students to experienced clinicians. The results of the present study clearly revealed that one particular operator (operator A) caused significantly more postoperative sensitivity than the other three (Table 5). The operator A had five year experience, the same as operator B. The latter, however, caused significantly less postoperative sensitivity and obtained similar results to the two operators with the clinical experience of over 20 years. This finding indicated that personal professional skill during cavity preparation and restorative procedure could have had greater influence on the incidence of postoperative sensitivity than the clinical experience of the operator.

## REFERENCES

- Hannig M, Friedrichs C. Comparative in vivo and in vitro investigation of interfacial bond variability. *Oper Dent.* 2001; 26(1):3-11.
- Swift EJ Jr. Dentin bonding. *J Esthet Restor Dent.* 2003; 15(2):71.
- Bouschlicher MR, Rueggeberg FA. Effect of ramped light intensity on polymerization force and conversion in a photoactivated composite. *J Esthet Dent.* 2000; 12(6):328-39.
- Schneider LF, Cavalcante LM, Silikas N. Shrinkage stresses generated during resin composite applications: a review. *J Dent Biomech.* 2010; 2010. pii: 131630.
- Santini A, Plasschaert AJ, Mitchell S. Effect of composite resin placement techniques on the microleakage of two self-etching dentin-bonding agents. *Am J Dent.* 2001; 14(3):132-6.
- Zou Y, Armstrong SR, Jessop JL. Quantitative analysis of adhesive resin in the hybrid layer using Raman spectroscopy. *J Biomed Mater Res A.* 2010; 94(1):288-97.
- Ernst CP, Meyer GR, Klockner K, Willershausen B. Determination of polymerization shrinkage stress by means of a photoelastic investigation. *Dent Mater.* 2004; 20(4):313-21.
- Santini A, Milia E. Microleakage around a low-shrinkage composite cured with a high-performance light. *Am J Dent.* 2004; 17(2):118-22.
- Yap AU, Soh MS, Siow KS. Post-gel shrinkage with pulse activation and soft-start polymerization. *Oper Dent.* 2002; 27(1):81-7.
- Calheiros FC, Sadek FT, Braga RR, Cardoso PE. Polymerization contraction stress of low-shrinkage composites and its correlation with microleakage in class V restorations. *J Dent.* 2004; 32(5):407-12.
- Swift EJ Jr. Causes, prevention, and treatment of dentin hypersensitivity. *Compend Contin Educ Dent.* 2004; 25(2):95-106, 109; quiz 110.
- Brannstrom M. The hydrodynamic theory of dentinal pain: sensation in preparations, caries, and the dentinal crack syndrome. *J Endod.* 1986; 12(10):453-7.
- Emami N, Soderholm KJ. Dynamic mechanical thermal analysis of two light-cured dental composites. *Dent Mater.* 2005; 21(10):77-83.
- Sarrett DC. Clinical challenges and the relevance of materials testing for posterior composite restorations. *Dent Mater.* 2005; 21(1):9-20.
- Adebayo OA, Burrow MF, Tyas MJ. Bond strength test: role of operator skill. *Aust Dent J.* 2008; 53(2):145-50.
- Kramer N, Garcia-Godoy F, Frankenberger R. Evaluation of resin composite materials. Part II: in vivo investigations. *Am J Dent.* 2005; 18(2):75-81.
- Aw TC, Lepe X, Johnson GH, Mancl LA. A three-year clinical evaluation of two-bottle versus one-bottle dentin adhesives. *J Am Dent Assoc.* 2005; 136(3):311-22.
- Perdigao J, Geraldini S, Hodges SJ. Total-etch versus self-etch adhesive. Effect on postoperative sensitivity. *J Am Dent Assoc.* 2003; 134(12):1621-9.
- Porte A, Lutz F, Lund MR, Swartz ML, Cochran MA. Cavity designs for composite resins. *Oper Dent.* 1984; 9(2):50-6.
- Davidson C. Composite resins for posterior use. *Actual Odontostomatol.* 1986; 40(153):9-16.
- Kidd EAM, Smith BGN, editors. *Pickard's Manual of Operative Dentistry.* 7th ed. Oxford, New York, Tokyo: Oxford University Press; 1996.
- Fortin M, Vargas M. The spectrum of composites: new techniques and materials. *J Am Dent Assoc.* 2000; 131(Suppl):265-305.
- Opdam NJ, Roeters FJ, Feilzer AJ, Verdonschot EH. Marginal integrity and postoperative sensitivity in Class 2 resin composite restorations in vivo. *J Dent.* 1998; 26(7):555-62.
- Hayashi M, Wilson NH. Failure risk of posterior composites with post-operative sensitivity. *Oper Dent.* 2003; 28(6):681-8.
- Kleverlaan CJ, Feilzer AJ. Polymerization shrinkage and contraction stress of dental resin composites. *Dent Mater.* 2005; 21(12):1150-7.
- Ghulman MA. Effect of cavity configuration (C factor) on the marginal adaptation of low-shrinking composite: a comparative ex vivo study. *Int J Dent.* 2011; 15(9):74-9.
- Santini A, Ivanovic V, Ibbetson R, Milia E. Influence of marginal bevels on microleakage around Class V cavities bonded with seven self-etching agents. *Am J Dent.* 2004; 17(4):257-61.
- Santini A, Ivanovic V, Ibbetson R, Milia E. Influence of cavity configuration on microleakage around Class V restorations bonded with seven self-etching adhesives. *J Esthet Restor Dent.* 2004; 16(2):128-36.
- Akpata ES, Sadiq W. Post-operative sensitivity in glass-ionomer versus adhesive resin-lined posterior composites. *Am J Dent.* 2001; 14(1):34-8.
- Perdigao J, Anauate-Netto C, Carmo AR, Hodges JS, Cordeiro HJ, Lewgoy HR, et al. The effect of adhesive and flowable composite on postoperative sensitivity: 2-week results. *Quintessence Int.* 2004; 35(10):777-84.

