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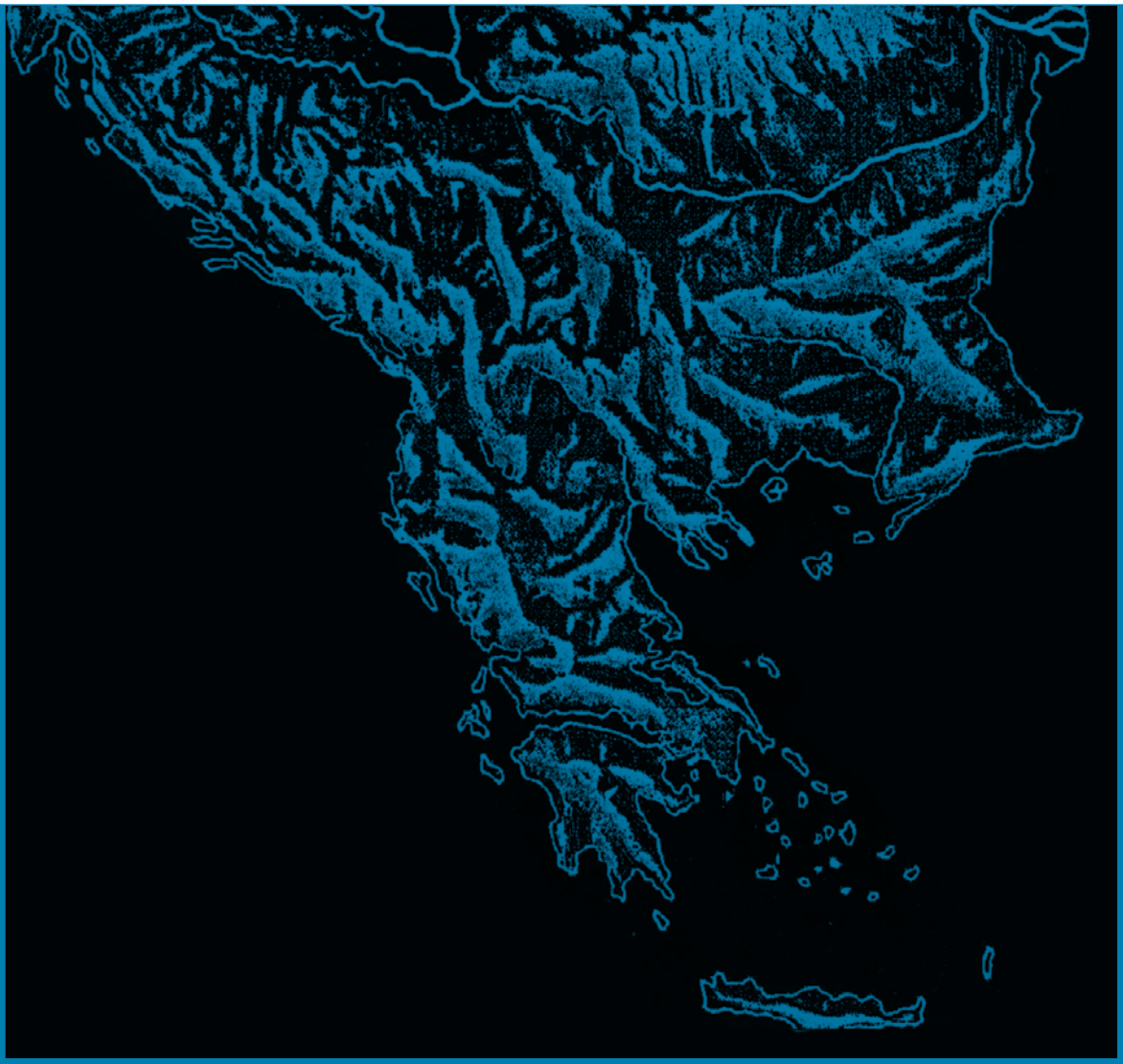

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Incidence of Voids in Packable *versus* Conventional Posterior Composite Resins: An *In Vitro* Study

SUMMARY

Aim. *Study aimed to determine effects of flowable composites as liner on marginal and internal voids in MOD composite restorations with different gingival levels.*

Methods. *45 molars were prepared for MOD cavities. Finish line was prepared 1 mm apical to mesial, and 1 mm coronal to the cemento-enamel junction on distal. Teeth were restored with: Solitaire; Solitaire + Revolution; Surefil; Surefil + Dyract Flow; Alert; Alert + Flow-it; Amelogen (control); Amalgam (negative control); and Prodigy Condensable. Then resin embedded and sectioned specimens were observed under stereomicroscope to determine the number and size (mm) of voids at margins and within material. Data was analyzed by Kruskal-Wallis analysis of variance and Wilcoxon Signed Ranks Test (α = .05).*

Results. *According to number of voids, there was no significant difference at margins (P>0.05,) but Alert showed significant differences with Solitaire, Amalgam and Solitaire + Revolution at occlusal material (P<0.05) and Solitaire at distal material. According to size, Alert showed differences with Solitaire, Amalgam, Surefil, Surefil + Dyract Flow, also between Aler + Flow-it, and Solitaire at total material. Mesial and distal comparisons were significant in Amalgam (P = 0.042) at material for number, and in Amelogen (P = 0.042) at margin for size of the voids.*

Conclusion. *The number and size of voids of packables did not show difference at restoration margins, within material. Different gingival levels and flowable usage did not make difference among packables. Usage of flowable with packable in a MOD resin restoration at different gingival levels did not achieve reduction in the number and size of voids at the margins and internally.*

Keywords: Void, packable, flowable, MOD, gingival level

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Introduction

Posterior resin-based composites have become an important part of restorative process. In larger Class II preparations, it may be more difficult to obtain proper contour and achieve adequate proximal contact with conventional composite than with amalgam. To improve ease of manipulation, the ideal resin-based composite should have a viscosity stiff enough to facilitate placement without adhering to the condensing instrument[1-4]. Continuous development of composite restorative materials has lead to the development of packable composites. These materials have a higher, modified filler content and, as a result a stiffer consistency than conventional resin composites, they have been described “condensable” [5]. In addition, it was also reported by manufacturer that these materials could be manipulated as amalgam clinically, condensed as amalgam and have physical properties that are similar to amalgam[6]. Therefore, packables can be described for this amalgam alternative material[7-10].

