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CLINICAL IMPACT OF DENTAL ADHESIVES ON POSTOPERATIVE SENSITIVITY IN CLASS I AND CLASS II RESIN-COMPOSITE RESTORATIONS

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КЛИНИЧЕСКОЕ ВОЗДЕЙСТВИЕ СТОМАТОЛОГИЧЕСКИХ АДГЕЗИВОВ НА ПОСТОПЕРАТИВНУЮ ЧУВСТВИТЕЛЬНОСТЬ КОМПОЗИТНЫХ ОБТУРАЦИЙ I И II КЛАССА

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ABSTRACT

BACKGROUND: Self-etch adhesives are believed to prevent postoperative sensitivity when used under posterior resin-based composite restorations. **STUDY OBJECTIVE:** A hypothesis that a one-step self-etch adhesive (1-SEA) would result in less postoperative sensitivity than a three-step etch-and-rinse adhesive (3-E&RA) was tested. **PATIENTS AND METHODS:** One hundred restorations were placed with a 1-SEA and 100 restorations with a 3-E&RA. Teeth were restored with Filtek Supreme nanofilled resin-composite and were evaluated for sensitivity to cold and masticatory forces at baseline, 7 days, 14 days, 30 days, and 6 months postoperatively. Vitality test scores of the teeth were recorded at the same periods. **RESULTS:** The evaluation of cold sensitivity intensity (VAS score) for all observation periods in both restoration groups did not reveal any statistical significance. The differences in the response time to cold stimulation (0 – 15 sec) for the restorations made with a 1-SEA and those made with a separate etch step are statistically insignificant. There are no significant differences in the vitality of the restored teeth at intra- or inter-group comparison. The statistical analysis revealed significant differences in postoperative sensitivity to masticatory forces at postoperative day 14 and day 30 in the 3-E&RA group. **CONCLUSIONS:** Postoperative sensitivity depends on the type of dentin adhesive used. More intensive complaints of postoperative sensitivity were recorded under masticatory forces at postoperative day 14 and day 30 in 3-E&RA in comparison with 1-SEA.

Key words: nanofilled resin-composite posterior restorations, one-step adhesive, three-step adhesive, postoperative sensitivity

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РЕЗЮМЕ

ВВЕДЕНИЕ: В научно-исследовательских и клинических кругах среди врачей-стоматологов существует мнение, что одношаговые самопротравливающие адгезивы редуцируют постоперативную чувствительность при композитных obturations жевательных зубов. **Цель:** Целью настоящей статьи является исследование клинического воздействия одношаговой адгезивной системы и трёхшагового бондинг агента на появление постоперативной чувствительности при композитных obturations жевательных зубов. Проверяется гипотеза: приводит ли употребление одношагового самопротравливающего адгезива Adper Prompt L-Pop к понижению постоперативной чувствительности композитных obturations I и II класса по сравнению с трёхшаговым агентом Scotchbond MultiPurpose. **МАТЕРИАЛ И МЕТОДЫ:** Проведено 200 obturations из нанофильного композита Filtek Supreme. В 100 из них использовался одношаговый самопротравливающий адгезив Adper Prompt L-Pop, а в остальных 100 obturations использовался трёхшаговый агент Scotchbond MultiPurpose. Все obturations были оценены на предмет

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появления постоперативной чувствительности в отношении жевательного давления и температурного раздражителя до лечения и по истечении 7 дней, 14 дней, 30 дней и 6 месяцев после obturation. Проведён тест на витальность всех obturированных зубов на всех этапах наблюдения. **Результаты:** При оценке постоперативной чувствительности в отношении температурного раздражителя (VAS единицы) в обеих исследованных группах не установлена статистически значимая разница на всех этапах наблюдения. Различия в данных в отношении времени реакции на температурный раздражитель в обеих исследованных группах статистически незначительны. Не установлена статистически значимая разница в показателях витальности восстановленных зубов при межгрупповом и внутригрупповом сравнении. Установлена статистически значимая разница в постоперативной чувствительности в отношении жевательного давления на 14 и 30 день в группе с трёхшаговым адгезивом. **Заключение:** Постоперативная чувствительность зависит от применяемого стоматологического адгезива. Большинство жалоб на постоперативную чувствительность установлены в отношении жевательного давления на 14 и 30 день в группе с трёхшаговой адгезивной системой.

