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EFFECT OF DIFFERENT CURING TIMES AND INTENSITIES ON THE PERFORMANCE OF COMPOUND CLASS II BULK-FILL RESIN COMPOSITE RESTORATIONS: AN IN-VIVO STUDY

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ABSTRACT

Objective: To compare effect of high-intensity (2200 mW/cm^2) for 1 s with conventional intensity light-curing (1200 mW/cm^2) for 20 s on clinical performance of bulk-fill resin composite restorations in compound class II cavities over 12 months follow-up.

Material and methods: A total of 28 class II cavities were randomly restored with bulk-fill resin composite (n=14/group) and cured either with high-intensity (2200 mW/cm^2) for 1 s (Intervention) or conventional intensity (1200 mW/cm^2) for 20 s (Comparator). Modified USPHS criteria for marginal discoloration, marginal adaptation, secondary caries and postoperative sensitivity were used in the evaluation of restorations at baseline (1 week), 6 and 12 months.

Results: There was no statistically significant difference between the two curing protocols at different follow-up intervals as regards the evaluated criteria ($P > 0.05$). High light intensity (2200 mW/cm^2) for 1 s showed more risk (score B) when compared to conventional intensity (1200 mW/cm^2) for 20 s, regarding marginal discoloration (RR = 5, P = 0.2851), marginal adaptation (RR = 2, P = 0.3737) and secondary caries (RR = 3, P = 0.4900), except for postoperative sensitivity with no risk for scores B and C (RR = 1, P = 1.0000).

Conclusion: High-intensity light-curing (2200 mW/cm^2) for 1 s has comparable clinical performance to conventional intensity light-curing (1200 mW/cm^2) for 20 s for bulk-fill resin composite restorations in class II cavities.

KEYWORDS: Bulk-fill, conventional light-curing, high-intensity light-curing, I-LED, short exposure time light-curing.

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INTRODUCTION

Resin composite restorative materials have become increasingly desirable for posterior restorations, with acceptable success rates and longer-term clinical performance reported in the literature[1,2]. The incremental filling technique of resin composites is technically sensitive and time-consuming, particularly in large cavities in posterior teeth [3,4]. Bulk-fill resin composites were consequently launched as an alternative to incrementally placed composites, presenting several clinical benefits. Their use simplifies technical handling and reduces clinical time, in addition to decreasing the risk of contamination between the increments and air bubbles incorporation that results in voids formation [1,3,5]. The translucency of these materials is higher, allowing greater light penetration into deeper preparations, with improved depth of cure due to incorporation of more reactive photoinitiators [1]. Another essential feature of bulk-fill resins is that the added modulating monomers in their composition reduce polymerization shrinkage[6]. Bulk-fill composites can be applied in increments of up to 4-5 mm in thickness, having clinical performance similar to conventional composites in posterior tooth restorations, as evidenced by the recent systematic reviews [1,5,7,8].

The light curing units (LCUs) are valuable tools in clinicians' daily routines [9]. The evolution of light-curing protocols has been following the technological advancements in light-curing devices, including increasing the radiant exitance and narrowing the emission spectrum to a useful wavelength range [10,11]. "High-intensity" is a currently used term, denoting values over 2,000 mW/cm^2 [11,12,13]. The described evolution of terminology refers mainly to LED curing units, which possess dominance in dental practice and market in the last decade [11]. I-LED curing light (Woodpecker Co., Ltd, Guilin, Guangxi, China) has a light intensity of 1000–2500 mW/cm^2 with a wavelength of 420–480 nm. It is commonly thought that such high irradiance could be delivered for a shorter time interval and supposedly obtain a similar polymerization result [9].

This simplification of the restorative procedures, as highlighted by the evolution of high-intensity light-curing units [14], universal adhesives [15], and bulk-fill resin composites [1,8], has resulted in a more improvement in cost-effectiveness of restorative treatment as well as reducing the risk of iatrogenic errors [11,16].

Improperly polymerized resin composite can result in insufficient monomer-to-polymer conversion, a predisposing factor to clinical problems as marginal discrepancy, secondary caries, and fracture, while a properly cured composite will have good physical properties in terms of wear, toughness, and strength [13,17]. Secondary caries due to the undercuring of resin composite is among the most commonly cited causes of restoration failures [18]. Even though light-emitting diode-curing units with high power and short exposure times have cost-saving and short-term implications, the integrity, quality, and performance of the restoration remain the primary concern [13]. Further, the research on the clinical survival rates of resin-based materials by newly developed high-power LED-LCUs is still scant [12]. So, the present study aimed to compare effect of high-intensity (2200 mW/cm^2) for 1 s with conventional intensity light-curing (1200 mW/cm^2) for 20 s on clinical performance of bulk-fill resin composite restorations in compound class II cavities over 12 months follow-up. The null hypothesis tested is that neither of the tested light-curing protocols will have an effect on clinical performance of bulk-fill resin composite restorations.