There are difficulties in placing conventional composites incrementally into the proximal box of Class II restorations. Any gap between the layers may lead to a definitive restoration that has a compromised integrity, either at the margins or within the bulk of the material[11].

Voids and porosities appear to have a negative effect on physical properties of the material[12,13].

Microleakage may result from many factors, such as the extent of marginal gap or polymerization shrinkage of materials used. Microleakage *via* the tooth restoration interface may lead to marginal stain, post-operative sensitivity, recurrent caries and possibly pulpal problems[14,15]. Gap formation is especially prevalent if gingival margins are located apical to the cementoenamel junction (CEJ) in dentin[16,17].

Amalgam insertion techniques used with packable composites can produce acceptable interproximal contacts[18]. Because of the claims for high depth of polymerization and low polymerization shrinkage of packable composites, a bulk-fill technique may be possible[19]. However, several studies reported that bulk placement causes insufficient polymerization, resulting in microleakage[20-23]. The stiffness and flow characteristics of packable composites may result in voids in the completed restoration[24]. Because of this risk, some manufacturers recommend that a flowable composite be injected initially, thus lining the internal surfaces of the preparation to a thickness ranging from 0.5 to 1.0 mm. Flowable composites exhibit favorable wetting properties and as a result adapt intimately to dentin and enamel surfaces of preparation, better than packable composites[25]. They also possess a relatively low elastic modulus, which theoretically could benefit the polymerization of packable composites[25,26]. As hypothesized by Moon[27], as the overlying packable composite undergoes polymerization contraction, the adjacent flowable composite can stretch or elongate, thus, acting as a stress breaker. Additionally, flowable composite in a packable restoration decreased microleakage at the gingival margin and thus improved the integrity of Class II restorations[28-30]. Besides, some *in vitro* studies have reported a reduction in microleakage but an increase in the presence of internal voids in Class I and II flowable composite fillings when compared to hybrid composite restorations[31,32]. However, 2 different studies by Chuang et al[33,34] showed that flowable composite reduced the voids in the interface and within the restoration, but didn't improve microleakage. They reported that there was no significant correlation between number of voids and microleakage as well. Another *in vitro* study by Malmström et al[35] was also unable to demonstrate reduced microleakage in Class II composite restorations with flowable.

The **aim** of this study was to compare the number and size of voids, present at the margins and internally, in packable composites (with/without flowable resins) to conventional composite in Class II restoration. The materials were placed according to the manufacturer's recommendation in bulk or by means of an incremental insertion technique with and without lining the preparation with a flowable composite. For this purpose, packable composites of different brands were used for the restoration of MOD cavities.

Materials and Methods

45 recently extracted sound human molar teeth disinfected in 10% buffered formalin solution, without incipient decay or cracks, were used for the study. The teeth were scaled and cleaned with slurry of pumice and tap water to remove any contamination. 5 teeth were selected and assigned to 9 groups. The teeth of each group were placed in a block made from pink wax to simulate interproximal gingival area (Cavex Set Up Modelling Wax; Cavex, Holland) and molar plastic teeth were placed to each side of the block. Then teeth were embedded into arch shaped stone blocks from apical thirds for each group. 1 operator prepared all the MOD cavities using a tungsten carbide bur (269; Brassler, USA) in a high-speed handpiece with water spray. The bucco-lingual width measured 4 mm and the pulpal depth was 2 mm. The proximal boxes of the preparations were 1 mm apical to CEJ on mesial surface and 1 mm coronal to CEJ on distal aspect (Fig. 1). The mesial gingival margins were located on dentin/cementum, while the distal margins were located solely on enamel. Digital compass and a ruler were used to standardize the all cavity preparations. The boxes were formed at a 90-degree angle to the cavo-surface. All specimens were polished with pumice powder and rinsed with tap water after preparation. A matrix system (Hawe SuperMat; Hawe-Neos Dental, Switzerland) was used and 2 wooden wedges (Hawe-Neos Dental, Switzerland) were inserted at the buccal and lingual sides to tightly seal the matrix-cavity margin.