Ключевые слова: нанофильные композитные obturation, постоперативная чувствительность, трёхшаговый адгезив, одношаговый адгезив

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INTRODUCTION

The potentialities of the new generation of aesthetic dental materials demand composite restorations as the most widely used method of choice in the treatment of dental caries. In adhesive restoration of class I and class II cavities, the incidence of complaints of postoperative sensitivity (POS) is not infrequent.

Over the last two decades the problem of postoperative sensitivity has manifested itself in the restoration of masticatory teeth with composite resins.¹⁻³ For some clinicians POS is not a frequent complication after treatment of dental caries, while others consider it a problem in classes I, II and V composite restorations⁴, even in the cases where a dentin liner was applied⁵.

There is no unanimous consensus among authors on the possible risk factors for POS incidence. The complication occurs in different clinical situations and seems to depend on: the peculiarities of the dental tissues as an adhesion substrate – physico-chemical and morphological characteristics, age and irritative changes (sclerosis); preparation trauma; cavity geometry – localization and depth of the carious lesion; C-factor; adhesion strategy – a one-, two- or three-step adhesive system; quality of the adhesive bond – strength and resistance to degradation; polymerization shrinkage of the composite material and distribution of the post-polymerization tensions exerted on the system of hard dental tissues – adhesive layer – composite material.

The data on the occurrence of POS with different adhesive systems are controversial. The choice of a bonding system capable of providing a strong and degradation-resistant bond and preventing the

occurrence of sensitivity is a moot question.

It was this polarity in the properties of the 3-E&RA and 1-SEA systems that provoked our interest in conducting a longitudinal clinical study on class I and class II nanofilled composite restorations with the Scotchbond Multi Purpose three-step system and the Adper Prompt L-Pop (3M ESPE) single-component adhesive.

STUDY OBJECTIVE

The hypothesis tested in our clinical study was: a 1-SEA would result in less postoperative sensitivity than a 3-E&RA.

PATIENTS AND METHODS

SELECTION CRITERIA

The clinical study included 89 patients (43 males and 46 females, aged 20 to 35 years), who received a total of 200 restorations. Before participating in the study, patients signed a consent form. The consent form and research protocol were reviewed and approved by an institutional review board (Ethics Committee of Medical University – Plovdiv)

All participants required Class I and Class II restorations in molars and premolars either for replacement of an existing restoration or for treatment of primary carious lesions. All patients demonstrated good oral hygiene and dental health status, except for ongoing restorative procedures in unrelated and unopposed quadrants. Box enumerates specific exclusion criteria. The teeth to be restored had a normal occlusal relationship with natural dentition and opposing and adjacent tooth contact. The average facio-lingual width of each prepara-

Table 1. Details of patients and restorations

Lesion or patient characteristic		Prompt LP	Scotchbond MP
Design of preparation	Conventional	44	42
	Minimal invasive	56	58
Number of restorations on	Males	37	36
	Females	63	64
Tooth location	Maxillary	49	41
	Mandibular	51	59
	Premolar	34	35
	Molar	66	65
Cavity classification	Class I	36	37
	Class II	64	63
Cavity depth	Caries media	33	34
	Caries profunda	67	66
Cavity location	Occlusal	37	38
	Mesio-occlusal	25	24
	Disto-occlusal	30	28
	Mesio-occluso-distal	8	10

Box. Patient exclusion criteria

- ✓ → Fewer than 20 teeth;
- ✓ → Non-vital tooth;
- ✓ → History of tooth sensitivity;
- ✓ → Xerostomia or periodontal disease;
- ✓ → Bruxism;
- ✓ → Allergy to resin materials;
- ✓ → Inability to return for recall appointments;
- ✓ → Fractured or cracked teeth;
- ✓ → Subject in another ongoing clinical dentistry evaluation;
- ✓ → Subject receiving desensitizing therapy, including desensitizing dentifrices or other over-the-counter products;
- ✓ → Medical, psychiatric or pharmacotherapeutic history that might compromise the protocol, including the long-term use of anti-inflammatory, analgesic and psychotropic drugs;
- ✓ → Pregnancy and breast-feeding;
- ✓ → Allergies and idiosyncratic responses to product ingredients;
- ✓ → Orthodontic appliance treatment within the previous three months;
- ✓ → Teeth restored in the preceding three months;
- ✓ → Abutment teeth used for fixed or removable prostheses;
- ✓ → Teeth or supporting structures with any painful pathology;
- ✓ → Periodontal surgery within the previous three months;

tion was greater than or equal to one-third of the distance between the cusp tips. Further details on the patients and the teeth are given in Table 1.