MATERIAL AND METHODS

Ethical approval and trial registration

This study was approved by the Research Ethics Committee of the Faculty of Dentistry at Cairo University, approval number 2122. All procedures were explained to participants, and written informed consents were taken prior to their enrollment in this study. The research protocol was registered at clinicaltrials.gov (NCT05334901).

Study design and setting

The study was a randomized controlled clinical trial with a two-part parallel group design, a 1:1 allocation ratio, an equivalence framework, a triple-blind (participants, assessors, and statistician) design, and a 12-month follow-up. The clinical study was conducted in the clinic of the Conservative Dentistry Department, Faculty of Dentistry at Cairo University. The participants' class II cavities (n = 28) were randomly restored with bulk-fill resin composite and cured either with high-intensity (2200 mW/cm^2) for 1 s (Intervention) or conventional intensity light-curing (1200 mW/cm^2) for 20 s (Comparator), where n = 14 per group. The restorations were evaluated using modified USPHS criteria at different time intervals: baseline (1 week), 6 months and 12 months. This trial was carried out following the CONSORT statement [19], Fig. 1.

Sample size calculation

A power analysis was designed to have adequate power to apply statistical test of the research hypothesis to evaluate high-intensity light-curing (2200 mW/cm^2) for short exposure time compared to conventional light-curing (1200 mW/cm^2) for long exposure time of bulk-fill composite for restoration of proximal carious lesions regarding marginal discoloration after 12 months. Based on a study by Bayraktar et al. [20], wherein the probability of score A for marginal discoloration of proximal restorations performed using bulk-fill composite using conventional light-curing (1200mW/cm^2) for long exposure time was 0.9767, the probability of score B was 0.0233, with an effect size w = 0.9534 (n=9). If the estimated probability of score A for marginal discoloration of proximal restorations performed using high intensity light-curing