4 packable composites (Solitaire, SureFil, Alert, and Prodigy Condensable), a hybrid composite (Amelogen as positive control), and amalgam (as negative control) were selected as experimental materials. All specimens were

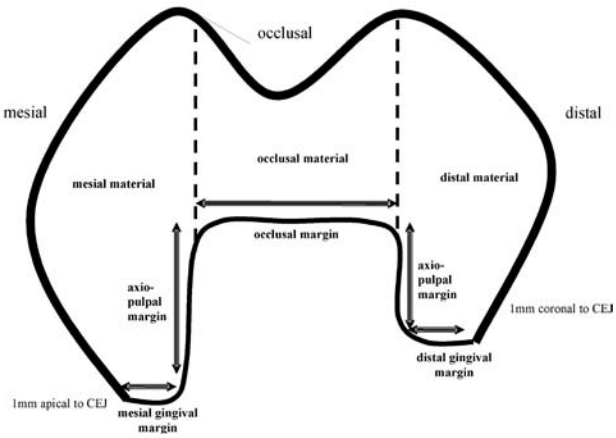

Figure 1. Representative cross section of MOD restoration.
Total material= mesial material + occlusal material + distal material
Mesial margin= axio-pulpal margin + mesial gingival margin
Distal margin= axio-pulpal margin + distal gingival margin
Total margin= mesial margin + occlusal margin + distal margin
Bulk material= margin total + material total

restored according to table 1. Use of the materials and application techniques provided by the manufacturers were carefully followed. Table 2 lists a summary of the material tested, including, type, composition, filler content and manufacturer information. The restorations were finished with a scalpel and fine diamond burs (# 0290; Denstply Maillefer, Switzerland) then polished with paper disks (Sof-Lex, 3M Co, USA). After finishing and polishing, the experimental teeth were removed from the wax block and sectioned in a mesio-distal direction along the long axis using a low speed diamond saw (Isomet 1000 Precision Saw, Buehler, USA) and continuous water cooling. It was possible to obtain 3 sections per tooth. Each section was immersed in 0.5% basic fuchsine dye for 24 hours for better dye penetration into the porosities. All sections were rinsed in tap water, and examined for internal voids using a stereomicroscope (Leica Microsystems Ltd. Business Unit SM, Switzerland) at x48 magnification (x102.81 magnification on screen).

Table 1. Groups planned for the study

Group 1	PQ1+ Solitaire
Group 2	PQ1+Revolution+ Solitaire
Group 3	Prime & Bond NT + Surefil
Group 4	Prime & Bond NT + Dyract Flow compomer resin + Surefil
Group 5	Bond One + Alert
Group 6	Bond One + Flow-it + Alert
Group 7	PQ1+ Amelogen
Group 8	Amalgam
Group 9	PQ1+ Prodigy Condensable

Table 2. The used materials

Material/ Manufacturer	Instructions for use	Type	Composition	Particle Size	Weight	Volume
PQ1 (Ultradent, South Jourdan, Utah)	etch with %35 acid gel 15s, rinse and lightly dry. Apply PQ1 with moderate pressure into the surface for 15s. Gently air thin and light polymerization for 20s.	Single component Dentin bonding system	HEMA, %40 filled with barium borosilicates, fluoride, % 8 ethanol			
Prime & Bond NT (Dentsply/ Caulk, Milford, De)	etch with %34 Tooth conditioner gel 15s, rinse and lightly dry. Apply Prime & Bond NT for 20s. Gently air thin for 5s and light polymerization for 20s	Single component Dentin bonding system	PENTA, urethane modified Bis-GMA, acetone, cetylamine hydrofluoride, nonofiller			
Bond One (Jeneric/ Pentron, Wallingford, Conn)	etch with %35 acid gel 15s, rinse and lightly dry. Apply Bond 1 into the cavity for 20s. Gently air thin for 10s and light polymerization for 10s.	Single component Dentin bonding system				
Revolution (Kerr, Orange, CA, USA)	Apply one or two drops of flowable composite to the internal surfaces light polymerization for 40s.	Flowable resin	Barium glass, synthetic silica	1 µm	62% 55%	46%
Dyract Flow (Dentsply/Caulk)	Apply one or two drops of flowable composite, avoid excessive pooling and remove it by air blowing. Light polymerization for 20s.	Flowable compomer				
Flow it (Jeneric/ Pentron)	Apply one or two drops of flowable composite to the internal surfaces light polymerization for 20s.	Flowable resin	Barium barosilicate glass	1,5 µm 1 µm	70.5%	54%
Solitaire (Heraeus Kulzer, Armonk, NY, USA)	Apply the resin in bulk	Packable composite resin	Polyglass monomers	2-20 µm	76%	45%, 66%
SureFil (Dentsply/ Caulk)	Apply the resin in bulk	Packable composite	Barium fluoroaluminoborosilicate glass, SiO2, nonofiller; Bis-GMA, TEG-DMA	0.8 µm	77%, 82%	58%, 66%
Alert (Jeneric/ Pentron)	Apply the resin in bulk	Packable composite	Ba-B-Al-Silicate, SiO2, Ethoxylated Bis-GMA	0.7 µm	80%, 84%	62%, 70%
Amelogen (Ultradent)	Apply the resin incrementally (maximum 2 mm)	Hybrid composite	Bis-GMA	0.7 µm	72%	60%
Prodigy condensable (Kerr)	Apply the resin in bulk	Packable composite	Barium fluorosilicate; BIS-GMA	Prodigy fillers	80%	62%
Amalgam (Novalloy, President Dental, München, Germany)	Condense and burnish after the initial setting	Gamma II- free	Ag 45 %, Cu 24%, Sn 31%			

The assessment of voids was performed in 6 different areas of the restorations; the first 3 within the material (mesial, occlusal and distal material) and the second 3 at the margins (mesial, occlusal and distal margins), as shown in figure 1. According to figure 1, bulk material refers to mesial + occlusal + distal material; total margins refers mesial + occlusal + distal margin. For all sections and groups, the number of voids was recorded by measuring the longest part of the voids were obtained for size measurements (Leica Q Win V3 Digital Image Processing and Analysis Software); then the mean values were achieved for the margins and internal material. The data was tabulated for statistical analysis.

