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Original Research

Assessment of Class II restorations using bulk-fill technique: a 2-year randomized controlled clinical trial

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Aim: This study aimed to evaluate the two-year clinical performance of class II restorations using bulk-fill resin composites. **Methods:** Thirty-five patients received 70 class II restorations (n=70) with conventional composite resin Filtek Supreme (3M-ESPE, group FS) and bulk-fill Surefill SRD (Smart Dentine Replacement-Dentsply, group SDR) composites using a split-mouth design. The restorations were assessed based on modified USPHS and FDI criteria for proximal contact at baseline, 6, 12, and 24 months after placement. **Results:** After 6 months, 31 patients were assessed and two FS restorations failed due to dentin sensitivity. After 12 months, each group had one restoration failure for fracture/loss of retention of the material. After 24 months, 58 restorations were assessed, and the following was observed: three FS restorations needed to be replaced due to fracture/loss of retention, marginal adaptation, and proximal contact; and three SDR restorations needed to be replaced due to secondary caries, fracture/loss of retention, and proximal contact defect. For each score in the 24 months, an increase in the surface roughness of FS (p=0.013) and SDR (p=0.0006) restorations was observed as well as a decrease in dentin sensitivity, respectively, p=0.0015 and p=0.00021. The highest number of failures occurred due to fracture/loss of retention for both restorations. The chi-square test showed no statistically significant difference between FS and SDR restorations regarding all parameters assessed (p>0.05). After two years of clinical assessment, no statistically significant differences were found between FS and SDR restorations for the parameters assessed. **Conclusion:** Both materials were shown to have similar clinical performance.

Keywords: Composite resins. Clinical study as topic. Dental restoration failure.

Introduction

The reasons for the increasing number of composite resin restorations are based on the relative simplicity of the technique, including color similarity to dental substrates, greater aesthetical acceptance, and less invasive preparations due to the use of adhesive systems[1,2]. However, there are controversies as to its effectiveness. Studies have shown that the shrinkage of the material can cause failures at the adhesive interface, leading to the development of caries[2]. Also, the tension resulting from the contraction may also cause fracture of the dental remnant, cuspal deformation, and post-operative sensitivity[3]. The operator's skills, the choice of materials and the technique to be used can influence the outcome[4].

The incremental technique is the most used to insert composite resins into the cavity, and according to the ISO 4049 depth of cure, 2-mm thickness increments should be inserted to minimize the contraction effects and to allow for a high-degree conversion of the composite resin during the light-curing process[5]. Even with this technique, restoration is subject to failures, such as incorporation of voids during accommodation of the resin, adhesive failure between the layers, possible contamination by saliva, and long chair time, since each increment should be made before polymerization for 20 seconds, on average[6].

Bulk-fill composite resins have been developed for extensive restoration of posterior teeth. The changes in the formulation allow lower polymerization shrinkage, less stress induction, easy adaptation to the cavity walls, and polymerization of layers of up to 4 mm thickness[7,8]. This is possible due to a greater depth of cure, which can be attributed mainly to increased translucency[9,10]. Moreover, studies have also emphasized that this technique reduces chair time, thus benefiting both patient and operator[6,7].

Among the available resin composites, Filtek Supreme (3M) is a nanohybrid composite that utilizes zirconia/silica nanoparticles and nanoclusters, providing excellent polishability, high wear resistance, and enhanced optical properties[11]. Unlike bulk-fill composites, Filtek Supreme requires an incremental layering technique due to its lower depth of cure and higher polymerization shrinkage[12]. Studies have demonstrated its high elastic modulus and hardness, making it a durable material suitable for both anterior and posterior restorations[13].

Among the available bulk-fill composites, Surefil™ SDR Flow+ (Dentsply) is a low-viscosity bulk-fill composite with a polymerization modulator that allows lower shrinkage stress and a better cavity adaptation. It contains barium-alumino-fluoro-silicate glass as its filler (68% by weight), ensuring radiopacity and flowability for improved handling in deep cavities[14]. Studies also indicate that this type of material may exhibit favorable polymerization, reduced porosity, and enhanced cavity adaptation[15].

