

Clinical and radiographic assessment of Class II esthetic restorations in primary molars

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Abstract

Purpose: The aim of the study was to assess the clinical performance of two esthetic materials (Vitremer and Z100 + Scotchbond Multipurpose) when used as Class II restorations in primary molars, and compare them to amalgam controls.

Methods: A total of 102 restorations were placed in primary molars of 29 schoolchildren; 40 were of Vitremer, 38 of Z100 + Scotchbond Multipurpose, and 24 of amalgam (Dispersalloy). The restorations were evaluated clinically at baseline and after 6, 12, 18, 24 months, or until tooth exfoliation or patient drop-out, following the modified Cvar and Ryge criteria. Radiographs were taken at yearly intervals, and the radiograph of the last examination available was assessed and scored.

Results: The majority of the restorations examined clinically up to 18 months was good (Alpha according to Cvar and Ryge), and no statistically significant differences between the groups was observed. However, at the 19-24 months evaluation, Z100 rated better than Vitremer for surface appearance and color match.

The prevalence of radiolucent defects at the cervical margin for the Z100 (47%) was significantly higher than for amalgam (11%) restorations ($P=0.002$) and for Vitremer (13%) restorations ($P=0.008$).

Conclusion: The three materials evaluated (Vitremer, Z100 and Dispersalloy) presented satisfactory clinical performance during the time evaluated (~2 years). Approximately half of the composite resin restorations presented radiographic defects that might require replacement at a later date. In contrast, glass ionomer and amalgam restorations presented significantly less radiographic defects at the time of the final examination. This study suggests that composite resins are indicated for class II restorations in primary molars that are expected to exfoliate within two years. (*Pediatr Dent* 22:479-485, 2000)

Dental amalgam has been the preferred restorative material for many decades, mainly for its durability, ease of handling, and low cost.¹ However, in recent years, there has been increasing awareness about the safety of dental amalgam, both for the human and the environment.² These concerns, although not supported by the major health care organizations,³⁻⁶ have helped the dental profession to focus on the need to develop alternatives to amalgam.¹

The most popular and almost exclusive esthetic restorative material for primary molars used to be, until recently, the composite resins.⁷ Composites are similar to amalgam in short terms studies, but have a high long term failure rate,⁸⁻¹⁰ mainly due to discoloration, loss of retention and secondary caries. These findings result from polymerization shrinkage, a problem that has not yet been completely solved.¹¹ Although some improvement has been achieved with better materials and incremental placing techniques, composites have also the disadvantage of not releasing fluoride, an asset for patients with high caries risk.

Glass ionomers cements (GIC) were developed in the early seventies and can be used as liners, luting cements or as a base/core material. As a restorative material, glass ionomer offers the advantage of being the only material with a true chemical bond to tooth structure.¹²⁻¹³ However, glass ionomers are extremely brittle, often esthetically unsatisfactory, and with clinical failure rates higher than amalgam.¹⁴ In order to overcome these inadequacies, an advanced type of glass ionomer was developed, the resin modified glass ionomer (RMGI), also known as resin-reinforced glass ionomers (RRGI). They contain the same component of traditional GICs, but have resin materials added to provide strengthening as well as the possibility of "command-cure" with a light-initiated curing of the resin composite component. RMGI offer several advantages over the traditional GICs, as they have better physical and mechanical properties, and are a stronger material. As with traditional GICs, RMGI's must be mixed from a two-component system. The GIC and self-curing resin elements must be separated to prevent reaction to occur until it is needed. The hydrophilic resin contained in the RMGI is necessary for participating in the water based GIC material. RMGIs allow the practitioner to place a GIC-containing material in cavities where an immediate cure is desired. The GIC component offers fluoride release, while the resin component offers strength and better esthetics than with the traditional GICs. However, because RMGI contains resins, these restorative materials can potentially shrink during polymerization.¹¹

The benefits of light-curing systems are well recognized, but they suffer a disadvantage inherent in all systems: all of them allow the penetration of visible light to only a limited depth. Thus, layering techniques are necessary, making the procedure