Statistical analyses can be grouped into 2 steps. Kruskal-Wallis test was used to determine the difference between 9 groups, in terms of number and size of voids at the margins and internal material. For the differences that were significant between groups, a Post Hoc test, Dunnett C was performed. In the second step, differences between mesial and distal, in each 9 groups were determined by using Wilcoxon matched paired sign test for number and size (P = .05).

Results

The mean and median values of number and size of voids at the margins and materials were illustrated in tables 3 and 4. Table 5 shows the comparison of groups according to their number of voids at the margins and materials. Post Hoc test results showed no significant difference between the groups at the mesial, occlusal and distal margins (P>0.05).

Table 3. Number of voids

Group (n = 5)	Margin (mean ± SD, median)				Material (mean ± SD, median)				Bulk Material (mar.total+ mat.total) (mean ± SD, median)
	mesial	occlusal	distal	margin total	mesial	occlusal	distal	material total	
Solitaire	2.2±1.9	1.0±0.7	0.8±0.5	4.0±1.7	6.2±2.2	3.6±2.6	2.4±1.1	12.2±4.13	16.2±9.52
	3	1	1	5	6	3	2	15	19
Solitaire+ Revolution	1.0±1.3	0.6±0.49	0.4±0.49	2.0±1.41	11.6±3.7	6.8±3.76	9.0±5.97	27.4±8.11	29.4±9.63
	-	1	-	2	12	5	7	33	34
Surefil	1.2±1.2	1.8±0.7	1.0±0.6	4.0±1.1	6.2±2.0	8.4±4.6	10.4±5.2	25.0±3.9	29±7.14
	1	2	1	4	6	8	8	24	28
Surefil+ Dyract Flow	1.2±0.85	2.6±1.3	1.4±0.9	5.2±1.3	9.4±7.1	10.2±4.6	10.4±6.3	30.0±14.2	35.2±14.6
	1	2	2	5	6	8	9	35	42
Alert	1.6±1.2	3.6±2.4	1.6±1.2	6.8±2.5	26.4±8.5	28.2±6.5	18.6±5.5	73.2±12.4	80±11.45
	1	2	1	8	23	28	19	72	80
Alert+ Flow-it	0.8±1.6	0.8±0.75	1.2±1.6	2.8±2.32	23.2±6.24	23.4±8.55	21.8±9.06	68.4±20.18	71.2±21.23
	-	1	-	4	26	24	16	77	80
Amelogen	1.6±2.0	5.2±2.3	2.8±1.2	9.6±4.0	11.4±6.7	13.4±3.4	8.8±4.2	33.6±11.5	43.2±9.36
	-	6	3	11	11	12	11	32	40
Amalgam	2.0±0.63	0.4±0.8	0.4±0.49	2.8±0.75	7.2±3.19	3.4±1.62	3.6±1.74	14.2±4.58	17±5.48
	2	-	-	3	5	3	3	12	16
Prodigy Condensable	1.2±1.2	2.4±2.4	2.4±2.1	6.0±5.2	14.8±7.5	12.4±3.3	6.0±1.7	33.2±7.8	39.2±12.87
	1	2	2	5	20	14	6	33	34

Table 4. The size of voids (mm)

Group (n = 5)	Margin (mean ± SD, median)				Material (mean ± SD, median)				Bulk Material (mar.total + mat. total) (mean ± SD, median)
	mesial	occlusal	distal	margin total	mesial	occlusal	distal	material total	
Solitaire	0.89±1.26 0.58	0.06±0.09 -	0.09±0.08 0.15	1.18±1.25 0.73	0.85±0.67 1.05	0.59±0.64 0.40	0.35±0.34 0.58	1.78±1.04 2.03	2.96±2.14 2.75
Solitaire+ Revolution	0.11±0.15 -	0.05±0.04 -	0.05±0.07 -	0.20±0.17 -	1.96±1.24 4.15	1.01±0.64 2.05	1.42±1.11 0.50	4.39±1.89 6.70	4.59±1.88 6.70
Surefil	0.17±0.23 0.20	0.31±0.29 0.10	0.11±0.09 0.08	0.59±0.24 0.38	1.07±1.14 0.35	1.15±0.83 0.45	0.68±0.58 0.68	2.89±2.35 1.48	3.48±2.44 2.00
Surefil+ Dyract Flow	0.16±0.10 0.25	0.71±0.76 0.20	0.16±0.14 0.20	1.03±0.77 0.65	1.09±0.85 0.15	1.34±0.48 0.60	1.22±0.74 0.53	3.65±1.58 1.28	4.67±1.69 1.93
Alert	0.80±0.99 0.65	0.64±0.74 0.18	0.27±0.30 0.60	1.70±1.60 1.43	3.76±1.63 3.08	3.10±2.02 4.60	2.10±0.84 1.15	8.90±0.90 8.83	10.65±2.08 10.25
Alert+ Flow-it	0.11±0.25 -	0.25±0.28 0.45	0.19±0.31 0.23	0.55±0.57 0.68	3.47±1.13 5.03	3.37±1.23 3.15	2.47±1.33 4.53	9.30±2.71 12.70	9.85±2.67 2.00
Amelogen	0.17±0.24 0.30	1.20±0.80 0.28	1.25±0.88 1.65	2.61±1.23 2.23	1.64±0.97 2.05	1.87±0.75 1.85	1.33±0.89 1.90	4.84±2.17 5.80	7.59±1.75 8.03
Amalgam	1.11±1.00 1.70	0.38±0.84 -	0.35±0.49 -	1.84±1.09 1.70	1.87±1.01 0.40	0.52±0.35 0.08	0.73±0.52 1.50	3.12±0.86 1.98	4.95±1.08 2.00
Prodigy Condensable	0.16±0.21 0.08	0.75±0.70 0.15	0.58±0.76 0.30	1.48±1.21 0.53	2.46±1.74 2.78	2.54±1.86 1.60	1.22±0.81 1.08	6.22±3.37 5.45	7.69±4.18 5.98