RESTORATIVE PROCEDURE

Preoperative radiographs of the teeth to be restored were obtained. Operative procedures were performed without local anesthesia. Operating sites were isolated

with cotton rolls and aspiration. Cavity preparation for adhesive restoration was performed using rotary tools with water/air cooling. Cavo-surface angles of all restorations were entirely within enamel, without any intentional bevel. An appropriate matrix (Super Mat and Super Cap, KerrHawe, Switzerland) and wood wedges (Hawe Sycamore Interdental wedges,

KerrHawe, Switzerland) to the cervical margins of Class II restorations were applied. All lesions were prepared, restored and finished by one experienced (NM) operator, who was familiar with adhesive dentistry and who followed the standard procedures and manufacturer's recommendations. The order of placement and selection of material to be placed were randomly allocated for each patient.

APPLICATION OF PRIMER AND ADHESIVE

The 1-SEA system tested was Adper Prompt L-Pop (3M ESPE, St. Paul, MN, USA) and the 3-E&RA system was Scotchbond Multi Purpose (3M ESPE, St. Paul, MN, USA). Both adhesives were combined with the nanofilled resin-composite Filtek Supreme (3M ESPE, St. Paul, MN, USA). To minimize the possible effects of patient related factors, no more than three restorations per patient were allowed for each adhesive system. The adhesives were used in accordance with the manufacturer's instructions (Table 2). The resin-composite was applied in 2-4 increments and light-cured for 40 sec/increment (Optilux, USA, 600 mW/cm²). The restorations were finished directly under water spray cooling with flame diamond burs (Komet, № 859 EF.314.014) and, finally, polished with Soft-Lex disc system (3M ESPE, St. Paul, MN, USA).

CLINICAL EVALUATION CRITERIA

Evaluation of post-operative sensitivity.

The restorations were examined at baseline and at 7 days, 14 days, 30 days and 6 months. At each evaluation, the sensitivity of each tooth was recorded to applications of a cold stimulus and masticatory forces as the patient's spoken response to a visual analog scale (VAS). It is a horizontal line, 100 mm in length, divided into four equal sections. Either end of the line is marked with "no sensitivity" and "worst sensitivity possible". In between, three descriptors are marked at equal intervals: "mild sensitivity", "moderate sensitivity", "severe sensitivity". The patients marked their perceived sensitivity with a cross ("x") on the scale. The distance of the mark in mm from the "no sensitivity" anchor determined the score. Thus, the numerical value was an objective representation of the intensity of the patient's perception.

A cold stimulus in the form of a cotton swab frosted with Cognoscin (KerrSpofa Dental) was applied on the vestibular surface at the cervical area of the restored tooth. The clinicians timed the applications of each stimulus until the subject responded by raising their left hand, with a maximum application lasting 15 seconds. Immedi-

Table 2. Adhesive systems and resin composite: composition and instructions for use

Adhesive/resin-composite	Classification	Composition	Instructions for use
Adper Prompt L-Pop	One-step, self-etch adhesive	Liquid 1: methacrylated phosphoric esters, Bis-GMA, initiators based on camphorquinone, stabilizers. Liquid 2: water, HEMA, polyalkenoic acid, co-polymer, stabilizers.	a – Mixed liquid A and liquid B; b – One coat of mixture application (15s); c – air-dry (10s); d – Second coat of mixture application (15s); e – air-dry (10s); f – Light-cure (10 sec. – 600 mW/cm ²)
Scotchbond Multi Purpose	Three-step, etch-and-rinse adhesive	1. Scotchbond etchant – 35% phosphoric acid (pH 0.6) 2. Primer – water, hydroxyethyl methacrylate (HEMA), polyalkenoic acid copolymer 3. Adhesive – BIS-GMA, HEMA, photoinitiators.	a – Acid-etch (15s); b – Rinse (15s); c – Air-dry (15s); d – Primer application; e – Gently dry with airstream; f – Adhesive application; g – Light-cure (10 sec. – 600 mW/cm ²)
Filtek Supreme	Nanofilled resin-composite.	Filler: 59.5 vol.% (78.5 wt.%) of combination of nanomeric particles and nanoclusters with primary particle size of 20 or 75 nm. Resin: Bis-GMA, UDMA, TEGDMA Additional contents: stabilizers, catalysts and pigments	a – Increment placement (< 1.5 mm); b – Light-curing (30 s – 600 mW/cm ²)

Table 3. Severity and time of response to cold and masticatory force, and electric pulp vitality test