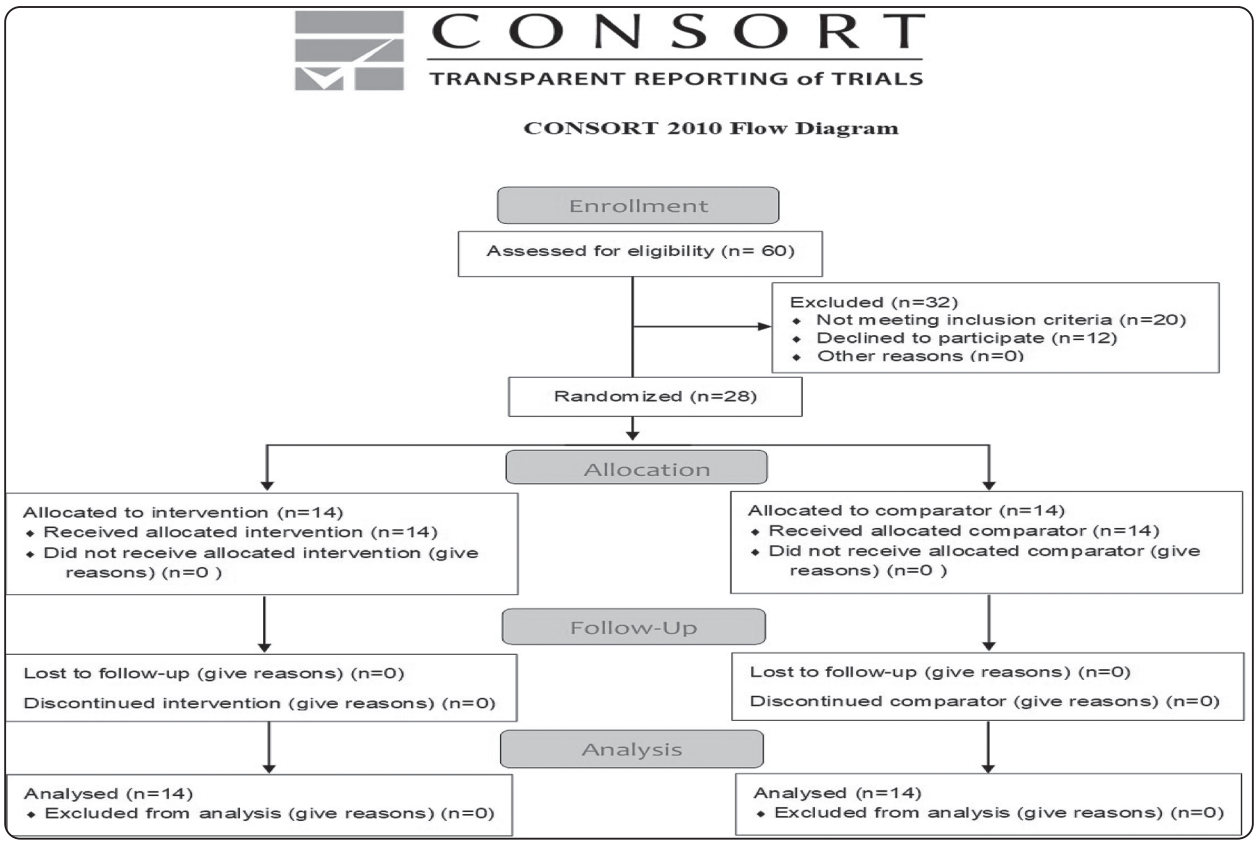

Fig. (1) CONSORT flow diagram

(2200mW/cm^2) for short exposure time was 0.9, the probability of score B was 0.1 with an effect size of w = 0.8 (n = 13). By adopting an alpha (α) level of 0.05, power = 80%, predicted sample size was total of 22. Considering a 20% possible drop-out rate during the follow-up intervals, the sample size was raised to a total of 28 cases (14 per group). The sample size was calculated using G*Power 3.1.9.2 using the Chi-square test.

Recruitment and eligibility criteria

The participants seeking treatment in the dental clinic were screened until the target population was reached. Healthy participants, aged 20–40 years old, with at least twenty teeth in normal functional occlusion with the natural opposing and adjacent teeth and moderate to deep primary lesions in molar or premolar teeth requiring class II restorations, were eligible to participate in the study. Other inclusion criteria were symptomless, vital, fully erupted, well-formed teeth with normal periodontal status. Patients with poor periodontal health or oral hygiene, parafunctional habits, or a medically compromised history were excluded from the study. Participants with allergies to test materials, lactating or pregnant women, and those incapable of attending the recall visits were also excluded from participation.

Randomization - sequence generation, allocation concealment mechanism- and Blinding

Simple randomization was performed by generating numbers from 1:28 into two separate columns using the random sequence generator (Randomness and Integrity Services Ltd.; https://www.random.org/) by a person not involved in the study. A random participant number was concealed using an opaque sealed envelope, which was opened just before intervention. The allocation sequence was obscured from the operator. This study was designed as a triple-blind trial, in which the participants, assessors, and statistician were blinded to intervention/ comparator assessment methods. Only the operator was not blinded to assigned groups since the differences between both light-curing intensities and time protocols could not be masked.

Clinical procedure

Following the prophylaxis session and anesthesia, the rubber dam (Nic Tone, Expertech Solutions, Bucharest, Romania) system was applied ensuring proper isolation during the operative procedure. Class II cavities were performed with a #330, 245 burs (MANI, INC, Japan) under water-cooling using high-speed handpiece. Sharp excavator (Maillefer, Dentsply; Switzerland) for soft caries excavation and low-speed round carbide burs in removing the remaining deep carious lesion were used. The outline form of the preparation was limited to caries removal and the depth of prepared cavities was checked using a periodontal probe. A sectional matrix system (Composi-Tight 3D Fusion, Garrison Dental Solution, USA) was used with wedging for optimum adaptation. Selective enamel etching (Cica Etching Gel, PROMEDICA Dental Material GmbH, Germany, Table 1) was performed for 15 s. The surfaces were rinsed with water spray for 15 s and dried by blowing gently with oil-free compressed air for 5 s, removing all excess moisture without desiccating the dentin structure until the chalky white appearance of the enamel margin was shown. A single coat of universal adhesive (Futurabond M+, VOCO GmbH, Cuxhaven, Germany, Table 1) was applied with a microbrush in a rubbing motion and agitation for 20 s. Air thinning was performed for 5 s until a glossy and uniform layer resulted. The adhesive was cured for 10 s using Woodpecker I-LED (Woodpecker Co., Ltd., Guilin, Guangxi, China), as recommended by the manufacturer. The x-tra fil bulk-fill resin composite (VOCO GmbH, Cuxhaven, Germany, Table 1) was applied as one increment into the prepared cavity and light-cured with Woodpecker I-LED according

