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EFFECTS OF DENTAL FLUOROSIS ON CLINICAL PERFORMANCE AND ACCEPTABILITY OF A COMPOSITE FILLING MATERIAL IN FLUOROSED TEETH OF CHILD AND ADOLESCENT PATIENTS

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ABSTRACT: Chronic excessive exposure to high levels of fluoride can give rise to a developmental problem called dental fluorosis during the development of teeth. The aim of this study was to evaluate the clinical success and acceptability of a composite–resin filling material (Filtek Z250, 3M-ESPE, USA) in fluorosed permanent teeth in children and adolescents over the course of a year. A total of 147 Class-I restorations were performed in the molar teeth of 60 patients aged 9 to 17 years. Tooth fluorosis was classified according to the Thylstrup–Fejerskov index (TFI) (normal: TFI 0, mild: TFI 1–2, moderate: TFI 3–4, severe: TFI 5–7). Restorations were clinically and radiographically assessed immediately following the procedures and in the sixth and twelfth months afterwards according to modified Ryge criteria. The majority of restorations exhibited alpha scores for all evaluated criteria for each TFI group in the twelve-month recall. Only three restorations in the TFI 3–4 group received bravo scores, the criterion for marginal discoloration. Similarly, three restorations in TFI 5–7 group received a bravo score indicating marginal adaptation. Consequently, for fluorosed permanent teeth in children and adolescents, the clinical performance of composite–resin filling material was found to be entirely acceptable up to one year after treatment.

Keywords: Clinical performance; Composite–resin; Dental fluorosis; Endemic fluorosis; Microhybrid composites; Modified Ryge criteria.

INTRODUCTION

The chronic intake of high amounts of fluoride may cause a wide range of adverse health issues, such as infertility, miscarriage,[1] hypothyroidism,[2] low IQ,[3] and dental[4] and skeletal[5] fluorosis. The main source of fluoride intake is water[6] and the factors that cause dental fluorosis are cumulative,[7] depending on the duration and total intake. The critical period for fluoride overconsumption is childhood,[8] particularly between the first and fourth years of life, but the risk continues to around eight years of age.[9] Fluorosed teeth usually need to be restored for esthetic or functional reasons, and both children and adolescents may be affected by this condition. Composite–resin filling materials may be used for the treatment of fluorosed teeth.[10–12] The modified Ryge criteria[13] scale is used most by researchers to assess the longevity of restorations and restorative materials.[14] The aim of this study was to evaluate the effects of dental fluorosis on the clinical performance and acceptability of a composite–resin filling material in permanent molar teeth in children and adolescents.

MATERIALS AND METHODS

A total of 60 children and adolescent patients (aged between nine and seventeen years) in a fluoride endemic area (Isparta City, Turkey) were selected on the basis of having occlusal caries of fluorosed permanent molar teeth. Intra-oral clinical and radiographic examinations of patients were performed. Teeth were grouped

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according to the Thylstrup–Fejerskov index (TFI) into normal (TFI 0), mild fluorosis (TFI 1–2), moderate fluorosis (TFI 3–4), and severe fluorosis (TFI 5–7). Class I cavities were prepared using cylindrical diamond burs with water cooling and stainless-steel burs (#329, 330, 245; KG Sorensen, Barueri, São Paulo, Brazil) in all teeth. Cavities were filled using a microhybrid composite–resin filling material (Filtek Z250, 3M ESPE Dental Products, St. Paul, USA). A self-etch adhesive material (Adper™ SE Plus Self-etch Adhesive, 3M ESPE Dental Products, St. Paul, USA) was used to bond filling material. A full list of materials used in the study is shown in Table 1.

Table 1. Description of materials used in the study

Material	Manufacturer	Type of product	Type of matrix	Filler type, volume and weight
Filtek ™ Z250 Universal Restorative System	3M ESPE Dental Products, St. Paul, USA	Microhybrid composite	Bis-GMA[1], TEGDMA[2], UDMA[3], Bis-EMA[4]	Zirconia-silica filler, mean particule size 0.6 µm, filler level volume 60%, weight 82%

Material	Manufacturer	Type of product	Chemical content	Application method
Adper™ SE Plus Self-etch Adhesive	3M ESPE, Dental Products St. Paul, USA	2 steps self-etch adhesive system	Primer (liquid A): Water (80%), HEMA[5], Pink colorant, surfactant Adhesive (liquid B): HEMA, TMPTMA[6], UDMA, TEGDMA, phosphate and MHP[7] acidic monomers, bonded zirconia nanofiller, initiator system	Apply liquid A, vigorously apply liquid B (20 sec), Dry with air stream (20 sec), Apply a second coat of adhesive, Dry with air stream (20 sec), Light cure (10 sec).

