

Three-year clinical evaluation of posterior inlay restorations made of three different composite materials

Amal Abd El-Samad Sakrana, DDS, PhD,^a Hiroyasu Koizumi, DDS, PhD,^b Hideo Matsumura, DDS, PhD,^b Naomi Tanoue, DDS, PhD,^c and Ossama Badie Abouelatta, BSc, MSc, PhD^d

^aDepartment of Crown and Bridge Prosthodontics, Mansoura University Faculty of Dentistry, Mansoura, Egypt, ^bDepartment of Crown and Bridge Prosthodontics, Nihon University School of Dentistry, Tokyo, Japan, ^cDepartment of General Dentistry, Nagasaki University Hospital of Medicine and Dentistry, Nagasaki, Japan, and ^dDepartment of Production Engineering and Mechanical Design, Mansoura University Faculty of Engineering, Mansoura, Egypt.

Purpose: The purpose of this study was to evaluate clinical performance of posterior inlay restorations made of different three composite materials.

Materials and Methods: A total of 156 posterior cavities were restored with inlay restorations made of different brands of composite (Filtek Supreme, Z250, and Pertac II, n=52 each). These teeth were restored according to the universal methodology of inlay restorations. Surface texture, anatomic form, marginal integrity, discoloration, occlusion, and pulp sensitivity were evaluated on the basis of the modified United States Public Health Service (USPHS) criteria immediately after insertion and after three years. The data were analyzed by Kruskal-Wallis test.

Results: Restorations made of the Filtek Supreme composite overall exhibited better clinical performance than those made of the other two composites especially after 3-year service period.

Conclusion: It can be concluded that the Filtek Supreme nanocomposite is clinically improved and reliable material for use as indirect composite restoratives. (Int Chin J Dent 2005; 5: 43-46.)

Key Words: hybrid composite, indirect composite, nanocomposite.

Introduction

Esthetic alternatives to amalgam filling and cast gold inlays include direct composite restoratives, composite and ceramic inlays. Composite materials are being widely used for both direct and indirect restorations, although there is a room for improvement in material properties.^{1,2} Indirect composite restorative systems were developed to overcome problems associated with direct composite systems.

Composite restorative materials are categorized according to their filler size and loading. Traditionally, composites have been classified as; macrofilled composites with high inorganic filler loading up to about 86 wt% and 1-70 μm particles sizes; microfilled composites including 0.04 μm grain sized colloidal silica incorporated into the prepolymerized filler particles; and hybrid composites consist of both macro- and microfillers with total inorganic filler loading of 80 wt%.³ Improvement in properties of composite is essential to reduce complications associated with their application in the oral cavity. Nanotechnology was applied recently for the production of new material categorized as nanocomposite restorative material. The difference between nanocomposite and conventional composite is the presence of nanofillers and nanoclusters to improve the loading of filler particles, wear resistance, strength, polishing, and other properties. This study clinically evaluated posterior inlay restorations made of nanocomposite and two hybrid composite materials.

Materials and Methods

Three composites were selected as indirect restorative materials; the Filtek Supreme nanocomposite (3M ESPE Dental Products AG, Seefeld, Germany), the Filtek Z250 composite (3M Dental Products Division, St. Paul, MN, USA), and Pertac II Aplutip composite (3M ESPE Dental Products AG). A total of 156 posterior cavity preparations were restored with these composite inlay restorations (n=52 each). The inlay restorations were placed in 62 premolar and 94 molar teeth. The 85 inlays were placed in mandibular teeth and 71 in maxillary teeth.