TABLE (1) Materials used in this study

Materials	Description	Composition	Manufacturer (Lot no.)
Cica Etching gel	An etching agent for the acid-etch-technique.	Phosphoric acid (35%), H_2O, dyes stuff.	PROMEDICA Dental Material GmbH, Germany (2240491)
Futurabond M+	Universal adhesive	Bis-GMA, HEMA, ethanol, water, HEDMA, methacrylate phosphoric acid ester, methacrylate functionalized polyacid, UDMA, initiators and stabilisers.	VOCO GmbH, Cuxhaven, Germany (2031283)
x-tra fil	▪ Highly radiopaque, light-curing hybrid composite that was designed for cost-effective and time-saving use for posterior teeth. ▪ The combination of new multi-hybrid filler technology with an innovative initiator system forms the basis for a filler material exhibiting minimal polymerization shrinkage and excellent depth of cure. ▪ Can be cured in increments of 4 mm and with very short polymerization times.	86 % by weight inorganic filler (= 70.1 % by volume) in a methacrylate matrix. Barium aluminium borosilicate glass, BisGMA, UDMA, silicon dioxide, barium sulphate, TEGDMA, initiators, stabilisers, pigments.	VOCO GmbH, Cuxhaven, Germany (2149109)

to the assigned groups: intervention, high-intensity light-curing (2200 mW/cm^2) for 1 s, or comparator, conventional light-curing (1200 mW/cm^2) for 20 s. A light meter (DTE, Woodpecker, LM-1 Light Meter, China) was used to monitor the light output of the curing unit. The occlusal adjustment was performed after the removal of the rubber dam and checked using carbon articulating paper to establish appropriate occlusal morphology and contacts. The finishing procedure was performed using a finishing diamond stone (MANI, INC., Japan) under copious water coolant, then at low speed under water coolant within a decreasing sequence of abrasiveness (Sof-Lex, 3 M, ESPE, St. Paul, MN, USA). Sof-Lex Diamond Spirals (3 M, St. Paul, MN, USA) were used under water for a smooth and glossy surface. Polishing was performed using paste and a rubber polishing kit (Microdont, Sao Paulo, Brazil). Finally, diamond-impregnated brushes for high-shine polishing (Eve Diabrush, Ivoclar Vivadent, Zurich, Switzerland) were used, which require no messy pastes to create a high-gloss polish on textured surfaces. The interproximal contacts of the restorations were checked using dental flossing. All operative procedures were performed by the same experienced operator. Demonstrative photos are shown in Fig. 2

Clinical evaluation

Modified USPHS criteria [20,21] (Table 2) were used in evaluating dental restoration by two experienced assessors at baseline (1 week), 6 and 12 months for marginal discoloration, marginal adaptation, secondary caries and postoperative sensitivity. In cases of inconsistencies between scores, the restorations were re-evaluated by the two assessors, reaching a final consensus. The assessors were blinded to assigned groups.