[1] Bis-GMA: Bisphenol A glycidyl methacrylate,
[2] TEGDMA: Triethylene glycol dimethacrylate,
[3] UDMA: Urethane dimethacyrylate,
[4] Bis-EMA: Bisphenol A polyethylene glycol diether dimethacrylate,
[5] HEMA: hydroxyethyl dimethacrylate,
[6] TMPTMA: hydrophobic trimethacrylate,
[7] MHP: dimethacrylate phosphate.

Each layer of materials was polymerized for 20 sec using a halogen light-curing unit (Blue Swan, Dentanet, Ankara, Turkey), with a light output of 550 mW/cm^2. The finishing and polishing procedures of the restorations were completed using water-cooled microfine diamond finishing burs and polishing discs (Sof-Lex™, 3M ESPE Dental Products, St. Paul, USA).

All procedures were performed according to the manufacturer's directions, and all restorations were installed by the same operator. The distribution of restorations according to TFI grouping is presented in Table 2.

Table 2. Distribution of composite-resin restorations into the Thylstrup-Fejerskov index (TFI) groups

N=147	
Normal (TFI = 0)	37
Mild fluorosis (TFI = 1-2)	32
Moderate fluorosis (TFI = 3-4)	46
Severe fluorosis (TFI = 5-6-7)	32

The restorations were clinically evaluated using the double-blind method by two highly qualified independent examiners on the day immediately following the operation (baseline data) and then after six and twelve months. When disagreements arose during evaluation, a consensus was achieved between the examiners. All clinical parameters were assessed using the modified Ryge criteria: marginal discoloration, secondary caries, marginal adaptation, anatomic form, postoperative sensitivity and retention, and color matching (see Table 3).

Table 3. Modified Ryge criteria

Criteria	Scores*
Marginal Discoloration	A: No penetration of staining at the marginal interface. B: Removable and localized slight discoloration along the margin, but not into dentin. C: The discoloration penetrated along the margin into the dentin level.
Marginal Adaptation	A: Restoration closely adapted to the tooth, No crevice along margincan be detected by Explorer. B: Crevice detected, but without exposure of dentin or base. C: Dentin or base exposed.
Secondary Caries	A: No evidence of caries at the magrin. B: Evidence of caries along the margin of the restoration.
Anatomic Form	A: Restorations continuous with existing anatomic form. B: Restorations discontinuous with existing anatomic form but missing material not sufficient to expose dentin base. C: Sufficient material lost to expose dentin or base.
Postoperative Sensitivity	A: Not present. B: Present.
Retention	A: Full retention. B: Partial retention. C: Restoration is lost.
Color Matching	A: Restoration matches adjacent tooth structure in color and translucency. B: Mismatch is within an acceptable range of tooth color and translucency. C: Mismatch is outside the acceptable range.

*For each criterion, we used a score of alpha (A) to indicate the highest degree of clinical success and acceptability, while bravo (B) and charlie (C) indicated progressively lessening degrees of success.

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RESULTS

A total of 147 composite–resin restorations were applied to 60 patients (22 boys, 38 girls) whose average age was 14.1 ± 2.28 years. No patients withdrew during the clinical follow-up. In fluorosed teeth, color-matching criterion were not considered because of the staining of enamel due to structural defects and environmental factors. All results are presented in Table 4.

Table 4. Clinical results of restorations according to Modified Ryge Criteria (Bs=baseline assessment; 6th m=six month assessment; 1 yr= 1 year assessment)

	Score	Normal			Mild fluorosis			Moderate fluorosis			Severe fluorosis		
		Bs	6th m	1 yr	Bs	6th m	1 yr	Bs	6th m	1yr	Bs	6th m	1 yr
Retention	A	37	37	37	32	32	32	46	46	46	32	32	32
	B	-	-	-	-	-	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-	-	-	-	-	-
Marginal discoloration	A	37	37	35	32	32	32	46	45	43	32	32	31
	B	-	-	2	-	-	-	-	1	3	-	-	1
	C	-		-	-	-	-	-	-	-	-	-	-
Anatomic form	A	37	37	37	32	32	31	46	46	45	32	32	31
	B	-	-	-	-	-	1	-	-	1	-	-	1
	C	-		-	-	-	-	-	-	-	-	-	-
Marginal adaptation	A	37	37	35	32	32	31	46	45	45	32	32	29
	B	-	-	2	-	-	1	-	1	1	-	-	3
	C	-	-	-	-	-	-	-	-	-	-	-	-
Secondary caries	A	37	37	37	32	32	32	46	46	45	32	32	32
	B	-	-	-	-	-	-	-	-	1	-	-	-
Postoperative sensitivity	A	37	37	37	32	32	32	46	46	46	32	32	32
	B	-	-	-	-	-	-	-	-	-	-	-	-
Color matching	A	37	37	37	-	-	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-	-	-	-	-	-