In vitro studies have confirmed the good properties of these composites, such as better marginal sealing of dentine[9] and low creep deformation[10]. Moreover, clinical studies have shown similar clinical performance between these techniques[11,16,17].

Based on the above, the objective of the present randomized clinical trial was to assess the clinical performance of bulk-fill composite resin in Class II restorations compared with a nanohybrid composite resin by using the incremental technique, after two years of service. The null hypothesis to be tested was that the techniques used have similar clinical success over an experimental period.

Methods

This double-blind study with two arms was written according to the CONSORT statement[12]. The study was conducted at the clinic of the Institute of Science and Technology of São José dos Campos, Brazil. All participants were informed about the nature and objectives of the study. The study was approved by the Institutional Review Board and has been registered in the Brazilian Clinical Trials Registry (Registro Brasileiro de Ensaios Clínicos – REBEC). Written informed consent was obtained from all participants before starting the treatment.

Trial Design

This study was double-blind (evaluator and patient) and split-mouth randomized clinical trial with two arms, and an equal allocation ratio.

Sample Size Calculation

The sample size was calculated by using the Internet site www.sealedenvelop.com with calculation power function and equivalence trial with the following parameters: α = 5%, 80% power, 96.4% success percentage for control and experimental groups, and equivalence limit of 15%, resulting in a sample size of 30 restorations *per* group[13].

Recruitment and eligibility criteria

Individuals seeking treatment in a screening clinic in the Restorative Dentistry department of the local university were recruited for the study. A total of 73 participants were examined by two calibrated dental students to determine whether they met the eligibility criteria. Thirty-five patients were selected for the study. The inclusion criteria were the following: the necessity of two Class II restorations with composite resin for decayed teeth or the necessity of changing the restoration; teeth which can be used rubber dam isolation; the presence of antagonist and adjacent tooth; and teeth with vital pulp, no pain, direct pulp capping and no history of hypersensitivity. The exclusion criteria were patients with very extensive caries lesions, pulp exposure during caries removal, or cavities with a high risk of exposure, pain, or spontaneous sensitivity; the presence of severe periodontal disease; patients presenting with parafunctional habits or clinical signs of attrition; patients suffering from systemic diseases or allergies to the materials to be used.

Randomization and allocation concealment

The randomization lists were prepared using a website (www.sealedenvelop.com) with an equal allocation ratio for the two materials used. For the allocation, opaque and sealed envelopes were used and numbered by a person not involved in the study. Just before the beginning of the restorative procedure, the envelope was opened,

which ensured allocation concealment. The tooth located in the quadrant of the smaller number and more mesial in this quadrant was the first to be assigned.

Restoration Procedure

Three operators performed the restoration procedures. Firstly, the inter-proximal radiographic examination was performed. The cavity depth was ranked after complete removal of the failed restoration or carious lesion, and then the tooth was isolated. In cases of deep lesions, glass-ionomer cement was used in the pulp wall. Enamel and dentin were etched with 37% phosphoric acid gel for 30 and 15 seconds, respectively. An adhesive system (Adper Single Bond 2 – 3M ESPE) was used according to the manufacturer's recommendations. Sectional matrices (Unimatrix System, TDV, Pomerode, SC, Brazil) were used for restoration in association with a distancing ring and wooden wedge.

Each patient received two restorations as follows: 1) Bulk-fill: SDR (Surefill SDR, Smart Dentine Replacement, Dentsply), in which the resin is applied at the deepest point of the cavity, letting the tip of the applicator immersed until reaching 4 mm inside the cavity and then light cured for 20 seconds (power density of 900mW/cm^2), with the final 2-mm of the cavity being filled with Filtek Supreme resin (3M ESPE) and light cured for 20 seconds; 2) Conventional: FS (Filtek Supreme, 3M ESPE) was added by using the incremental technique, with increments up to 2mm, with each increment being light cured for 20 seconds.