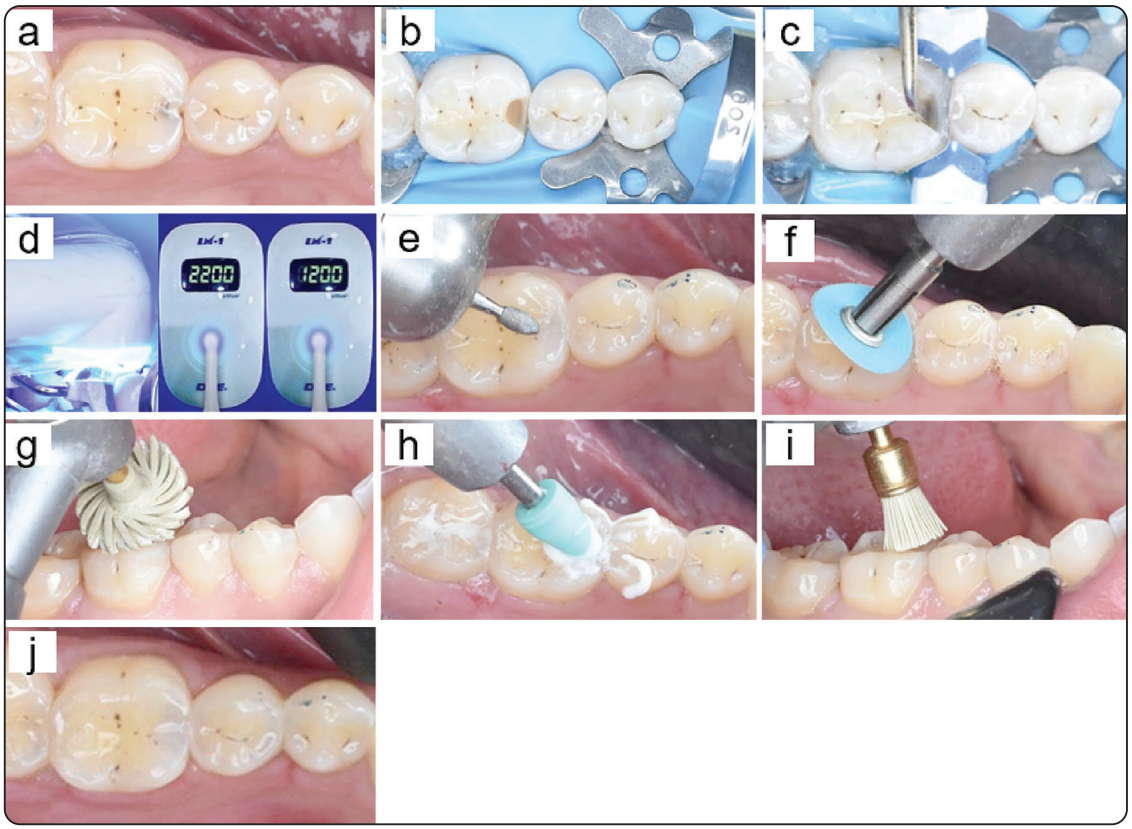

Fig. (2) Illustrating some of the clinical steps: (a) Preoperative class II caries (mesial) in lower right posterior tooth (46); (b) rubber dam isolation and prepared compound class II cavity; (c) x-tra fil bulk-fill resin composite application after matricing, selective enamel etching and bonding; (d) light-curing using Woodpecker I-LED, monitoring intensities of 2200 mW/cm^2 and 1200 mW/cm^2 using DTE, Woodpecker, LM-1 Light Meter; (e, f, g, h and i) finishing and polishing (noting one of the sequences according to manufacturer instructions per kit); (j) postoperative restoration.

TABLE (2) Clinical evaluation using modified USPHS criteria

	Marginal discoloration	Marginal adaptation	Secondary caries	Postoperative sensitivity
Alpha (A)	Absence of marginal discoloration	Closely adapted, no visible crevice	Absent	Absence of the dentinal hypersensitivity
Bravo (B)	Presence of marginal discoloration, limited and not extended	Visible crevice, explorer will penetrate	Present	Presence of mild and transient hypersensitivity
Charlie (C)	Evident marginal discoloration, penetrated toward the pulp chamber	Crevice in which dentin is exposed	-	Presence of strong and intolerable hypersensitivity

Statistical analysis

Data were analyzed using MedCalc software, version 19 for Windows (MedCalc Software Ltd., Ostend, Belgium). Categorical data were described as frequency and percentage; the Chi-square test was used for comparisons between categorical variables, whereas intragroup comparisons within each intervention were performed using Cochran's Q test followed by pairwise multiple comparisons. Relative risk was used to assess the clinical difference. All tests were two-tailed. A P value≤0.05 was considered statistically significant.

RESULTS

Twenty-eight participants requiring class II restorations were recruited; all participants attended baseline, 6-, and 12-month evaluations (100% retention rate), Fig. 1. Twenty-six participants were female, and two were male. The participants' average age was 30.6 ±6.4 years old; the demographic data are shown in Table 3.

Inter- and intragroup comparisons for the study outcomes between high light intensity (2200 mW/cm^2) for 1 s and conventional intensity (1200 mW/cm^2) for 20 s groups are presented in Table 4 and Fig. 3. Regarding the evaluated criteria —marginal discoloration, marginal adaptation, secondary caries, postoperative hypersensitivity —the intergroup comparisons between both light-curing protocols

TABLE (3) Patients' demographic data

Data		Intervention (2200 mW/cm^2 for 1 s)	Comparator (1200 mW/cm^2 for 20s)	P value
Age (years)	Mean (± SD)	31.1 ±6.75	30.07 ±6.43	0.671
Gender n (%)	Female	13 (92.9%)	13 (92.9%)	1.0000
	Male	1 (7.1%)	1 (7.1%)	
Teeth distribution n (%)	Maxillary premolar	5 (35.7%)	2 (14.3%)	0.5754
	Maxillary molar	2 (14.3%)	3 (21.4%)	
	Mandibular premolar	4 (28.6%)	4 (28.6%)	
	Mandibular molar	3 (21.4%)	5 (35.7%)	

TABLE (4) Clinical evaluation of restorations in comparisons between two curing protocols at baseline (1 week), 6 and 12 months