Table 5. Comparison of results of voids' number

		Chi - Square	P	Post hoc Test Results
Margin	mesial	4.390	0.820	
	occlusal	23.596	0.003	
	distal	13.748	0.089	
	total	17.478	0.025	
Material	mesial	22.864	0.004	
	occlusal	31.436	0.000	Solitaire & Alert Solitaire+Revolution & Alert Alert & Amalgam
	distal	25.743	0.001	Solitaire & Alert Solitaire & Alert+Flow-it
	total	32.499	0.000	Solitaire & Alert Solitaire+Revolution& Alert Alert & Amalgam Alert & Prodigy Alert & Surefil Alert+Flow-it & Amalgam
Margin + Material	mesial	2.906	0.940	
	occlusal	20.954	0.007	Amalgam & Amelogen
	distal	11.498	0.175	
	total	32.877	0.000	Solitaire & Alert Solitaire+Revolution& Alert Surefil & Alert Surefil+Dyract Flow & Alert Amelogen & Alert Amalgam & Alert Amalgam& Alert+Flow-it Amalgam& Amelogen

For the overall comparison Kruskal-Wallis analysis of variance test and Post hoc analysis were carried out.
Only statistically significant results are summarized in the table. Significant level $P<0.05$

While there was no significant difference at the mesial, Alert showed significant differences with Solitaire, Amalgam and Solitaire + Revolution groups at the occlusal material (P<0.05). At distal material, the only difference was between Solitaire and Alert. At the total material, Alert and Solitaire, Alert and Solitaire + Revolution, Alert and Surefil, Alert and Amalgam, Alert and Prodigy, Alert + Flow-it, and Solitaire, Alert + Flow-it and Amalgam showed significant differences (P<0.05).

Figures 2 and 3 showed huge amount of voids in the sections. When we consider margin and material together, the significant differences were between Alert and Solitaire, Solitaire + Revolution, Surefil, Surefil + Dyract Flow, Amelogen, Amalgam groups and also between Amalgam and Alert + Flow-it, Amelogen (P<0.05). Figures 4 and 5 showed the microscopic view of an amalgam specimen.

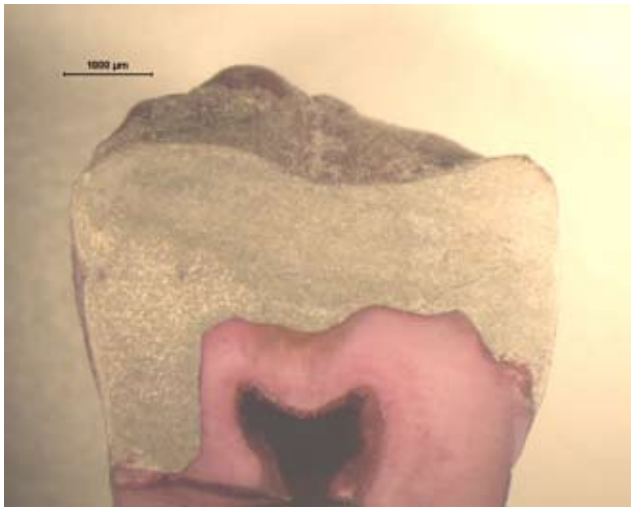

Figure 4. Image of an Amalgam specimen (x9.45)

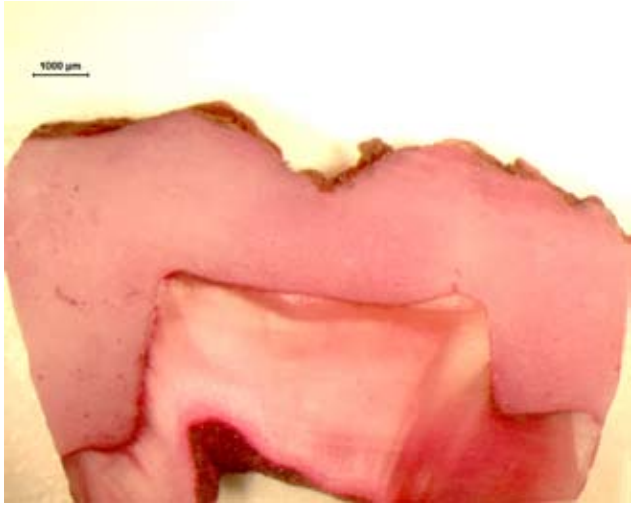

Figure 2. Image of a specimen from Alert group (x9.45)

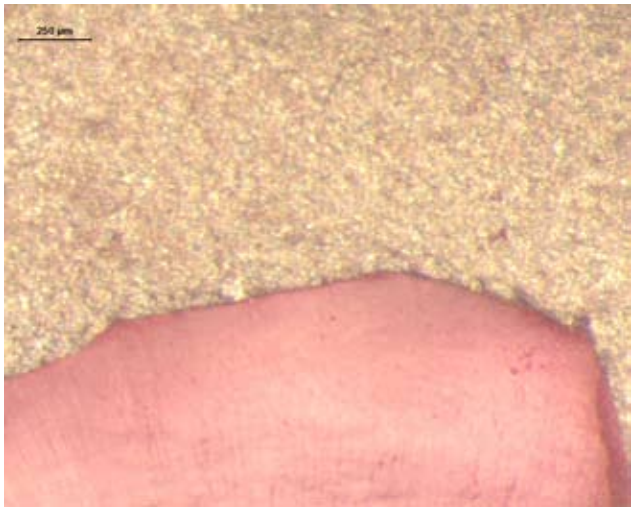

Figure 5. Same specimen in figure 4 at higher magnification at occlusal (x48)

