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Original Article

Evaluation of Cervical Restorations Performance Using Modified Universal Adhesive Compared to Conventional Universal Adhesive: A Randomized Clinical Trial

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Abstract

Objectives: The aim of the present study was to evaluate the early clinical performance of a radio-opaque universal adhesive, versus a conventional universal adhesive over 6 months in carious cervical lesions.

Materials and methods: Thirty participants with carious cervical lesions were randomly divided into two groups (n=15): Group (1) received Scotchbond™ Universal Plus Adhesive, while Group (2) received Single Bond™ Universal Adhesive. Both materials were applied in etch-and rinse mode and following the manufacturers' instructions. Restorations were assessed at baseline and after 6 months using the modified USPHS criteria.

Results: After 6 months, all restorations in Group (1) scored alpha, while in group (2), one restoration scored Charlie after 6 months for postoperative hypersensitivity. There was no statistically significant difference between both materials ($P > 0.05$).

Conclusions: Both adhesives showed comparable clinical performance in cervical restorations after 6-months.

Clinical Relevance*:* Scotchbond Universal Plus Adhesive can provide clinically successful performance, comparable to Single bond Universal Adhesive, when used in cervical restorations.

Keywords: Cervical; class V restorations; clinical performance; Universal adhesive and USPHS criteria.

Introduction

Over the past decades, carious cervical lesions, a common finding in middle-aged patients, have been restored using a variety of materials, including glass-ionomer cements (GI), resin-modified glass-ionomer cements (RMGI) and composites. Resin composites have been widely used for restoring class V lesions due to their aesthetic qualities and capability to adhere to enamel and dentin ***Algailani et al. (2022)***. Despite advancements in restorative materials throughout the previous years, the restoration of cervical lesions seems to be rather challenging. Numerous factors, including the type of resin composite, the adhesive strategy, the type of tooth and the practitioner's skills, can influence the clinical success of class V composite restorations ***Namgung et al. (2013)***. Cervical cavities have a non-retentive outline with margins ending on cementum or dentin substrates that are not ideal for bonding, in addition to their proximity to the gingival margin ***Kim et al. (2017)***.

One of the main obstacles in cervical lesions is the difficulty of sealing the cavity completely, leading to microleakage. Microleakage can result in marginal discoloration, secondary caries and pulpal inflammation or necrosis ***Algailani & Alqaysi (2019)***. The marginal failure of resin-based

composites has been demonstrated to be greatly related to the quality of adhesion to the tooth tissues ***Karaman & Güler (2016)***. The adhesive system plays a critical role in the success of resin-based composite restorations. Therefore, various adhesive systems have been introduced to overcome this issue ***Fathpour et al. (2021)***.

The development of universal adhesives, the latest generation of adhesive systems, led to the simplification of bonding procedures. The term "universal adhesive" refers to a versatile, multi-purpose adhesive system that may be employed in all strategies; either self-etch, selective-etch, or etch-and-rinse bonding strategies ***Perdigão & Swift (2015)***. Minimizing chair time and decreasing technique sensitivity while maintaining satisfactory bonding durability became possible ***Tsujimoto et al. (2017)***. Moreover, the existence of functional monomers, such as 10-methacryloyloxy-decyl-dihydrogen-phosphate (10-MDP), facilitates bonding to a variety of adherends, including resin composites, glass ceramics, zirconia and metal alloys ***Josic et al. (2022)***.

The clinical effectiveness of adhesive bonding agents is assessed by the clinical performance and bond durability within the restorations placed in class V cavities ***Carvalho et al. (2012)***. To standardize the quality assessment of restorative materials and techniques in clinical trials, different criteria have been proposed. One of the most widely used standards for evaluating adhesive restorations are those provided by the US Public Health Service (USPHS), sometimes referred to as the "Ryge criteria" ***Cavalheiro et al. (2020)***. A lot of clinical trials have used the modified USPHS criteria and showed their validity and reliability ***Namgung et al. (2013)***.