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Table 1. Experimental Design Distribution of the Restored Teeth

Group	Number of teeth	Type of restoration
1	40	Vitremer
2	38	Z100
3	24	Amalgam

difficult and time consuming in deeper restorations. Conventional glass ionomers do not have this drawback as the acid-base reaction is not dependent on light. However, all light-cured glass ionomers have constituents with methacrylate groups that, in absence of light, as in deep cavities, would remain uncured. Vitremer (3M Dental Products Co. St. Paul, MN 55 144), a tri-cure glass ionomer system, overcomes the disadvantage of light cured GIs maintaining their advantages, due to its three distinct curing reactions:

1. acid-base glass ionomer reaction (initiated when powder and liquid are mixed);
2. photoinitiated free radical methacrylate cure (initiated when the powder/liquid mix is exposed to light, and occurs only where light penetrates);
3. dark cure free radical methacrylate cure - initiated when powder and liquid are mixed, and can proceed in the dark (3M Technical Product Profile 1992, 3M).

A clinical study described the successful results of 600 Vitremer restorations followed between 12 to 18 months.¹⁵

The purpose of the present study was to evaluate, clinically and radiographically the performance of Class II restorations placed with a resin modified glass ionomer Vitremer and with a composite resin (Z100 + Scotchbond Multipurpose) in primary molars, and compare them to those restored with the amalgam.

Methods

Study design

Twenty nine children, 15 males and 14 females attending the Dental School Clinic of the University of Sta. Maria, Brazil, were included in the study. To be eligible to participate, the children had to be between 8 to 10 years of age, have at least one primary molar with interproximal caries with occlusal and proximal contacting adjacent teeth, be available for recall appointments every six months until shedding of the teeth, and have parental consent. The procedures, possible discomforts, or risks, as well as possible benefits, were explained fully to the human subjects involved, and their informed consent was obtained prior to the investigation.

Following medical history and clinical examination, bilateral bite-wing radiographs were taken. The suitable teeth were randomly assigned to one of 3 groups: Vitremer, Z100, or amalgam. A total of 102 restorations were placed and their distribution is presented in Table 1.

Clinical procedures

All restorations were placed by a single operator (LBO) with local anesthesia and rubber dam. Conventional Class II cavities were prepared using a #330 carbide bur under water coolant, having their cervical margins placed on enamel.

Restorative steps – group 1 – Vitremer

Upon completion of the cavity preparation, a transparent celluloid matrix (Howe-Neos Dental, CH6925 Gentilino, Switzerland) was adapted with a Tofflemire matrix holder and clear wedges with light-reflecting surfaces (Howe – Luciwedges, Howe – Neos Dental). The enamel and dentin cavity margins were primed with the Vitremer primer for 30 seconds, dried with an air syringe and light cured for 20 seconds. Two scoops of Vitremer powder were mixed with two drops of Vitremer liquid for 45 seconds. A thick blend of cement was placed in a Centrix Accudose syringe tip (Centrix Inc Shelton, CT) and carefully injected into the cavity in bulk and shaped with a ball burnisher. The restoration was then light cured for 40 seconds through the occlusal surface and then for another 20 seconds from the buccal and lingual surfaces of the box. The matrix band was removed and the restoration was trimmed with a sharp hand carving instrument or a periodontal scaler.

Polishing with Soflex discs (3M Dental Products) followed by the application of a finishing gloss and light curing for 20 seconds completed the restoration.

Restorative steps – group 2 – Z100

The initial steps including cavity preparation and adaptation of a transparent matrix and wedge were similar to group 1. The cavity walls were etched for 15 seconds with phosphoric acid from the Scotchbond Multipurpose kit. The preparation was then rinsed with water, air-dried, and primer was applied and spread with gentle blasts of air. The bonding agent was applied and cured for 10 seconds, followed by placement of one buccal and one lingual increment of Z100 at the proximal box, leaving place for a third increment as described by Holan et al¹⁶. These increments were exposed to a light source directed from buccal or lingual for 20 seconds. A third increment was then placed, filling the cavity up to the level of the pulpal floor and light polymerized for 20 seconds. The rest of the cavity was filled and light polymerized for another 20 seconds. The matrix band and wedge were removed, and the restoration was trimmed with finishing burs and polished with Soflex discs.