Stimulus	Baseline	Postoperative period					Baseline	Postoperative period				
		7 days	14 days	30 days	6 months			7 days	14 days	30 days	6 months	
		Adper	Prompt	L-Pop				Adper	Scotchbond	Multi-Purpose		
Cold												
Mean (SE)	1.9	1.6	1.7	1.7	1.7		1.9	1.6	1.6	1.6	1.6	
Response time (0 – 15s)	(0.2)	(0.3)	(0.2)	(0.2)	(0.2)		(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	
Cold												
Mean (SE)	-	21.5	19.2	9.6	-		-	11.5	19.6	11.1	-	
Severity (1 to 100 VAS units)		(9.3)	(5.3)	(6.4)				(3.4)	(2.5)	(3.0)		
Masticatory force												
Mean (SE)	-	8.6	7.9	3.1	-		-	14.7	17.7	11.6	-	
Severity (1 to 100 VAS units)		(3.9)	(3.0)	(1.7)				(2.2)	(1.7)	(2.1)		
Electric Pulp Vitality Test	12.7	11.2	11.5	13.5	12.6		15.0	13.2	14.0	11.9	11.7	
Mean (SE) (μA)	(1.5)	(1.3)	(1.4)	(2.7)	(1.5)		(1.8)	(1.3)	(1.9)	(0.9)	(1.8)	

ate responses were recorded as zero seconds. Each evaluation was conducted in the presence of two of the co-authors to help ensure standardization.

Vitality test scores of the teeth were recorded before any preparation and at every recall (at baseline, 7 days, 14 days, 30 days and 6 months).

STATISTICAL ANALYSIS

Descriptive statistics were used to describe the frequency distributions (Mean and Standard Error of the Mean) of the evaluated criteria.

A test for independent means was conducted to assess the importance (impact) of the type of adhesive system for the incidence of postoperative sensitivity. The choice of test (parametric t-test or nonparametric Mann-Whitney test) depended on the type of empirical distribution, verified by the Kolmogorov-Smirnov One-Sample Test. Paired t-test and Wilcoxon signed-rank test were used to compare post-operative sensitivity between evaluated periods in each test group. The Fisher's exact test was used to estimate post-operative sensitivity in each evaluated period. α was set at 0.05.

RESULTS

Table 3 shows the "severity" and "response time" to cold and masticatory forces, as well as electric pulp vitality test.

Postoperative sensitivity was found in 31% (± 4.64) of all restorations in which Scotchbond MP adhesive system was used, while in the group of

Prompt L-Pop restorations 25% (± 4.35) of the patients reported complaints. There was no statistically significant difference between the two groups 30 days postoperatively ($p = 0.431$).

The evaluation of cold sensitivity intensity (VAS score) for all observation periods in both restoration groups did not reveal any statistical significance.

The analysis of the data about sensitivity to masticatory forces indicated that the complaint levels in the group with the three-step adhesive Adper Scotchbond Multi-Purpose were higher at postoperative day 14 and day 30 at the follow-up evaluation.

The differences in the response time to cold stimulation (0 – 15 sec) for the restorations made with a self-etch adhesive and those made with a separate etch step did not reach statistical significance. There were no significant differences in the vitality of the restored teeth at intra- or inter-group comparison.

DISCUSSION

The age filter for the participants in the study (20-35 years of age) was used with the aim to standardize the biological substrate (the hard dental tissues) on which adhesives were applied using different strategies. Despite the different adhesion mechanisms, the results obtained in this study indicate that in both adhesive systems the incidence probability for this complication is similar in the age bracket of

25-30 years. No evidence of POS in the same age group was found in this study. POS frequency in subjects up to 22 years old was twice as big (56%) as our results⁶, with emphasis on the importance of the structural and physicochemical peculiarities of dentin in young patients for the manifestation of POS. In many studies POS is recorded in patients from 18 to 80 years of age^{5,7,8} in the absence of comparative groups or reports about the risk age for sensitivity manifestation. Compared to these data, the POS frequency established in this study is higher. The young age of the subjects in the present study could be a factor that contributed to such a result. For comparative evaluation of the risk of POS further studies should be carried out in other age groups.

The data on the origin of POS with different adhesive systems are not uniform. The adhesives with a separate etching step tend to cause POS more frequently.^{5,6} Tar et al.⁹, however, did not report such a difference. The present results did not find any statistically significant difference in POS frequencies between Adper Prompt L-Pop and Scotchbond MP nanofilled restorations. The analysis of the type and intensity of POS for the studied periods for each adhesive system, however, revealed that there are significantly more complaints due to masticatory forces at postoperative day 14 and day 30 in the Scotchbond MP group.