Outcome	Follow-up	Intervention (2200 mW/cm^2 for 1 s)			Comparator (1200 mW/cm^2 for 20s)			P value
		A	B	C	A	B	C	
Marginal discoloration	Baseline	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	1.0000
	6 months	12 (85.7%)	2 (14.3%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	0.1495
	12 months	12 (85.7%)	2 (14.3%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	0.1495
	P value		0.3311			1.0000		
Marginal adaptation	Baseline	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	1.0000
	6 months	10 (71.4%)	4 (28.6%)	0 (0%)	12 (85.7%)	2 (14.3%)	0 (0%)	0.3657
	12 months	10 (71.4%)	4 (28.6%)	0 (0%)	12 (85.7%)	2 (14.3%)	0 (0%)	0.3657
	P value		0.0845			0.3311		
Secondary caries	Baseline	14 (100%)	0 (0%)		14 (100%)	0 (0%)		1.0000
	6 months	14 (100%)	0 (0%)		14 (100%)	0 (0%)		1.0000
	12 months	13 (92.9%)	1 (7.1%)		14 (100%)	0 (0%)		1.0000
	P value		0.3590			1.0000		
Postoperative sensitivity	Baseline	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	1.0000
	6 months	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	1.0000
	12 months	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)	1.0000
	P value		1.0000			1.0000		

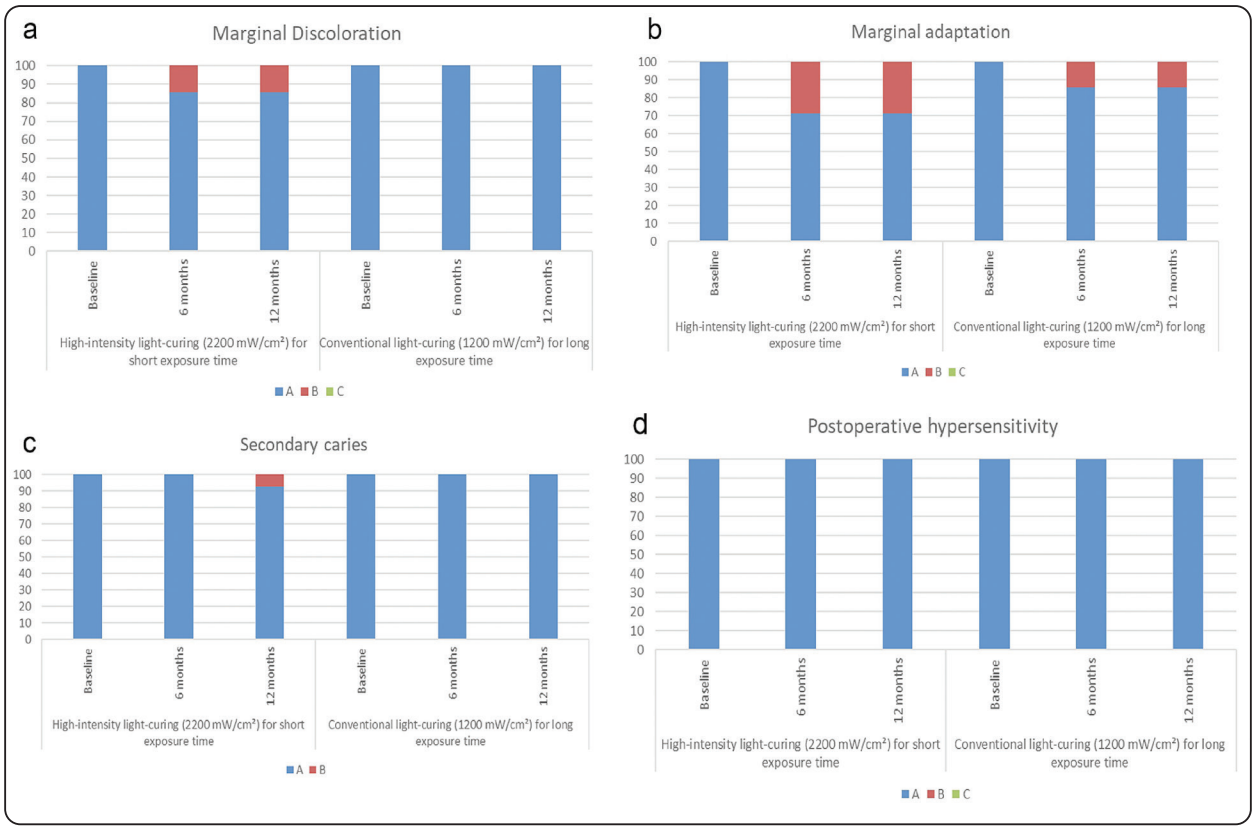

Fig. (3) Bar charts showing percentage scores within each light-curing protocol at different follow-up periods regarding: a) marginal discoloration, b) marginal adaptation, c) secondary caries, and d) postoperative hypersensitivity