Restorative steps – group 3 – amalgam

After cavity preparation the axiopulpal dentin walls were covered with Dycal (LD Caulk DN., Densply International, Milford DE 19963). Stainless steel “T-bands and wooden wedges were adapted, and the cavities were filled with Dispersalloy (Lee Pharmaceutical Corp. South El Monte, Ca), following a conventional technique. The restorations were polished after at least 48 hours, with finishing burs.

Evaluation

The quality of the restorations was clinically evaluated at baseline and every six months for surface appearance, color match, marginal adaptation, marginal discoloration, anatomic form, and secondary caries using the criteria described by Cvar and Ryge.¹⁷ In addition, the quality of the contact area was assessed with waxed dental floss and classified as follows:

- A. Excellent - resistance was met while passing the dental floss
- B. Fair-contact was present, but the floss passed without resistance
- C. Poor - no contact was present.



Fig 1. Maxillary second primary molar restored with Vitremer (MO) 22 months after placement. The surface is somewhat rough, but the color match is good.

Some restorations were evaluated for more than two and a half years, others until tooth exfoliation or the patient dropped-out the study. Most restorations were assessed independently by two dentists (LBO + FBA or FBA + ABF). If a disagreement was observed, the restoration was reexamined, and a consensus was reached. Radiographs were taken at yearly intervals until tooth exfoliation or patient drop-out. All the radiographs were evaluated by the senior investigator (ABF), for the presence of radiolucent defects at the cervical margins, caries and/or bubbles in the body of the restorations. The radiograph of the last examination available was assessed and scored. The results of the clinical and radiographic evaluation were submitted to statistical analyses (Kruskal – Wallis one-way ANOVA with Bonferroni correction and chi-square with Bonferroni correction).

The children were encouraged to return exfoliated teeth, or, preferably, to come to the clinic when increased tooth mobility was evident. Eighteen teeth exfoliated or were extracted after 20 to 22 months. The retrieved teeth were examined visually by SEM, by dye penetration, and by polarized light microscopy, and will be described separately.

Results

The results of the parameters evaluated for the three groups at the different follow-up times are presented in tables 2 to 4. Some children presented only for the 6 months and one year evaluation, others remained in the study until tooth exfolia-



Fig 2A. Maxillary first primary molar restored with Z100 and Scotchbond Multipurpose 20 months post-operatively. The margins are almost imperceptible, and the surface appearance is excellent.

tion. A great number of restorations were assessed periodically, and the results presented in the tables refer to the last clinical and radiographic examination.

The majority of the restorations examined clinically up to 18 months rated Alpha according to Cvar and Ryge,¹⁷ and no statistically significant differences between the groups could be observed for most of the parameters assessed. However, a considerable difference could be noticed concerning surface appearance and color match at the 19-24 months evaluation. Two Vitremer restorations were rated A and 10 B for surface appearance, while 12 Z100 restorations scored A and 1B and 3 amalgams scored A and 4 B for this parameter (chi square $P < .0008$). All 13 Z100 restorations rated A for color match while 3 Vitremer restorations scored A and 9 B; this difference was statistically significant (chi-square $P < .0001$). The amalgam restorations were not assessed for this parameter. Contact point was good for most restorations, and only one Vitremer restoration had no contact and was scored C, and in 3 restorations of each group contact was present but were rated B (floss passed without resistance). Representative samples of Vitremer and Z100 restorations are presented in Figures 1 and 2 (A & B).