Many attempts to determine the effectiveness and longevity of various materials have dominated most current research to enable practitioners to choose the most appropriate material for clinical use. However, the current evidence cannot support a single restorative material to routinely restore cervical lesions until this day ***Bhatavadekar et al. (2022)***. Hence, efforts are exerted to enhance the physical and adhesive properties of resin-based bonding agents, and the dental market is growing in response to the rising demand for advances in adhesion ***Cadenaro et al. (2023)***.

One of the recent innovations is a modified radio-opaque universal adhesive, Scotchbond Universal Plus Adhesive ***Alam et al. (2024)***. Similar to any newly introduced material, evidence-based information about this product is still limited. Therefore, clinical trials are necessary to reach consistent conclusions about the bonding performance of this adhesive in the oral cavity.

The objective of the current clinical trial was to evaluate the clinical performance of a universal adhesive containing a novel crosslinking radiopaque resin, versus a conventional universal adhesive, for restoring carious class V cavities over 6-months. The null hypothesis tested was that there will be no difference in the clinical performance of the radio-opaque universal adhesive and the conventional universal adhesive in cervical restorations.

Materials and Methods

A. Materials

The materials' names, descriptions, compositions, lot numbers and manufacturer were presented in **Table (1)**.

Table (1): Materials' description, composition, lot number and manufacturer:

Material	Description	Composition	Lot number	Manufacturer
Scotchbond Universal Etchant	Etching gel	35% phosphoric acid	8019534	3M Deutschland GmbH, Neuss, Germany.
Scotchbond Universal Plus Adhesive	One-step universal adhesive	10-MDP phosphate monomer, Vitrebond copolymer, HEMA, brominated dimethacrylate resin, dual-cure accelerator, camphorquinone, optimized silane, ethanol, and water.	7910510	3M Deutschland GmbH, Neuss, Germany
Single Bond Universal Adhesive	One-step universal adhesive	10-MDP phosphate monomer, Vitrebond, copolymer, HEMA, Bis-GMA, dimethacrylate resin, camphorquinone, silane, ethanol, a	20524A	3M Deutschland GmbH, Neuss, Germany
Filtek Z350 XT	Nano-filled resin composite	Bis-GMA, UDMA, TEGDMA, Bis-EMA, non-agglomerated/ non-aggregated 20 nm silica filler, non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, and aggregated zirconia/ silica cluster filler.	NF26118	3M ESPE, St. Paul, MN, USA

MDP: Methacryloxydecyl dihydrogen phosphate, HEMA: Hydroxyethyl methacrylate, Bis-GMA: bisphenol A glycidyl methacrylate, UDMA: Urethane dimethacrylate, TEGDMA: Tri-ethylene glycol dimethacrylate, Bis-EMA: Bisphenol A ethoxylated diglycidyl methacrylate.

B. Methods

Trial registration and study Setting

The protocol of the present study was submitted to clinical trials registry (NCT05509127). Ethical permission was granted through the Research Ethics Committee, Faculty of Dentistry, Cairo University (181122). The present study was accomplished in the department of Conservative Dentistry.

Trial design:

The current study type was a randomized controlled clinical trial (RCT), the design was parallel with two arms, 1:1 allocation ratio and the framework work of the present study was superiority framework.

Recruitment:

Convenient consecutive sampling was used to recruit the participants from the diagnostic center according to the eligibility criteria. **Table (2 & 3)** Before enrollment all candidates received information about procedures of the study. After that, an informed consent was obtained through signing an Arabic version of the informed consent.

Sample size calculation:

According to the results of ***Koc Vural et al. (2021),*** the success rate of resin composite cervical restorations using universal adhesive was 100% after 6 months. By adopting α level of 5%, power of 80%, sample size was a total of 24 in order to detect a difference of 40%. Sample size was increased by 25% to compensate for dropouts to be 30 cases i.e. 15 for each group. Sample size calculation was performed using G*Power 3.1.9.2.