groups have shown no statistically significant difference within the different follow-up periods: at baseline (1 week), 6 months and 12 months ($P > 0.05$). There was no statistically significant difference between the different follow-up periods ($P > 0.05$) for the intragroup comparisons within each group, as regards each evaluated parameter separately. After 12 months, high light intensity (2200 mW/cm^2) for 1 s showed more risk (score B) when compared to conventional intensity (1200 mW/cm^2) for 20 s as regards marginal discoloration (5 times, RR = 5.0000 (95% 0.2615 to 95.6128; P = 0.2851)), marginal adaptation (2 times, RR = 2.0000 (95% 0.4343 to 9.2107; P = 0.3737), secondary caries (3 times, RR = 3.0000 (95% 0.1325 to 67.9136; P = 0.4900)), except for postoperative sensitivity (no risk for scores B and C, RR = 1.0000 (95% 0.02119 to 47.1867; P = 1.0000)).

DISCUSSION

The simplification of operative procedures is desirable in daily clinical practice. In this context, light-curing protocols evolve with technological advancements, as do bulk-fill resin composites, which are attractive alternatives for posterior restorations [5,11]. Furthermore, curing resin composite restoration is a vital step for a successful, long-lasting restoration [17,18]. In the current study, the effects of the high-intensity (2200 mW/cm^2) for 1 s and the conventional intensity light-curing (1200 mW/cm^2) for 20 s on clinical performance of bulk-fill resin composite restorations in compound class II cavities were compared. The results revealed no significant difference between the tested groups at baseline, after 6 and 12 months, regarding marginal discoloration, marginal adaptation, secondary caries, and postoperative sensitivity; hence, the null

hypothesis was accepted. Similarly, to our findings Fahim et al. [22].

Marginal adaptation has a greater effect on restoration prognosis. Improvements in the placement technique of resin composites, composite formulation, and curing can minimize shrinkage stresses [23]. Moreover, the presence of secondary caries may be associated with marginal defects in a restoration [24] or high-caries-risk patients [18].

The current study found that bulk-fill composite restorations showed clinically satisfactory marginal adaptation scores, with no significant difference between two groups of curing protocols at different follow-up periods. These findings were in agreement with Fahim et al. [22], who reported no significant differences between light-curing in either high-intensity or low-intensity. However, they observed a significant increase in the percentage of discontinuities at the tooth-restoration interface in the in vitro assessment. A perfect seal between the tooth and restoration prevents microleakage and its clinical consequences, including marginal discoloration, recurrent caries, and pain [25]. A previous in-vitro study by Par et al. [26] found that a rapid high-intensity curing protocol (3 s for 3440 mW/cm^2) has led to similar marginal integrity as a conventional curing protocol (10 s for 1340 mW/cm^2). The marginal integrity was considerably more affected by the composite type than the variations in curing conditions, as clarified by their findings.

The current study findings could be attributed to the Futurabond M$^+$ used in the study, which contains ethanol as a co-solvent and, with its high solubility and osmotic pressure, aids in the exit of residual water and transports the monomers into the dentinal tubules. Thus, it can lead to a higher adaptation of the adhesive to the dentin, decreasing marginal microleakage [27]. In addition to finishing and polishing affect the marginal integrity of resin-composite, to maintain the seal of the restoration and prevent the microcracks. Moreover, finishing techniques and their timings affect the ability of resin-composite to resist leakage [28,29].

The present study demonstrated that high-intensity light-curing for short exposure time was two times more risk for marginal adaptation (score B) when compared to conventional intensity for long exposure time. This could be attributed to the fast high-irradiance light cure, which can create high stresses within the composite and at the tooth-restoration interface, which affect bond strength [30]. This might lead to slow hydrolysis, causing degradation of the resin composite/bond interface [31].

Marginal discoloration is a common early clinical sign of resin composite restoration failure, resulting from defects between the restoration and the tooth surface. It could be caused by unsatisfactory bonding, and/or subsequent stress, insufficient restoration placement or finishing procedures [32].

The present study found no marginal discoloration in the high-intensity light-curing (1 s) group at baseline, but only two restorations with clinically acceptable scores (score B) were observed at 6 and 12 months. No marginal discoloration was noted in conventional intensity for 20 s at 12-month evaluation. There was no significant difference between the two curing protocols for restorations at different follow-up periods. These results were in accordance with Fahim et al. [22], who reported that the majority of the scores allocated for the marginal discoloration criteria were 0. Their study found that color changes at restoration margins after 6 and 12 months were not associated with secondary caries or loss of marginal adaptation.

Yazici et al. [25,33] reported that no marginal discoloration was observed in restorations cured with an irradiance of 1400 for 20 s until the 12-month evaluation, which coincided with our results. On the other hand, after 12 months, three restorations of x-tra fil that were cured for 10 s at 1200 mW/cm^2 light intensity showed marginal discoloration (scoring B) according to Karaarslan et al. [34].