All the restorations evaluated clinically were also assessed radiographically except for those marked with an asterisk in tables 2 to 4. Thus, 31 of the 40 Vitremer restorations were also assessed radiographically. Two radiographs were discarded due to overlap and the remaining 7 were not taken, either due to poor patient cooperation or because of parental request. For the same reasons 6 Z100 and 6 amalgam restorations were not evaluated radiographically. Table 5 summarizes the radiographic assessment of the restorations at the time of the last examination. The prevalence of radiolucent defects at the cervical margin for the Z100 (47%) restorations was significantly higher than that for amalgam (11%) restorations ($P = 0.03$), and for the Vitremer (13%) restorations ($P = 0.01$). Figures 3 to 6 show the radiographic appearance of representative restorations.

Discussion

In a comprehensive review on the durability of posterior primary restorations, Kilpatrick⁸ stated that the demands for a restoration in the primary dentition are somewhat different from those for the permanent dentition. This is due to the limited lifespan of the teeth themselves, the variations in the child's age and level of cooperation, and the different morphology of the teeth.^{8,18} The mean longevity of Class II amalgams in the primary dentition is about two years for some trials, for others about 3 years, whereas in one trial, a median value of 7.5 years has been described.⁸ A very detailed study conducted by

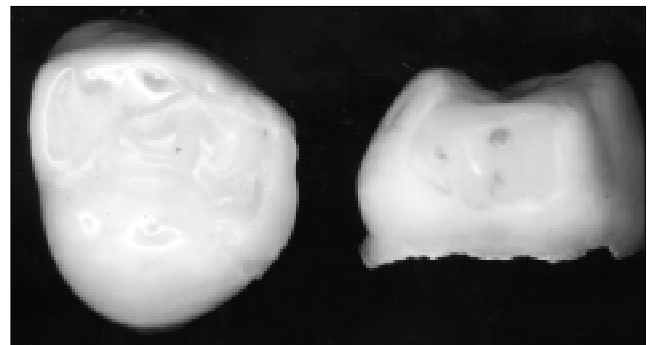


Fig 2B. Occlusal and proximal view of the same tooth after exfoliation. The occlusal is smooth and excellent but defects are evident at the proximal surface.

Table 2. Clinical Scores of Vitremer Restorations

Recall Time	Up to 12 m			13 – 18 m			19 – 24 m			More than 25 m			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Surface Appearance	8	-	-	7	4	-	2	10	-	3	6	-	40
Color Match	8	-	-	7	4	-	3	9	-	5	4	-	40
Marginal Adaptation	7	1	-	9	1	1	5	5	2	2	6	1	40
Marginal Discoloration	8	-	-	11	-	-	10	2	-	7	2	-	40
Anatomic Form	8	-	-	9	2	-	5	7	-	1	7	1	40
Secondary Caries	8	-	-	10	1	-	11	1	-	9	-	-	40
Contact Point	8	-	-	9	1	1	10	2	-	9	-	-	40
Total	8			11			12*			9**			40

All restorations were also evaluated radiographically, except for those with a bullet point.

* 7 restorations were assessed radiographically

** 5 restorations were assessed radiographically

Welbury and co-workers¹⁹ reported a median for amalgam of 3.5 years and for glass ionomer of 2.8 years. All the amalgam restorations in the present study performed well and none of them had to be replaced for bulk fracture.

In many highly developed countries the number of placed amalgam fillings has decreased considerably in the last years, and the tooth colored restorations gained increasing importance. Among the reasons for this increase is the patients' demands for improved esthetics.^{20,21} Widstrom and Forss²⁰ reported in 1994 that in Finland, glass ionomer fillings were placed in 91% of primary and 47% of permanent teeth of children under 17 years. These authors added that 52% of adult patients were treated with resin composite in private practices, while amalgam was used in only 15% of the children and 29% of the adult patients. In contrast to that, Christensen²² reported in 1996 that in the United States, amalgam was the material most commonly used for restoring pediatric posterior teeth (73% of all restorations placed), followed by glass ionomer or RMGI (15%) resin composites (10%) and stainless steel crowns (1%). Despite these findings he predicted that the most promising material to replace dental amalgam for restorations of "pediatric Class II areas" would be the RMGI. Despite his opinion, except for some preliminary reports,^{23,26} not many