Eligibility Criteria

Table (2): Eligibility criteria of participants

Inclusion Criteria	Exclusion Criteria
• Carious cervical lesions in upper premolar teeth. • Age 20–40 years. • Mild to moderate plaque accumulation.	• Class V lesions in anterior teeth, molars and lower teeth. • Systemic conditions. • Allergy to resin. • Absence of compliance. • Possible pregnancy. • Poor oral hygiene. • Heavy smoking. • Xerostomia. • Parafunctional habits or bruxism • Temporomandibular joint problems.

Table (3): Eligibility criteria of teeth

Inclusion Criteria	Exclusion Criteria
• Small to moderate c carious cervical lesion with (ICDAS scores 3,4). • Vital maxillary premolars. • Favourable occlusion and normal occlusal contact.	• Deep caries (close to pulp, less than 1 mm distance). • Irreversible pulpitis or pulp necrosis. • Dentin hypersensitivity. • Possible future prosthetic restoration of teeth. • Severe periodontal condition.

Allocation of participants:

Sequence generation and allocation concealment:

Random allocation sequence was generated using the simple randomization method. Numbers from 1:30 were generated Random Sequence Generator, Randomness and Integrity Services Ltd (https://www.random.org/) into two columns; either intervention or comparator group. The allocation was concealed from the operator, who chose between numbers from a sealed opaque envelope. The participants and assessors were blinded to the materials used. Consort flow diagram showing the participant's flow through every step of the current trial is presented in **Figure (1)**.