Restoration finishing and polishing procedures were performed using fine-grit diamond burs (FG 2135F - KG Sorensen, Cotia, Sao Paulo, Brazil) to remove excess material and ensure proper occlusal adjustment. Polishing was achieved through a sequential application of Enhance abrasive cups (Dentsply Sirona, York, PA, USA) followed by silicon carbide brushes (Astrobrush, Buffalo Dental, Syosset, NY, USA), with consistent pressure and thorough rinsing between each step. Upon completion of each restoration, patients received standardized oral hygiene instructions.

Materials, manufacturers, and compositions are listed in Table 1.

Table 1. Materials, Manufacturers, and Their Compositions

Material	Manufacturer	Composition
Magic Acid	Vigodent, Rio de Janeiro, Brazil	37% phosphoric acid
Adper Single Bond 2	3M ESPE, St. Paul, MN, USA	Bis-GMA, HEMA, dimethacrylates, ethanol, water, a novel photoinitiator system, and a methacrylate functional copolymer of polyacrylic and polyitaconic acids
Filtek Supreme	3M ESPE, St. Paul, MN, USA	Bis-GMA, UDMA, TEGDMA, and bis-EMA resins
Surefill SDR	Dentsply, Caulk, USA	Modified UDMA, TEGDMA, EBPDMA

Bis-GMA: Bisphenolglycidyl dimethacrylate.
HEMA: Hydroxyethylmethacrylate.
UDMA: Urethane dimethacrylate.
TEGDMA: Triethyleneglycol dimethacrylate.
Bis-EMA: bisphenol-A polyethylene glycol diether dimethacrylate.
EBPDMA: Ethoxylated bisphenol-A dimethacrylate.

Calibration procedures

For calibration, ten representative photographs of each score for each criterion were examined by two independent and experienced dentists. Also, ten patients, not involved in this study, were evaluated on two consecutive days. A Kappa concordance test was performed.

Blinding

The two examiners and all participants were blinded to the group allocation during all recalls, resulting in a double-blind trial design.

Assessment Periods and Criteria

The restorations were assessed by using the modified USPHS (the United States Public Health System) criteria developed by Cvar and Ryge[15-18] (Table 2).

- Alpha: restorations with good quality and excellent clinical pattern.
- Bravo: partially satisfactory restoration and clinically acceptable.
- Charlie: non-acceptable restorations.

For the assessment of the contact point, the World Dental Federation criteria were used[19,20] (Table 2). An initial assessment was made following the polishing of the restorations, and others were performed after 6, 12, 18, and 24 months. Each patient was individually evaluated by two calibrated examiners rather than the operator, and when there was any discordance regarding a given case, discussion occurred until a consensus was achieved. Table 2 lists the parameters assessed in each restoration. Statistical analyses were performed using Chi-square and Fisher's tests to compare treatment success within each experimental period and Kaplan-Meier's test to determine the survival rate of the restorations.

Table 2. Modified USPHS and FDI Evaluation Criteria.

Criterion	Classification	Characteristics
Retention / Fracture	Alfa (A)	Restoration completely retained
	Charlie (C)	Restoration partially or completely lost
Marginal discoloration	Alfa (A)	There is no visual evidence of marginal discoloration. There is no difference between the restorative material color and the adjacent structure color.
	Bravo (B)	There is visual evidence of marginal discoloration between tooth structure and restoration but does not penetrate the interface in the pulp direction
	Charlie (C)	There is visual evidence of marginal discoloration between tooth structure and restoration, and there is evidence that penetrated along the restoration in the pulp direction