clinical studies appeared in the literature utilizing these materials. This might be due to the more demanding mixing technique of the RMGIs, and to the appearance of the compomers, which are definitely easier to handle and more operator friendly.^{1,2,7,27} The clinical evaluation of the tooth colored restorations in the present study reveals that most of them performed well, and none had to be replaced due to fracture or recurrent caries. However, composite restorations had a better surface appearance and color match than the Vitremer restorations (Tables 2 – 4). In some of the composite restorations the texture of the material, its marginal adaptation and its color match was such that the occlusal margins could not be identified (Figs 2A and B).

High success rates of clinical composite restorations were described in earlier studies.²⁸⁻³⁰ The longest study by Varpio,³¹ however, describes success rates for composites of 86% after one year and of 38% after 6 years. Although there are not many updated studies on Class II composite restorations in primary molars,³² Hse and Wei¹ reported in a recent study a failure rate of 1.7% of the hybrid composite Prisma TPH one year after placement. This material was used as a control for a Dyract study.

Table 3. Clinical Scores of Z100 Restorations

Parameter	Up to 12 m			13 – 18 m			19 – 24 m			More than 25 m			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Surface Appearance	9	-	-	8	-	-	12	1	-	8	-	-	38
Color Match	9	-	-	8	-	-	13	-	-	8	-	-	38
Marginal Adaptation	8	1	-	7	1	-	12	1	-	7	1	-	38
Marginal Discoloration	9	-	-	8	-	-	11	2	-	6	2	-	38
Anatomic Form	9	-	-	6	2	-	12	1	-	7	1	-	38
Secondary Caries	9	-	-	8	-	-	13	-	-	6	1	1	38
Contact Point	8	1	-	8	-	-	11	2	-	8	-	-	38
Total	9			8			13*			8**			38

All restorations were also evaluated radiographically, except for those with a bullet point.

* 9 restorations were assessed radiographically

** 6 restorations were assessed radiographically



Fig 3. Radiograph of mesio-occlusal Vitremer restoration on a maxillary second primary molar showing good adaptation.

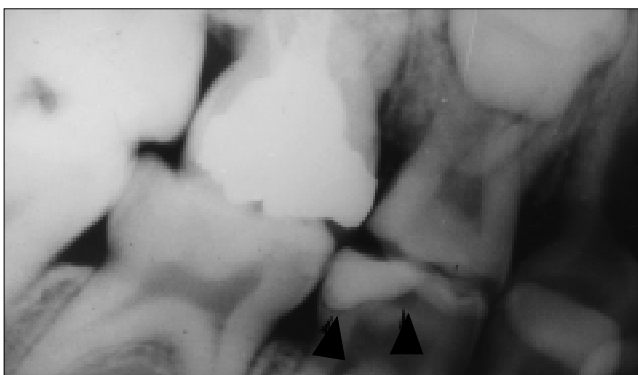


Fig 4. Disto-occlusal restorations on maxillary (Vitremer) and mandibular (Z100 + Scotchbond Multipurpose) first primary molars. Notice the good adaptation and higher radiolucency of the Vitremer and the presence of radiolucent defects (pooling and void) under the radiopaque composite material (arrows).

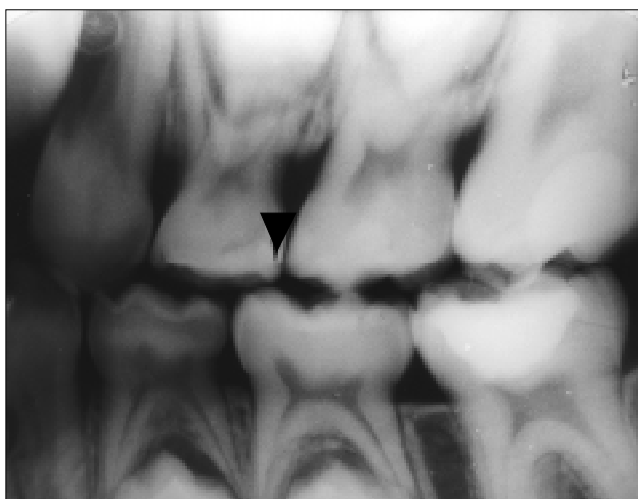


Fig 5. Maxillary first primary molar with DO composite restoration. Notice the presence of a radiolucency all along the cavity floor (pooling) and a bubble (arrow) on the body of the material.