DISCUSSION

Dental fluorosis is characterized by structural changes in the hard tissues of the teeth due to the excessive intake of fluoride during the patient's developmental period.[15–17] The Thylstrup–Fejerskov index (TFI) is a sensitive system for evaluating fluorosed teeth, while the modified Ryge criteria scale is the gold standard for the assessment of restorative filling materials in dentistry clinical studies.

The previous study most similar to ours in age profile, cavity type, and materials used is the assessment of clinical performances of Class I restorations performed on 123 non-fluorosed permanent molar teeth of 41 adolescent patients with a mean age of 13.44 years (SD ± 2.22) at the 6th, 12th, and 30th months.[18] In that study, quite high alpha scores were reported for almost all the criteria. The results of our study were seen to be in line with those of the earlier study. Secondary caries and postoperative sensitivity were not recorded after a year for any of the restorations in that study. In our study, secondary caries was seen in only one restoration in the moderate fluorosis group. Susceptibility of most of the monomers to the absorption of water is a factor that may harm the resin–tooth junction.[19] Andrade et al.[18] have suggested that the reason for the bravo scores, seen particularly in marginal adaptation and color matching, was impairments occurring in the resin–bond interface due to water hydrolysis. Zavala-Alonso et al.[17] showed that both the enamel surface roughness and the range between the deepest and the highest regions on the enamel surface increased as the fluorosis became more severe in fluorosed third molar teeth. Using atomic force microscopy, they found that the enamel surface roughness was 92.6 nm in the control group, 188.8 nm in the TFI 1–3 group, 246.9 nm in the TFI 4–5 group, and 532.2 nm in TFI 6–9. The reason for this condition is that despite displaying similarities with healthy enamel crystal, fluorosed enamel crystals have a higher, more irregular surface roughness due to abnormal development.[20] The main change in the histopathology of fluorosed teeth was reported to be microporosity and the damage seen in the outer one-third of the enamel.[21] In our study, it has furthermore been suggested that the reason for the high bravo scores in the severe fluorosis group for marginal adaptation criteria was the irregular ultrastructural cavity margins and substance loss caused by fluorosis. Marginal discoloration is usually the result of defects between the cavity margin and the restorative material. In our study, the moderate and severe fluorosis groups showed higher bravo scores than the control and mild fluorosis groups combined. The self-etch adhesive Adper SE Plus, a two-stage actual adhesive material, was used in our study. We consider that the high clinical success rates seen in the fluorosis and the control group restorations may reflect the fact that the disruption of the collagen network and problems, such as secondary caries and postoperative sensitivity, are encountered less frequently in the self-etch adhesive systems compared to conventional total-etch systems.[22–23]

In our study, child and adolescent patients, who had fluorosed teeth and had cavities filled with the composite–resin material, were followed for one year, and the material's clinical success and acceptability were evaluated. At the end of the year, the total alpha scores for restorations performed with Z250, the microhybrid material that was used in our study, were determined to be 98.5% in the control group, 99.0% in the mild fluorosis group, 97.8% in the moderate fluorosis group, and 97.4% in the severe fluorosis group. In pediatric dentistry, there are few studies that have

investigated the composite restorations in fluorosed teeth. The results of our study are therefore valuable for this reason, and for the fact that it was conducted on pediatric and adolescent patients for whom clinical studies are much more difficult to perform compared to adult patients.

CONCLUSIONS

In conclusion, fluorosed permanent molar teeth of children and adolescents with Class-I microhybrid composite–resin restorations were found to be acceptable in terms of clinical performance and success. Longer-term investigations are needed for fluorosed permanent teeth in children and adolescents to study all dental restorative materials.

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The ethical approval for this clinical trial was obtained from the Ethics Committee of the Faculty of Medicine of Süleyman Demirel University. Subjects signed an informed consent form before their participation to the study.

CONFLICT OF INTERESTS

The authors confirm that they have no conflict of interest.

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