All cavities were prepared under local anesthesia according to the common principles for adhesive inlays. To achieve convergence angles between opposing walls from 10 to 12 degrees, 80 µm diamond burs were used for cavity preparations. These cavities were then finished with 25 µm slight taper grit diamond burs. Internal line and point angles were rounded. The finishing lines of the cavities were completely prepared within enamel layer. The margins of enamel were not beveled. The finish line was about 1 mm over the mucosal line to avoid the possible gingival bleeding and fluids. After placement of rubber dam, the cavities were rinsed and air-dried. A calcium hydroxide liner base (Alkaliner, 3M ESPE Dental Products AG) was placed onto deep dentinal surface. A glass ionomer base (Ketac-Bond Aplicap, 3M ESPE Dental Products AG) was placed to eliminate undercuts of the cavities. An impression was made using acrylic tray and a polyether material (Impregum F, 3M ESPE Dental Products AG). Temporary restorations were cemented with non-eugenol cement. Each inlay was light-polymerized then post-cured for 10 minutes in light-curing unit (Degulux, Degussa Hüls, Frankfurt, Germany) to reduce polymerization shrinkage and to improve their physical properties. At the second appointment, the temporary filling was removed and the prepared tooth was cleaned with rubber cup and pumice slurry. The cavities were isolated with a rubber dam. The anatomic form, marginal fit, and color match were assessed at try-in. The adhesive surfaces of the inlays were etched for 15 s with 5% hydrofluoric acid (Ceramics Etch, Vita, Bad Säckingen, Germany), rinsed with water, and air-dried. A silane primer (Monobond S, Ivoclar-Vivadent, Schaan, Liechtenstein) was applied to etched surfaces of the restorations. All enamel and dentin surfaces were etched with 37% phosphoric acid for 20-30 s, washed under a constant jet of water for 20 s and dried with compressed air. The preparations were coated with an enamel-bonding agent (Mirage bonding agent, Chamelon Dental Products, Kansas City, KS, USA), which was not light-cured. The dual-activated luting composite (SonoCem, 3M ESPE Dental Products AG) was applied to the restoration and preparation with a disposable brush or application syringe. The composite cement was light-polymerized for 60 s from each of the occlusal, buccal and lingual aspects. Occlusion and articulation were corrected carefully after placement. The inlays were finished with 40 µm and 15 µm diamond burs, polishing disks and strips (Sof-lex, 3M ESPE Dental Products AG), and a composite polishing kit (Enhance, Dentsply, Milford, DE, USA).

Each restoration was checked by two experienced examiners separately. The restorations were assessed immediately after insertion (baseline) and yearly up to three years using modified United States Public Health Services (USPHS) criteria for direct evaluation. The data were statistically analyzed with Kruskal-Wallis test. Interexaminer reliability was determined by calculating Cohen's kappa value, which measures agreement between the evaluations of two raters when both are rating the same object.

Results

One hundred fifty inlays were evaluated for 3-year recall. Six restorations were excluded from the study; one

case was extracted for periodontal reason and the other five restorations could not participate at the 3-year recalls. Determination of the interexaminer reliability kappa values showed above 0.65 for all criteria.

Table 1. Clinical performance of inlay restorations made of different three composite materials.

Criterion	Material	Baseline (%)		After three years (%)			
		Alfa	Bravo	Alfa	Bravo	Charlie	Delta
Surface texture	Supreme	86	14	82	18		
	Z250	84	16	70	30		
	Pertac II	80	20	68	32		
Anatomic form	Supreme	70	30	66	34		
	Z250	62	38	40	60		
	Pertac II	62	38	34	64	2	
Marginal integrity	Supreme	84	16	74	24	2	
	Z250	82	18	50	44		6
	Pertac II	84	16	52	40		8
Marginal discoloration	Supreme	100		68	32		
	Z250	100		62	38		
	Pertac II	100		64	36		
Occlusion	Supreme	88	12	80	20		
	Z250	86	14	62	32	6	
	Pertac II	90	10	44	52	4	
Pulp sensitivity	Supreme	100		92	6		2
	Z250	100		88	12		
	Pertac II	100		86	14		

Table 2. Summary of failure.

Service period	Tooth	Cavity	Material	Reason of failure
10 months	Right maxillary first molar	MOD	Pertac II	Secondary dental caries
15 months	Right maxillary second molar	MOD	Z250	Secondary dental caries
17 months	Left maxillary second premolar	OD	Pertac II	Inlay fracture
25 months	Left mandibular first molar	MO	Pertac II	Secondary dental caries
26 months	Right maxillary second premolar	MOD	Z250	Loss of pulp vitality
30 months	Left maxillary second molar	OB	Pertac II	Inlay fracture
33 months	Left maxillary first molar	MOD	Supreme	Secondary dental caries
34 months	Left mandibular second molar	MOD	Z250	Secondary dental caries

Results of the clinical evaluation comparing composite inlays at baseline and 3-year follow-up are presented in Tables 1 and 2. Kruskal-Wallis test revealed the significant difference between alfa-bravo rating among the inlays in the criteria of surface texture ($p=0.0039$). Restorations made of the Filtek Supreme material exhibited significantly smoother surface texture (82% alfa) than those made of the Filtek Z250 (70% alfa) and Pertac II (68% alfa) materials. Assessment of the criterion of anatomic form presented significantly better results for the Filtek Supreme material than for the Z250 and Pertac II materials at 3-year recall. Many bravo results for Z250 (60%) and Pertac II (64%) were scored ($p=0.1006$).