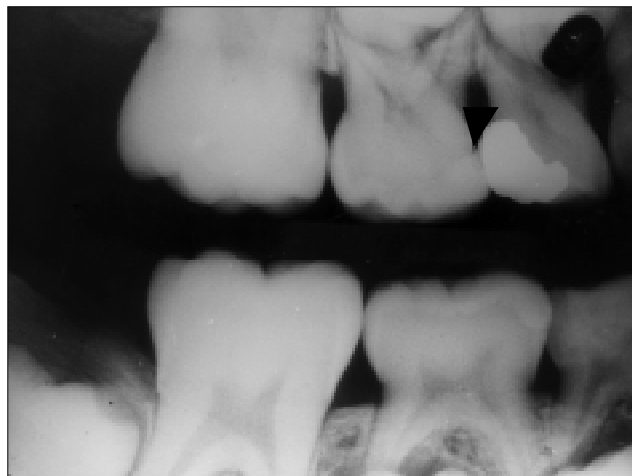


Fig 6. First and second and maxillary primary molars restored with amalgam and Vitremer. Notice the good adaptation of the amalgam and the presence of a radiolucent defect at the cervical margin of the Vitremer (arrow). This might be due to residual caries (decay not completely removed at the time of the restoration) or to improper placement of the Vitremer.

Radiographic examination revealed that the cervical margin continues to be the Achilles heel of Class II composite restorations. In the present study, only 17 (53%) of the 32 Z100 restorations assessed radiographically presented without radiolucent defects at the cervical margin. These restorations might require replacement at a later date. Although the percentage of defects (47%) is similar to that described by Eidelman et al,²⁸ that reported 40% of radiolucencies of the gingival margin, one would expect that by employing an incremental technique and a 5th generation dentin adhesive as used in this study, the quality of the margins would improve.¹⁶ Conversely, Vitremer presented a much lower percentage of radiolucencies at the cervical margin. Of the 31 restorations assessed, 27 (87%) had a good adaptation and only 4 (13%) presented radiolucencies. Since all the restorations were placed by the same dentist (LBO), the differences between operators is not a problem in the present study. Consequently, the discrepancies observed probably result from differences in the clinical behavior of the materials.

The factors that might influence the clinical behavior of the materials are: 1) the higher polymerization shrinkage of the composite; 2) the better adaptation of the RMGI to the cavity walls; 3) the fluoride release of the RMGI.³² Although RMGI showed less or similar microleakage than a compomer when tested in vitro,³³ Vitremer had a much better caries inhibition potential when compared to P50, when submitted to an artificial challenge in vitro.³⁴

Many clinical glass ionomer trials claim, similar to silicate cements, remarkably less occurrence of secondary caries compared to composites. Mjor in 1996³⁵ described the longevity of glass ionomer fillings at five years, and reported secondary caries as being the foremost reason for failures. This and other review articles published findings from an era when only traditional glass ionomer cements were available.^{8,14} Good clinical results have been reported using resin modified glass ionomers.³⁶⁻³⁸ Donly et al.³⁸ reported that one of these materials (Vitremer) functioned clinically as well as amalgam in Class II restorations of primary molars, and exhibited significantly less enamel demineralization at the restoration margins than

Table 4. Clinical Scores of Amalgam Restorations

Recall Time	Up to 12 m			13 – 18 m			19 – 24 m			More than 25 m			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Surface Appearance	8	1	-	4	2	-	3	4	-	1	1	-	24
Marginal Adaptation	9	-	-	6	-	-	4	3	-	1	1	-	24
Marginal Discoloration	9	-	-	5	1	-	3	4	-	1	1	-	24
Anatomic Form	9	-	-	6	-	-	7	-	-	2	-	-	24
Secondary Caries	9	-	-	6	-	-	6	1	-	2	-	-	24
Contact Point	9	-	-	6	-	-	4	3	-	2	-	-	24
Total	9			6			7*			2**			24

All restorations were also evaluated radiographically, except for those with a bullet point.