The reason for better marginal adaptation might be attributed to lower polymerization stress, which may be affected by the composition and filler content of bulk-fill. Further, marginal discoloration and adaptation might be affected by the adhesive type as aforementioned. The findings of the present study can be also attributed to the high depth of polymerization of the x-tra fil, which was applied at 4 mm [35]. x-tra fil contains a resin mixture of (Bis-GMA) with high cross linking with lower shrinkage. In addition, (UDMA) tends to lend color stability, hydrophobicity, high viscosity and tensile strength [36]. Moreover, proper finishing and polishing give an improved appearance and prevent plaque retention, secondary caries, and marginal discoloration.

Secondary caries may be associated with a defective restoration that allows acidic fluids or biofilm to enter the interface [18]. The current study revealed that all secondary caries criteria scores were A, which could be attributed to good sealing, good marginal adaptation, and adequate oral hygiene in the patient. There was only one case in the intervention group (high-intensity light-curing with short exposure time) that showed secondary caries (score B); this was due to some medical issues within the follow-up periods. While, Fahim et al. [22] found that all restorations (100.0%) showed a score of 0 (caries absent) at different evaluation periods for both groups. Three x-tra fil composite restorations (10 s, 1200 mW/cm^2 light-curing) revealed secondary caries in a 12-month follow-up study by Karaarslan et al. [34], contrary to our findings. They explained that the restoration placement may have been contaminated by saliva or associated with marginal adaptation discrepancy.

Postoperative hypersensitivity is a common patient complaint following resin composite restorations as a result of shrinkage stress [37]. In the current study, both groups showed excellent performance regarding the postoperative hypersensitivity (score A), which is closely related to the good marginal adaptation of the restorations. Furthermore, this could be attributed to the importance of rubber dam isolation for high-quality class II resin composite restorations [38]. Moreover, selective etching by using universal adhesive material reduces the potential for postoperative sensitivity due to the incomplete impregnation of the resinous monomers in the demineralized dentin [39]. The low-intensity light-curing will only cure the top surface of the composite, leading to incomplete polymerization, which may be a cause of postoperative pain [40]. Nevertheless, two intensities were used in the current study (1200 mW/cm^2 and 2200 mW/cm^2), which were not considered low intensity. The results of this study were similar to those of Fahim et al. [22], who found all restorations in both groups showed a score of 0 after 6 and 12 months. They explained that the lack of long-term sensitivity may be attributed to the use of resin-modified glass ionomer liner in cases with deep and very deep cavities. Nevertheless, they found three restorations in the intervention group (high-intensity) and four in the comparator group (low-intensity), showing score 1 (sensitive but diminishing in intensity) at baseline. Bulk-fill without the need for capping was used in the present study. On the other hand, Karaarslan et al. [34] found postoperative sensitivity (score B) in four teeth restored with x-tra fil bulk-fill and cured with 1200 mW/cm^2 for 10 s. They clarified that this was due to the absence of calcium hydroxide liner in deep cavities. Further, the lack of sensitivity could be the result of decreasing the possibility of electric or thermal stimuli, minimizing hydrodynamic fluid movements. Costa et al. [41] reported a 20.3% risk of postoperative sensitivity within 48 hours of a restorative procedure with a light intensity of 1200 mW/cm^2 for 20 s.

A review by Miranda et al. [42] emphasized that new bulk-fill resin composites can be light-cured with a short exposure time and high intensity, providing a time-saving benefit in clinical practice, in addition

to showing similar results to standard light-curing in conventional composites. The longevity of the restorations is related to the clinical condition of the patient's oral cavity [43,44,45]. However, variation in the results between studies is due to differences in cavity size, type of light cure, bonding strategy, restorative materials, and techniques followed and even evaluation methods. In the current study, one type of bulk-fill restoration was selected and tested, which may be considered a limitation, but this was done for better standardization. The research on the clinical survival rates of the resin-based materials by newly developed high-power LED-LCUs is still insufficient. Long-term clinical trials using various bulk-fill resin composites and other types of cavities could be of value.

CONCLUSION

Under the limitation of the following trial, it can be concluded that high-intensity light-curing (2200 mW/cm^2) for 1 s has comparable clinical performance to conventional intensity light-curing (1200 mW/cm^2) for 20 s for bulk-fill resin composite restorations in class II cavities.

RECOMMENDATION

High-intensity light-curing and short exposure times should be studied with prolonged follow-up evaluation periods, also with different types of bulk-fill resin composites.

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