Continue

Continuation

Marginal adaptation	Alfa (A)	The explorer does not stick when it is passed along the restoration surface until the tooth or if the explorer stays trapped and there is no visible fracture along the restoration periphery
	Bravo (B)	The explorer is stuck, and there is no clear and visible fracture where the explorer enters, indicating that the margin of restoration is not adapted closely to the structure of the tooth. The dentin and base are not exposed, and restoration has no mobility
	Charlie (C)	The explorer enters the mass grave of the fracture that extends to merge enamel/dentin
Secondary Caries	Alfa (A)	There is no visual evidence of dark and deep discoloration adjacent to the restoration
	Charlie (C)	There is visual evidence of dark and deep discoloration adjacent to the restoration
Wear (loss of anatomical form or contour or loss of substance)	Alfa (A)	The restoration shows the continuity of existing or anatomical shape is slightly flattened. It can be provided on the frame. When the side of the explorer is positioned tangentially along the restoration, it does not play on two opposing points of the line of the cavosurface angle at the same time
	Bravo (B)	The surface of the concavity is evident. When the side of the explorer is placed tangentially on the restoration, the explorer touches two points of the line of cavosurface angle at the same time, but the dentin or the base is not exposed.
	Charlie (C)	There is a loss of restorative substance so that the concavity of the surface is evident, and the base and/or dentin are exposed
Surface Texture	Alfa (A)	The surface has a smooth appearance. There is no tactile perception of roughness.
	Bravo (B)	The surface presents with roughness or it feels roughness when inspected with the explorer. There are no clear pores or craters.
	Charlie (C)	The surface of the restoration presents pores or craters. When the tip of the explorer is passed on the pores or craters are seen, it is trapped.
Postoperative sensitivity	Alfa (A)	No post-operative sensitivity
	Bravo (B)	Sensitivity present, decreasing intensity
	Charlie (C)	Sensitivity present, not decreasing intensity
Proximal Contact	1	Normal contact point (floss or 25 um metal blade can pass)
	2	Contact is slightly too strong but has no disadvantage (floss or a 25µm metal blade can only pass with pressure
	3	Somewhat weak contact, no indication of damage to the tooth, gingiva, or periodontal structures (50ummetal blade can pass
	4	Too weak, 100 um metal blade can pass.
	5	Possible damage due to food impaction

Results

In this study, 73 individuals were examined. Thirty-eight did not fulfill the inclusion criteria, so they were not included. Thus, 35 participants were enrolled in the clinical trial. A total of 70 restorations were performed in the present study in which one of each material was tested in the participants by using the split-mouth technique, totalizing 35 patients who received restoration with Filtek Supreme resin and 35 patients who received restoration with SDR resin (Figure 1).

The analysis revealed that both Filtek supreme and SDR resins were predominantly utilized in restorations with medium-sized cavities, accounting for approximately 70% and 76% of cases, respectively. Filtek exhibited a slightly higher occurrence of extensive cavities (24%) compared to SDR (21%), while small cavities were more frequently restored with Filtek (6%) than SDR (3%). The mean restoration depth was comparable between Filtek (4.36 mm) and SDR (4.24 mm). Regarding preparation types, Filtek was more commonly employed in OD (occlusal-distal) preparations, whereas SDR showed a higher usage in MO (mesio-occlusal) preparations.

Restorations with Filtek Supreme resin were performed in 80% of the premolars and 20% of the molars, with 51.42% of the restorations being considered of medium depth and 48.58% of greater depth. Restorations with SDR were performed in 77.14% of the premolars and 22.85% of the molars, with 54.28% of the restorations being considered medium depth, 42.85% deep, and 2.87% very deep.