* 3 restorations were assessed radiographically

** the restorations were not assessed radiographically

amalgam. Important for the reduction of secondary caries is not the amount of fluoride released into the saliva, but the uptake of fluoride into the adjacent tooth structure. The extent of caries reduction depends clinically on many other factors, such as nutrition, oral hygiene, gap formation, etc. However, the higher the fluoride content, the better the caries protection.³⁹ Since the fluoride release values for RMGI (like Vitremer) range between 50 – 600mg/cm²,² much higher than those for composites (0–10mg/cm²),³² it might be appropriate to recommend these materials for children with high caries susceptibility. The property of high fluoride release, in addition to a good adaptation, as observed from the low number of radiographic defects in the present study, could be enough to overcome the disadvantage of minimal wear (one restoration had no contact point) and less than optimal esthetics.

In the last few years several articles appeared in the literature reporting on the success of compomers.^{1,7,27,40} These materials might have similar properties of the RMGI without their manipulation deficiencies, as compomers come in capsules, and can be syringed into the cavities without mixing.

Conclusion

The three materials evaluated (Vitremer, Z100 and Dispersalloy) presented satisfactory clinical performance during the time evaluated (~2 years). Approximately half of the composite resin restorations presented radiographic defects that might require replacement at a later date. In contrast, glass ionomer and amalgam restorations presented significantly less radiographic defects at the time of the final examination. This study suggests that composite resins are indicated for Class II restorations in primary molars that are expected to exfoliate within two years.

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Table 5. Radiographic Findings of the Restorations Assessed

Material	Restorations Assessed	No Defect		Defective at Cervical Margin		Total**	
		N ^o	(%)	Pooling	Caries	N	(%)
Vitremer	31	27	(87)	2	2	4	(13)
Z100	32	17	(53)	9*	6	15	(47)
Dispersalloy	18	16	(89)	-	2	2	(11)

* Two restorations presented bubbles at the body of the material.

**Z100 x Vitremer – Fisher exact test (P=0.01)

**Z100 x Dispersalloy – chi-square (P=0.03)

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ABSTRACT OF THE SCIENTIFIC LITERATURE



STABILITY OF EARLY TREATMENT OF UNILATERAL POSTERIOR CROSS-BITE

The purpose of this prospective study was to evaluate the treatment at 4 years of age for correction of a unilateral posterior cross-bite over time. Twenty-nine subjects, 20 years old who were all treated at 4 years of age for a unilateral dento-alveolar cross-bite by grinding or by expansion (a modified quad-helix appliance) were clinically examined to evaluate the long-term effects of their treatment. The 14 subjects who received grinding at age 4 only, had 7 corrected at age 20. The 15 subjects who received a quad-helix at age 4 only, had 9 corrected at age 20. Of the 29, 11 were treated again at age 8 to 12 and only 2 failed at age 20. Mouth-breathing, breathing obstacles, and snoring were found to occur more frequently in the 8 to 12 year old. Thus the degree of success in the elimination of the cross-bite was 93% with a follow-up in the permanent dentition.

Comments: Early treatment at age 4 for a unilateral cross-bite is a cost-benefit especially if grinding is a success. **LHS Address correspondence to:** Panagiota Tsarapatsani, Dept. of Orthodontics, Institute of Odontology, Karolinska Institutet, Box 4064, SE-141 04 Huddinge, Sweden

Long-term follow-up of early treatment of unilateral forced posterior cross-bite. Orofacial status. Tsarapatsani, P., Tullberg, M., Lindner, A., and Huggare, J. *Acta Odontol Scand* 57(2):97-104, 1999.

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