A statistically significant better marginal integrity was found at 3-year recall for the Filtek Supreme inlays. The parameters exhibited 24% bravo and 2% charlie scores for the Supreme inlays, 44% bravo and 6% delta for Z250; and 40% bravo and 8% delta for Pertac II ($p=0.0065$).

The Filtek Supreme inlays were significantly better for the parameter occlusion than other inlays ($p=0.0058$). Of the 150 restorations, eight inlays were judged as unacceptable; five inlays due to marginal opening with secondary caries, two inlays due to fracture, and one inlay due to loss of pulp vitality. Normal sensitivity could be detected for all teeth after 3-year recall except for slight post-operative sensitivity to masticatory forces in the deep cavities during the first year. One premolar restored with the Z250 inlay required endodontic treatment after 26 months because of loss of pulp vitality.

Discussion

The 4-step USPHS rating system is designed to reflect absolute differences between the acceptable and unacceptable categories. Specifically, restorations scored with alfa and bravo are clinically acceptable while charlie and delta scores are unacceptable.⁴

At the baseline, surface texture among inlays seemed to be similar because the polishing technique employed was identical. Proper finishing and polishing of composite restorations are important steps that enhance both aesthetics and longevity of restored teeth. Absolute smooth composite surface, however, cannot be achieved by the currently established polishing systems. Surface roughness may enhance plaque accumulation and antagonist wear rate. On 3-year recall, the result of surface texture exhibited a significantly smoother surface texture of the Supreme material compared with those of the Z250 and Pertac II material. This is probably attributed to nanometer (10^{-9} m)-size of the inorganic filler incorporated into the Supreme material.

Results of evaluation of anatomic form, marginal integrity, and occlusion suggest that the Supreme material is more resistant to wear and fracture than the two materials. Improved filler loading of nanofiller through the use of the cluster may contribute to improved properties of the composite material. Also, reduced discoloration of the Supreme material indicates improved conversion of matrix monomer contained in the composite component.

On the basis of the results of 3-year clinical evaluation, it can be concluded that the Filtek Supreme nanocomposite is more clinically reliable indirect composite material than the two conventional composite. Further evaluation should be continued for long-term success of composite inlay restorative systems.

Acknowledgment

This work was supported in part by a Grant-in-Aid for Young Scientists (B) 16791210 (2005) from the MEXT-Japan.

References

1. Anusavice KJ. Criteria for selection of restorative materials: properties versus technique sensitivity. In: Anusavice KJ, Ed. Quality evaluation of dental restorations: criteria for placement and replacement. Chicago: Quintessence; 1989. p. 15-59.
2. Freilich MA, Goldberg AJ, Gilpatrick RO, Simonsen RJ. Direct and indirect evaluation of posterior composite restorations at three years. Dent Mater 1992; 8: 60-4.
3. Mjor IA, Pakhomov GN. Dental amalgam and alternative direct restorative materials. Oral Health Division of Noncommunicable Diseases World Health Organization: Geneva; 1997. p. 17.
4. Ryge G, Cvar JF. Criteria for the clinical evaluation of dental restorative materials. US Dental Health Center, San Francisco: US Government Printing Office; 1971. Publication No. 7902244.

Reprint request to:

Dr. Amal Abd El-Samad Sakrana
Department of Crown and Bridge Prosthodontics, Mansoura University, Faculty of Dentistry
Mansoura 35516, Egypt
FAX: 2050-2216099, E-mail: shalsakran123@yahoo.com

Received April 24, 2004. Revised May 10, 2005. Accepted June 8, 2005.
Copyright ©2005 by the Editorial Council of the *International Chinese Journal of Dentistry*.