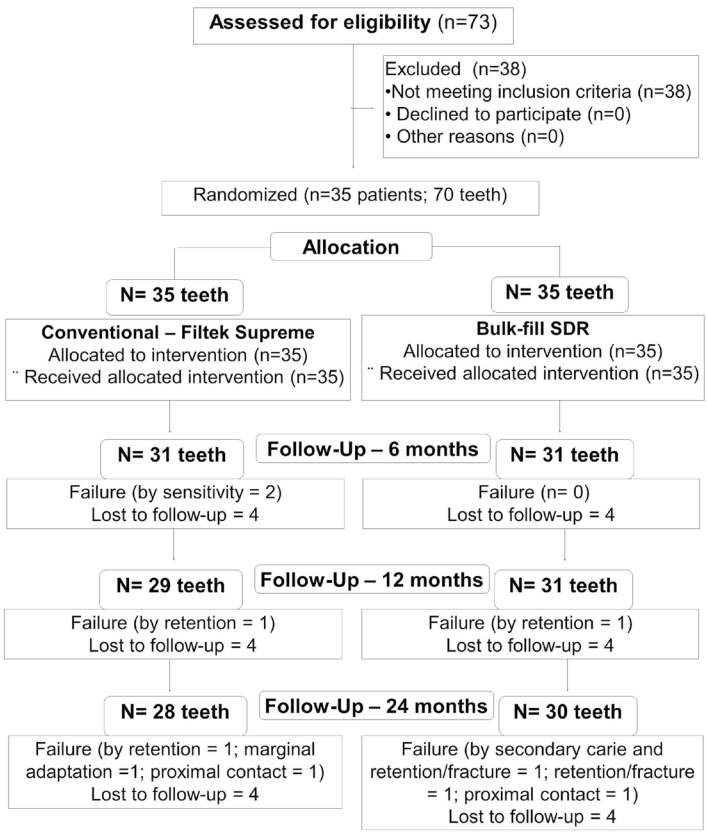


Figure 1. Flowchart of the model under study.

Kappa coefficients revealed moderate to good concordance for inter-rater (0.500 to 0.602) and intra-rater (0.412 to 0.772) reliability. In case of disagreement during the assessment, a consensus was obtained. During the assessment periods, 4 patients

did not attend the sessions. Initially, 2 restorations with Filtek Supreme resin were lost due to dentinal sensitivity; after 12 months, 1 restoration failed for both resins and after 24 months 3 restorations with Filtek Supreme and three with SDR resin failed, totalizing 10 failures (i.e., 6 failures with Filtek Supreme and 4 with SDR).

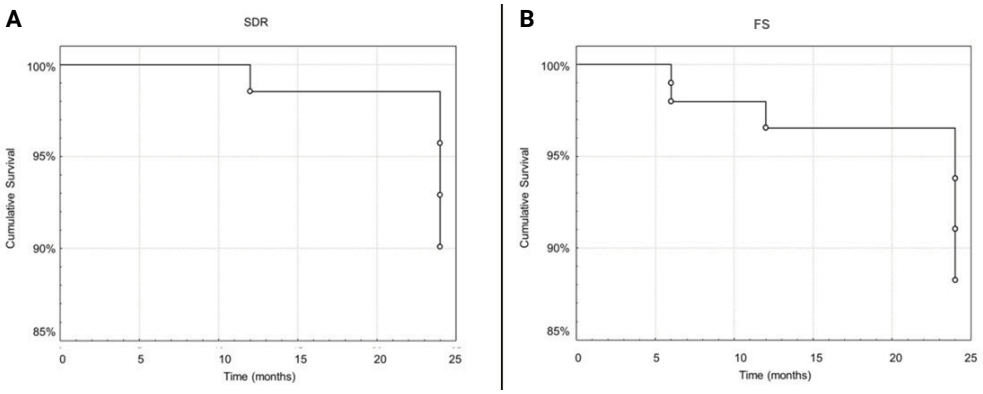
Table 3 shows the results obtained after all the assessments. After 24 months, Bravo scores were found for the parameter "marginal discoloration" (42.42% for Filtek Supreme and 46.66% for SRD). The parameter "surface texture" was also found to have a high percentage for Bravo scores (25% for Filtek Supreme and 36.66% for SDR), where the Chi-square test showed the statistically significant difference between the assessment periods for Filtek Supreme (P = 0.013) and SDR (P = 0.0006). According to Fisher's test, dentinal sensitivity was found to be significantly reduced for Filtek Supreme (P = 0.00015) and SDR (P = 0.00021), with the latter having a 100% alpha score.