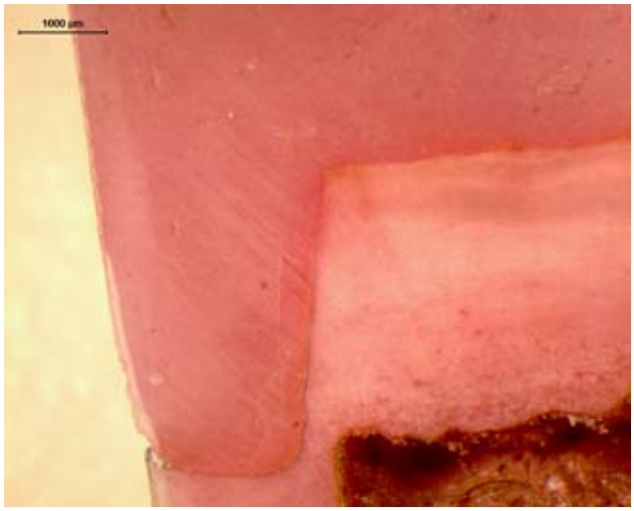

Figure 3. Image of a specimen from Alert + Flow-it group (x15)

Table 6 shows the comparison of groups according to their size of voids at the margins and materials. While there was no significant difference between the groups at the margins, Alert showed differences with Solitaire, Amalgam, Surefil, Surefil + Dyract Flow groups and also between Alert + Flow-it and Solitaire at the total material. Figures 6 and 7 show large voids at the margin and material from Alert group. When we consider margin and material together, the significant differences were between Alert and Solitaire, Alert and Amalgam.

Table 6. Comparison of results of voids' size

		Chi - Square	P	Post hoc Test Results
Margin	mesial	12.370	0.135	
	occlusal	17.965	0.021	
	distal	15.170	0.056	
	total	21.155	0.007	
Material	mesial	19.279	0.013	
	occlusal	22.908	0.003	
	distal	17.267	0.027	
	total	28.044	0.000	Solitaire & Alert+Flow-it Solitaire & Alert Surefil & Alert Surefil+Dyract Flow & Alert Alert & Amalgam
Margin + Material	mesial	8.791	0.360	
	occlusal	20.626	0.008	Solitaire & Amelogen
	distal	13.883	0.085	
	total	28.226	0.000	Solitaire & Alert Amalgam & Alert

For the overall comparison Kruskal-Wallis analysis of variance test and Post hoc analysis were carried out. Only statistically significant results are summarized in the table. Significant level P<0.05

Figure 6. A large void at the mesial material of a specimen from Alert group (x30)

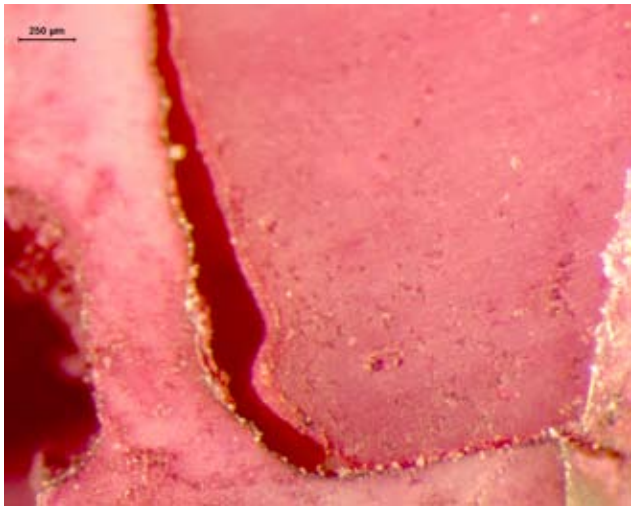

Figure 7. The mesial margin of a specimen from Alert group (x37.5)

Table 7 shows the mesial and distal comparison according to the number and size of the voids. A specimen from Solitaire + Revolution group showing similar views for mesial and distal margins and materials were in figures 8-10. There was no significant difference between mesial and distal at the margins, but was significant at the material in Amalgam (P=0.042) according to the number, as shown in figure 11. According to the size of the voids, the only difference was at the margins in Amelogen (P=0.042).

Table 7. Comparison of voids at mesial and distal sides

	Number				Size			
	margin		material		margin		material	
Group	Difference (d-m)	P	Difference (d-m)	P	Difference (d-m)	P	Difference (d-m)	P
Solitaire	-1.604[a]	0.109	-1.826[a]	0.068	-1.604[a]	0.109	-1.461[a]	0.144
Solitaire+ Revolution	-0.816[a]	0.414	-0.405[a]	0.686	-1.069[a]	0.285	-0.405[a]	0.686
Surefil	-0.272[a]	0.785	-1.461[b]	0.144	0.000[c]	1.000	-1.214[a]	0.225
Surefil+ Dyract Flow	-0.272[b]	0.785	-0.365[b]	0.715	-0.687[a]	0.492	-0.135[b]	0.893
Alert	0.000[c]	1.000	-1.214[a]	0.225	-0.674[a]	0.500	-1.483[b]	0.138
Alert+ Flow-it	-0.272[b]	0.785	-0.000[c]	1.000	-0.535[b]	0.593	-1.753[a]	0.080
Amelogen	-1.604[b]	0.109	-0.674[a]	0.500	-2.032[b]	0.042*	-0.944[a]	0.345
Amalgam	-1.841[a]	0.066	-2.032[a]	0.042*	-1.483[a]	0.138	-1.483[a]	0.138
Prodigy Condensable	-1.225[b]	0.221	-1.753[a]	0.080	-1.753[b]	0.080	-1.214[a]	0.225