The influence of the adhesive system on the occurrence of POS is possibly due to the different adhesion strategy. The reduced permeability and the hermetically sealed dentin surface lower the possibility of POS incidence.¹⁰ With the self-etch adhesives there are fewer cases of postoperative sensitivity, which is accounted for by their good sealing properties.¹¹ On the other hand, the application of a self-etch primer does not remove the "plugs" of the smear layer of the dentinal tubules.¹² The absence of a rinse step retains the dissolved mineral phase within the primer composition, there is no mass loss and the collagen fibrils do not change their diameter. The demineralization depth coincides with the level of resin infiltration.^{13,14}

In contrast to the self-etch systems, in the three-step adhesives the total etching of the enamel and dentin with phosphoric acid completely removes the smear layer. The increased dentin permeability and the collagen mesh shrinkage due to loss of mineral phase limit the resin infiltration and compromise the quality of dentin sealing.¹⁴ The complex and highly technique-sensitive clinical procedure increases the likelihood of POS incidence.

The present study did not establish a significant difference in the response time to cold, or in the pulp vitality test results in Scotchbond MP and Adper Prompt L-Pop restorations for all periods studied. The interpretation of the data from these studies rejects the hypothesis of connection between POS and the dental pulp hyperemia.

CONCLUSIONS

No statistically significant difference was found in the frequencies of postoperative sensitivity between nanofilled restorations with Adper Prompt L-Pop and Scotchbond MP.

More intensive complaints of postoperative sensitivity were recorded under masticatory forces at postoperative day 14 and day 30 in Scotchbond MP in comparison with Adper Prompt L-Pop.

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REFERENCES

1. Bodnar D, Cristache C, Bodna T, et al. Preliminary clinical-statistical study regarding postoperative sensitivity in the treatment of simple caries. *Acta Medica Transilvania* 2014;2(2):282-6.
2. Porto I. Post-operative sensitivity in Direct Resin Composite Restorations: Clinical Practice Guidelines. *Ind Jour Rest Dent* 2012;1:1-12.
3. Jiang JQ, Wang ZC, Jiang J, Cai W. 3M-Z250 nano-resin and 3M-Z100 composite resin for cosmetic restoration of anterior teeth with vital pulp: Evaluation of postoperative sensitivity and pain. *J Clin Rehabilitative Tiss Eng Res* 2010;14(3):469-72.
4. Christensen G. Preventing postoperative sensitivity in class I, II and V restorations. *JADA* 2002;133:229-31.
5. Unemori M, Matsuya Y, Akashi A, Gotto Y, Akamine A. Self-etching adhesives and postoperative sensitivity. *Am J Dent* 2004;17(3):191-5.
6. Opdam N, Roeters J, Burgersdijk R. Microleakage of Class II box-type composite restorations. *Am J Dent* 1998;11:160-4.
7. Aw TC, Lepe X, Johnson GH, Mancl LA. A three-year clinical evaluation of two-bottle versus one-bottle dentin adhesives. *JADA* 2005;136(3):311-22.
8. Burke FJ, Crisp RJ, Balkenhol M, Bell TJ, Lamb JJ, McDermott K, et al. Two-year evaluation of restorations of a packable composite placed in UK general dental practices. *Br Dent J* 2005;199(5):293-6; discussion 283.

9. Tar CA, Lepe X, Johnson GH, Mancil LA. A three-year clinical evaluation of two-bottle versus one-bottle dentin adhesives. *JADA* 2005;136:311-22.
10. Van Meerbeek B, Peumans M, Poitevin A, et al. Relationship between bond-strength tests and clinical outcomes. *Dent Mat* 2010;26:e100-e21.
11. Christensen GJ. Making class II resin-based composite restorations predictable and profitable. *JADA* 2010;141(4):457-60.
12. *Hornbrook D.* Metal-Free Restorative Dentistry "It's More Than Just About Aesthetics". *Oral Health Journal* 2014;4:e10-e24.
13. Carvalho RM, Manso AP, Geraldeli S, et al. Durability of bonds and clinical success of adhesive restorations. *Dent Mat* 2012;28:72-86.
14. Perdigao J. Dentin bonding – variables related to the clinical situation and the substrate treatment. *Dent Mater* 2010;26:e24-e37.