Table 3. Results of the clinical evaluation of tested resin restoration.

Evaluation criteria	Score	Baseline		6months		12 months		24 months	
		FS N=35	SDR N=35	FS N=31	SDR N=31	FS N=29	SDR N=31	FS N=28	SDR N=30
Retention	A	35 (100%)	35 (100%)	31 (100%)	31 (100%)	28 (89.6%)	30 (96.77%)	27 (96.42%)	28 (93.3%)
	C	-	-	-	-	1 (10.4%)	1 (3.33%)	1 (3.58%)	2 (6.7%)
Marginal discoloration	A	28 (80%)	27 (77.14%)	22 (70.96%)	24 (77.4%)	20 (69%)	23 (74.1%)	15 (53.57%)	16 (53.3%)
	B	7 (20%)	8 (22.86%)	9 (29.04%)	7 (22.6%)	9 (31%)	8 (25.9%)	13 (46.42%)	14 (46.7%)
	C	-	-	-	-	-		-	-
Marginal adaptation	A	31 (88.5%)	31 (88.57%)	27 (87.09%)	30 (96.8%)	22 (75.9%)	26 (83.9%)	22 (78.57%)	25 (83.3%)
	B	4 (11.5%)	4 (11.43%)	4 (12.91%)	1 (3.2%)	7 (24.1%)	5 (16.1%)	6 (21.43%)	5 (16.7%)
	C	-	-	-	-	-		1 (4.2%)	-
Secondary caries	A	35 (100%)	35 (100%)	31 (100%)	31 (100%)	29 (100%)	31 (100%)	28 (100%)	29 (96.7%)
	C	-	-	-	-	-	-	-	1 (3.3%)
Wear	A	35 (100%)	35 (100%)	29 (93.54%)	31 (100%)	28 (96.5%)	31 (100%)	27 (96.43%)	30 (100%)
	B	-	-	2 (6.46%)	-	1 (3.5%)	-	1 (3.57%)	-
	C	-	-	-	-	-	-	-	-
Surface texture	A	33 (94.2%)	34 (97.14%)	28 (90.33%)	27 (87.1%)	26 (89.6%)	25 (80.6%)	21 (75%)	19 (63.3%)
	B	2 (5.8%)	1 (2.86%)	3 (9.67%)	4 (12.9%)	3 (10.4%)	6 (19.4%)	7 (25%)	11 (36.7%)
	C	-	-	-	-	-	-	-	-

Post operative sensitivity	A	25 (71.4%)	26 (74.29%)	28 (90.33%)	29 (93.4%)	28 (96.5%)	31 (100%)	28 (100%)	30 (100%)
	B	10 (28.57%)	9 (25.71%)	3 (9.67%)	2 (6.6%)	1 (3.5%)	-	-	-
	C		-	-	-	-	-	-	-
Proximal contact	1	19 (54.3%)	20 (57.14%)	14 (45.16%)	14 (45.16%)	12 (41.37%)	12 (38.7%)	10 (35.71%)	11 (36.66%)
	2	4 (11.4%)	5 (14.29%)	4 (12.9%)	5 (16.1%)	3 (10.34%)	2 (6.5%)	1 (3.58%)	-
	3	12 (34.3%)	10 (28.57%)	9 (29.03%)	10 (32.25%)	10 (34.48%)	14 (45.1%)	11 (39.28%)	15 (50%)
	4	-	-	4 (12.9%)	2 (6.49%)	4 (13.81%)	3 (9.7%)	5 (17.85%)	3 (10%)
	5	-	-	-	-	-	-	1 (3.58%)	1 (3.33%)
OVERALL SUCCESS		35 (100%)	35 (100%)	29 (93.55%)	31 (100%)	28 (96.55%)	30 (96.77%)	25 (89.3%)	27 (90%)

Kaplan-Meier's test was performed to obtain the survival rate of the restorations, as shown in Figure 2.