Wilcoxon Signed Ranks Test

a : Based on positive ranks

b : Based on negative ranks

c : The sum of negative ranks equals the sum of positive ranks

* : Significant (P<0.05)

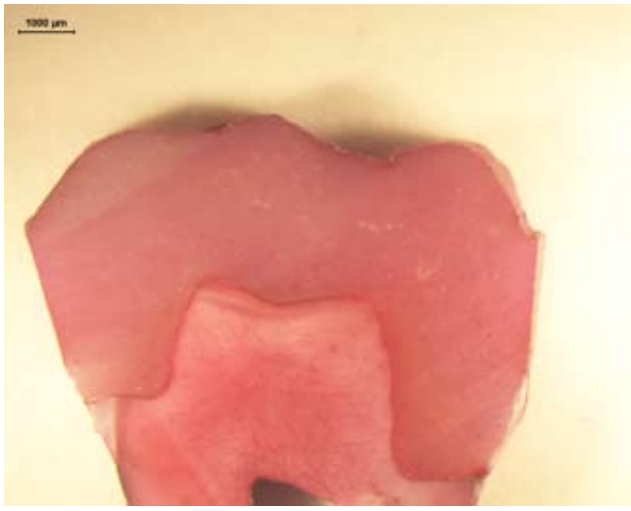

Figure 8. Image of a specimen from Solitaire group (x9.45)

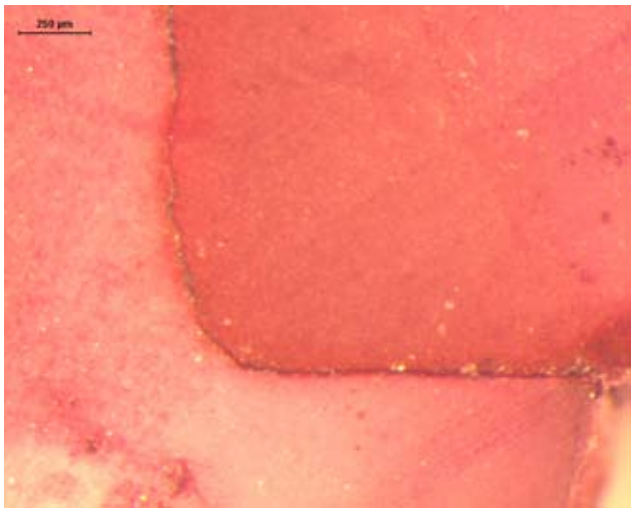

Figure 9. Mesial view of the same specimen in figure 8 (x48)

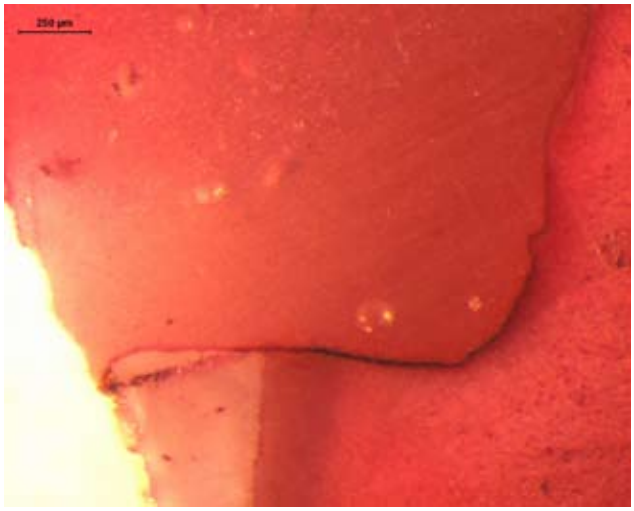

Figure 10. Distal view of the some specimen in figure 8 (x48)

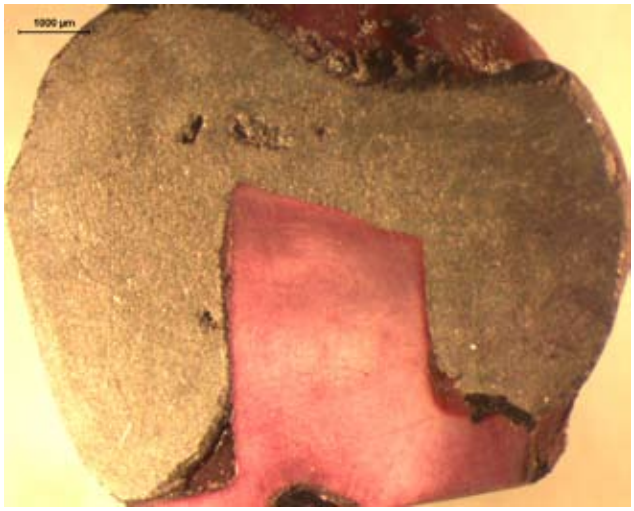

Figure 11. Image of an Amalgam specimen (x12)