## CONCLUSION

Conventional composite material Point 4 with its bonding agent caused significantly more postoperative sensitivity than low shrinkage composites Els and InTenS, combined with different adhesives. Operator's skill influenced the incidence of postoperative sensitivity.

## ACKNOWLEDGEMENTS

The authors would like to thank Professor Olivera Stojanović for the statistical analysis.

This study was the part of the Project No 1454042, funded by the Ministry of Science and Environment Protection of the Republic of Serbia.

## Утицај композита с малом контракцијом и конвенционалних композита на постоперациону осетљивост зуба

Владимир Ивановић<sup>1</sup>, Татјана Савић Станковић<sup>1</sup>, Бранислав Караџић<sup>1</sup>, Југослав Илић<sup>1</sup>, Арио Сантини<sup>2</sup>, Катарина Бељић-Ивановић<sup>1</sup>

<sup>1</sup>Одељење за ресторативну одонтологију и ендодонцију, Стоматолошки факултет, Универзитет у Београду, Београд, Србија;

<sup>2</sup>Единбуршки институт за стоматолошке студије, Универзитет у Единбургу, Лористон Плејс, Единбург, Велика Британија

### КРАТАК САДРЖАЈ

**Увод** После постављања композитних испуна може да се јави постоперациона осетљивост изазвана препаративним траумом, способношћу адхезивног система да херметички затвори дентинске каналиће, деформацијом под оклузалним оптерећењем или продором бактеријских токсина.

**Циљ рада** Циљ истраживања је био да се испита да ли је осетљивост зуба мања код композита с малом контракцијом у поређењу с конвенционалним композитима и одговарајућим адхезивним системима, као и утицај вештине стоматолога на инциденцију постоперационе осетљивости зуба.

**Методе рада** На 960 премолара и молара сталне дентиције с примарним каријесом, пацијената старости од 21 године до 40 година, препарисани су кавитети дубине 2–3 mm с рубовима у глеђи. Читаву процедуру су обавила четири специјалиста стоматологије, од којих су два имала пет (А и В), а друга два више од 20 година клиничког искуства (С и D). Зуби су сврстани у осам група од по 120 узорака према коришћеном композитном и адхезивном систему: 1) *Els®+James-2*; 2) *Els®+James-2* (нова формула); 3) *Els®+Excite*;

4) *InTenSe®+James-2*; 5) *InTenSe®+James-2* (нова формула); 6) *InTenSe®+Excite*; 7) *Tetric Ceram®+Excite*; и 8) *Point 4®+OptiBond Solo Plus*. Две недеље после интервенције два независна стоматолога (која нису учествовала у клиничкој процедури) оцењивала су посебним упитницима постоперациону осетљивост зуба. Подаци су анализирани непараметријским  $\chi^2$ , Ман–Витнијевим (*Mann–Whitney*) и ANOVA тестом.

**Резултати** У осмој групи утврђена је статистички значајно чешћа постоперациона осетљивост него у осталим групама зуба. Није било статистички значајне разлике између група 1, 2, 3, 4, 5, 6 и 7. Композити са нижом полимеризационом контракцијом изазвали су мању постоперациону осетљивост, али без статистичке значајности разлика (групе 2, 3 и 5). Код стоматолога А јављала се статистички значајно чешће постоперациона осетљивост него код остала три.

**Закључак** Тип композитног материјала с одговарајућим адхезивним системом и спретност стоматолога утичу на учесталост појаве осетљивости зуба после рестаурација средње дубоких кавитета II класе.

**Кључне речи:** дентални материјали; осетљивост; композити; контракција; адхезија