Legend: Kaplan-Meier analysis for the SDR (A) and FS (B) groups.
Figure 2. Kaplan-Meier survival curve showing the percentage of patients without failure.

Chi-square test was performed to compare the performance of Filtek Supreme resin to that of SDR resin after 6, 12 and 24 months, and no statistically significant difference was found between the resins used regarding all the parameters ($P > 0.05$).

Discussion

Clinical research is a reliable and relevant method for assessing the performance of dental restorations, since it analyses the actual influence of masticatory forces as well as the salivary enzymes, including the bacterial action on the materials involved[21,22]. By using the split-mouth technique, in which the use of each material to be tested is

performed in the same patient, it is possible to obtain more realistic results as both treatments receive the same type of load and agents[23].

The modified USPHS criteria were used in the present study because it is a well-known assessment method in clinical research[24,25]. This method is widely used because it assesses important characteristics of dental restorations, such as the presence of secondary caries lesions, postoperative sensitivity, marginal discoloration, and adaptation. For the assessment of the contact point, the FDI criteria were chosen because they are more sensitive to small variations and thus allow for the detection of minor differences between restorations compared to USPHS criteria[26,27].

There were no significant clinical differences between restorations performed with 4-mm thickness increments by using bulk-fill composite resin and those performed with 2-mm thickness increment (conventional) regarding all parameters and experimental periods[28].

This result corroborates with a systematic review and meta-analysis performed by Veloso et al.[29], which compared the clinical performance of posterior restorations performed with conventional composite and bulk-fill resins and concluded that both presented a similarly clinical performance for a period of follow-up of 12 to 72 months. The results were also consistent with those reported by Karaarslan et al., who observed that the resins exhibited comparable clinical performance across all parameters, except for color match[30].

There were differences between the experimental periods regarding the parameters "surface texture" and "post-operative sensitivity." A high number of restorations were found in the Bravo score for marginal decoloration, whereas a higher number of failures (Charlie score) was observed for fracture/loss of retention.

The polymerization shrinkage, a characteristic inherent to the direct restorative technique, can cause failures at the restoration interface, leading to marginal decoloration, secondary caries, postoperative sensitivity, loss of retention and fractures[31,32]. The incorporation of a significant amount of inorganic load particles causes a reduction of monomers, thus promoting a decrease in the polymerization shrinkage and an increase in the flexural modulus[33]. Although the Filtek Supreme resin has a high percentage of inorganic load (63.3% per volume) than the SDR resin (47.3% per volume), no statistical difference was found between them. Also, a high degree of marginal discoloration was observed in both materials after two years, with 46.42% of Bravo scores for conventional resin and 46.66% for Bulk-fill composite resin. Similar results for marginal discoloration were observed after two years in Class II restorations using resins with different viscosity[34].

Loss of retention/fracture of material was the parameter presenting the highest failure rate among the restorations, with one restoration failing for each resin after 12 months; 3.58% of the restorations with conventional resin and 6.66% with bulk-fill composite resin failed after 24 months. Previous clinical studies reported that fractures, secondary caries, and occlusal wear are all the main triggers of failures in posterior restorations with composite resins[35,22]. The fractures occurring mainly in the first three years after placement of the restoration have a close relationship with parafunction[35,36]. Although the restoration failure occurred in the occlusal layer

made with Filtek Supreme resin, the bulk-fill composite resin can influence, as this material possesses lower flexural modulus. According to Jung and Park[37], the flexural moduli of Filtek Supreme and SDR resins are, respectively, is 5.98 ± 0.66 GPa and 3.29 ± 0.64 GPa. Resins having a lower flexural modulus can absorb impacts and forces generated during mastication[38]. In the present study, therefore, there was no statistical difference between the resins assessed. Also, as the fractures were observed after 12 months, one believes that this high number of restoration failures occurred due to parafunction.

On the other hand, the results of marginal adaptation showed that the bulk-fill technique using SDR resin did not cause any negative impact when 4-mm thickness increment was used, whereas only one failure was observed with Filtek Supreme resin, but no statistical differences were found between the materials. Similar results regarding the marginal adaptation were found by Roggendorf et al.[39].