Discussion

Improved handling characteristics developed for packable composite materials have made them more suitable for posterior applications compared to conventional composites. For the gingival proximal area of posterior teeth, where isolation is difficult and access and visibility are compromised, the technique sensitivity of composite materials is more likely to put this type of restoration at risk[1]. To improve the quality of the restoration, the preparation should be filled without voids and porosities. It has been recognized that voids at the cervical margins are an undesirable complication in composite restorations[2]. Marginal gaps between the preparation walls and the restoration, and voids on the surface or within the restorative material, can cause microleakage, discoloration, post-operative sensitivity, and secondary caries[14-17]. Porosity on the external surface of the restoration will result in surface roughness and may lead to stain[11]. Opdam et al[12] reported that syringable composites result in a better restoration with less voids compared to a packing technique with a highly viscous composite. Similarly Fano et al[13] reported that the highest amount of porosities were found in a highly viscous resin composite. Kelsey et al[8] reported that the mechanical properties revealed significant differences among high-performance packable and conventional hybrid composites. Studies reporting on bulk placement showed a decrease in depth of polymerization, greater microleakage and inferior degree of polymerization at cervical thirds of composite specimen restorations[20-22]. On the contrary, packable composites used in this study, did not showed any differences with incrementally placed hybrid composites both in number and size of voids. Similar to this, among packable groups there was no difference at the margins according to the number and size. However, inside material, Alert showed significant differences with some groups both for size and number. As seen in tables 3 and 4, groups with Alert, which had individual micro-glass fibres, showed the highest number and size at the bulk material (Figs. 2 and 6). Leevailoj et al[2] reported that Alert was the stiffest material, while showing the most microleakage at the gingival margins.

The use of a combination of flowable and packable composites is an accepted concept[25]. As reported in some studies, flowable composite when used as a liner underneath a packable composite, demonstrated improved resistance to microleakage on enamel and dentin margins and was consistent with fewer voids[28-30]. However, Chuang et al[33] showed no significant difference in the marginal microleakage between with/without flowable composite linings. Leevailoj et al[2] reported that in Class II preparations, flowable composites reduced, but did not eliminate, microleakage of the tested packable and microhybrid resin composites at gingival margins apical to the CEJ. Chuang et al[34] showed a reduction in the presence of internal restoration voids when using flowable composites as a lining material for composite restorations. The incidence of internal voids was significantly reduced at both the restoration's interface and within its mass. This design of proximal cavity extension difference in this study and usage of flowable liner could conceivably have an effect on the voids in the restoration. The same study reported that no correlation exited between the number of voids and marginal microleakage[34]. In the present study, the use of flowable composites did not show any differences in number and size of the voids.

In the present study, to compare the different gingival levels, proximal margins were prepared 1 mm coronal and apical to the CEJ. In the literature there was a study comparing different gingival levels for microleakage but not for voids[35]. In the present study, there was no

statistically significant difference in number and size of voids in different gingival levels for packable composites at the margin and material. Besides, Amelogen showed difference for size (mm) of the voids at the margin. The reason for this might be related with incremental placement technique leading to more pores between layers during placement and lower inorganic content in hybrids (Figs. 12 and 13).

As a conclusion, the number and size of voids of the studied packables did not show any difference at the restoration margins and within the material. Also, different gingival levels and flowable usage did not make any difference among packables.

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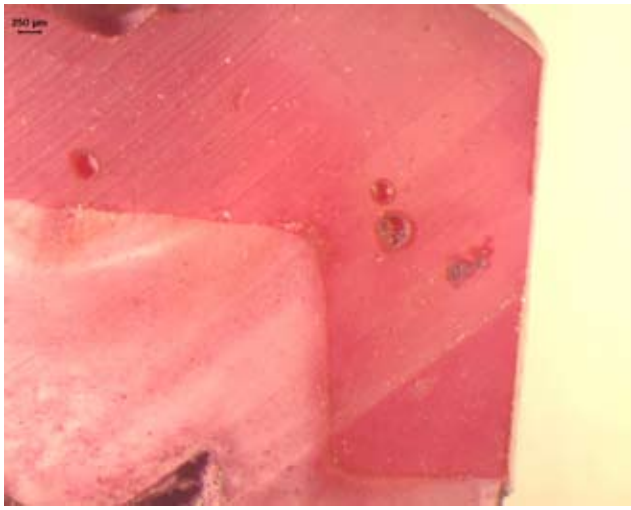

Figure 12. Image of a specimen from Amelogen group (x15)

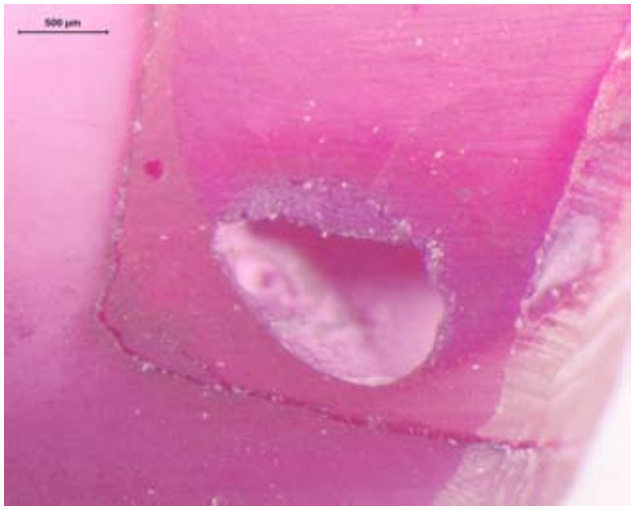

Figure 13. Mesial image of a specimen from Amelogen group (x30)

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