Concerning secondary caries, there was only one case of restoration failure with bulk-fill composite resin after 24 months. However, because this restoration failed not only in this parameter but also in the fracture/loss of retention, it is believed that secondary caries occurred due to dentin exposure, and this cannot be considered as a deviation or failure of the technique used. Studies have shown that bulk-fill resins may exhibit greater surface degradation over time, which could influence bacterial adhesion and increase the risk of caries development in proximal surfaces[40]. Additionally, recent findings highlight that inadequate polymerization or surface roughness can significantly impact biofilm formation, further contributing to secondary caries development[41].

The post-operative sensitivity, a cause of early loss of two conventional restorations in the present study, was more pronounced in the first re-evaluations as the Alpha score was 100% after 24 months and there was a significant reduction in this parameter in Filtek Supreme (p=0.00015) and SDR (p=0.00021) resins. Factors, such as stress generated during the polymerization contraction and poor polymerization of thick layers of the restoration, may be related to the sensitivity reported by the patients. Indeed, the two failures related to this parameter involved deep restorations. Previous studies reported that the sensitivity to cold, air and mastication commonly occur during the first week after restoration[42]. There are studies in the literature showing the necessity to remove restorations due to sensitivity in case of development of endodontic lesion[42]. The intensity of post-operative sensitivity was found to be similar between restorations using 2-mm thickness increments (conventional technique) and those using 4-mm thickness increments (bulk-fill technique). These results are similar to those reported by van Dijken and Pallesen[43] and Costa et al.[44].

About proximal contact, a more sensitive assessment method was chosen to detect smaller differences between the scores[26]. Because of the difference in the viscosity of the materials, it was thought that differences in this parameter might also occur after restoration in both short- and long-term due to possible wear of the restorative material. However, there were no statistical differences in the two techniques and resins assessed according to the assessment periods. This factor was related to the type of matrix used in the present study. It was demonstrated that the type of matrix might influence the quality of proximal contact in Class II restorations[45,46]. More adjusted

proximal contacts are obtained when a sectional system is used in comparison to the circumferential system[45].

Despite the different viscosities of the materials studied, the assessments between all experimental periods were found to be similar, which explain the results of the present study on the techniques in question. Besides, it was determined that the type of material used did not influence the establishment of the contact point, a finding also reported by Chuang et al.[46] and Torres et al.[34].

The quality of the dental restoration surfaces is considered a key factor for clinical success. A smooth surface increases the survival rate of restorations, thus improving the aesthetic appearance and reducing the accumulation of plaque[47]. In the present study, therefore, polishing techniques were performed in order to ensure durable restorations.

However, there was a statistical difference in the surface texture between the assessment periods, although not between the resins as the surface layer was of Filtek Supreme resin in both restorations. Therefore, these results show that the surface roughness of resins increases over time. Although all the restorations assessed had acceptable scores for this parameter, there was an increase in the Bravo score, which may be related to the patient's habits, diet, and oral hygiene. The literature shows that the action of toothbrushes and the use of abrasive dentifrices result in rougher surfaces, even when polishing and finishing procedures are optimally performed[48].

In the present study, the restorations placed by using incremental and bulk-fill techniques had a similarly clinical performance over the two-year assessment period. Both the Chi-square test and Kaplan-Meier survival curve showed that there was no statistical difference between the techniques assessed. Similarly to our results, the literature assessing the efficacy of bulk-fill composite resins in randomized clinical studies over two-year periods has also reported that such a technique has clinical performance comparable to that of the incremental technique[37,42,47].

However, more long-term assessments are necessary to ensure the behavior of these materials. Based on the two years of evaluation, it can be concluded that the bulk-fill technique using SDR resin has shown clinical results comparable to that of conventional technique with 2-mm thickness increments.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Data availability

Datasets related to this article will be available upon request to the corresponding author.

Author Contributions

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