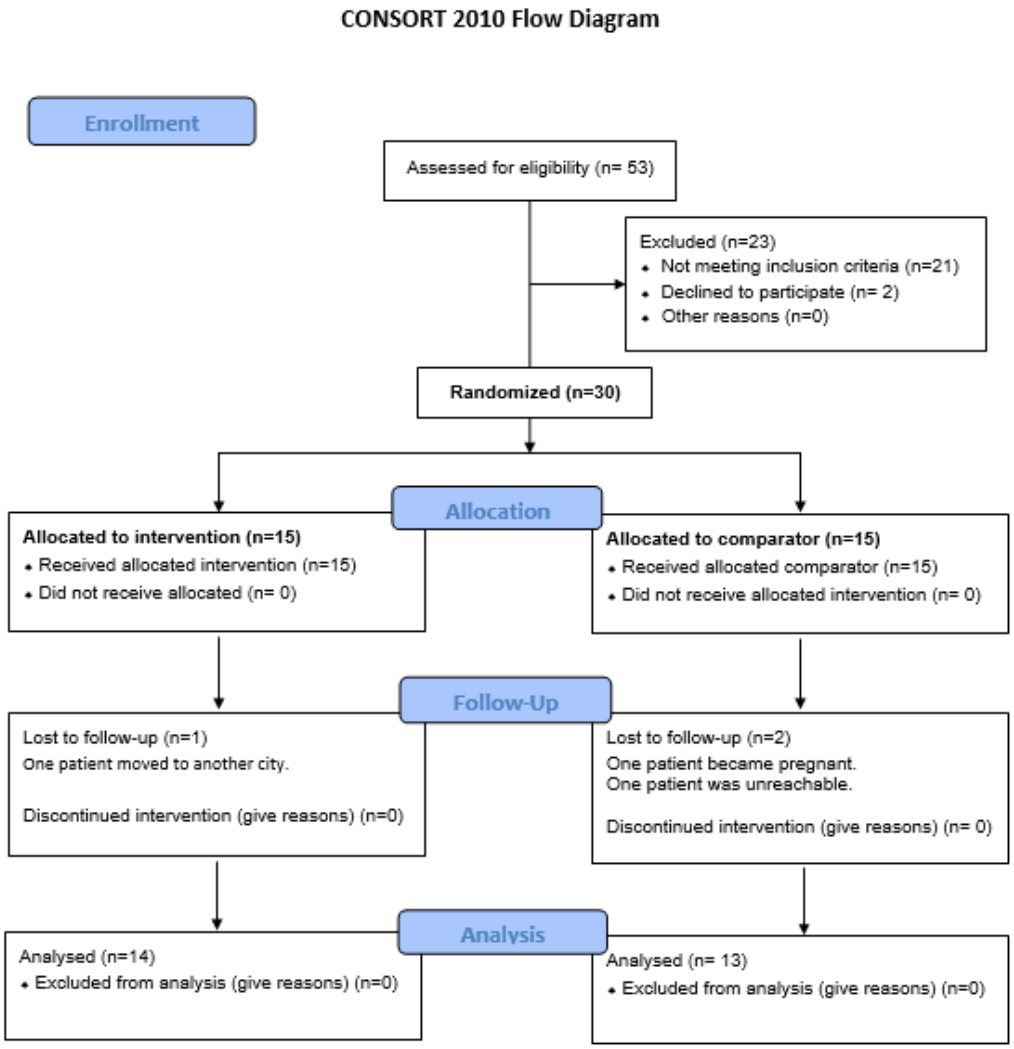

Figure (1): CONSORT flow diagram

Clinical restorative procedures:

Cavity preparation:

Selected teeth were anesthetised, shade was selected, then tooth was isolated using rubber dam following quadrant isolation technique and a subgingival clamp was used for gingival retraction. A No. #330 or #245 bur (0.8 mm in diameter and 1.6 mm in length) in a high-speed contra-angled hand piece with oil free air/water coolant was used to prepare class V cavities with mesio-distal width not exceeding to proximal surface and occluso-gingival length not exceeding to occlusal one third. A yellow coded tapered finishing stone (TR-12) was used for bevelling the occlusal cavity margins. The enamel margins of the prepared cavities were etched for 15 seconds and dentin was etched for 10 seconds using 3M™ Scotchbond Universal Etchant Gel. The surfaces were rinsed for 15 seconds and dried with oil free compressed air for another 15 seconds.

Intervention:

Scotchbond Universal Plus Adhesive was applied according to manufacturer's instructions using a micro-brush. It was agitated for 20 seconds using properly sized micro-brush, then gently air-thinned for 5 seconds, followed by light curing using LED light curing unit (I-LED, Woodpecker, Guangxi, China) for 20 seconds.

Comparator:

Single Bond Universal Adhesive was applied using a properly sized micro-brush, followed by active rubbing for 20 seconds, then gentle air thinning for 5 seconds, finally it was light cured for 20 seconds using LED light curing unit.

Cavity Restoration and Finishing:

Nano-filled resin composite 3M™ Filtek Z350 XT was used with both adhesives to ensure standardization of the restoration. Resin composite was applied in increments of 2 mm, then light cured using LED light curing unit for 40 seconds for each increment. Excess composite was removed using a fine diamond bur. Finishing and polishing was done using TOR VM discs, attached to a low-speed hand piece with air/water coolant, in the following sequence: Coarse (70-90µm), medium (40µm), fine (24µm), and super-fine (8µm) aluminum oxide discs.

Outcome Assessment:

Modified USPHS criteria was used by the two trained, calibrated and blinded assessors to assess each restoration at baseline and after 6 months according to the outcome chart supplied. When both assessors differed in score, they discussed to reach for a consensus. **Table (4)**

Table (4): Modified USPHS criteria, score, characteristics, measuring unit and method of diagnosis for assessment of dental restorations Bayne & Schmalz (2005)

Outcome	Score	Characteristics
Retention	A	No loss of restorative material.
	C	Missing restoration.
Post-operative sensitivity	A	No post-operative sensitivity
	C	Presence of post-operative sensitivity
Secondary caries	A	No caries present
	C	Caries present
Marginal Adaptation	A	Closely adapted, no detectable margin.
	B	Detectable marginal discrepancy clinically acceptable.
	C	Marginal crevice, clinically un-acceptable.
Marginal Discoloration	A	No discoloration between tooth structure and restoration.
	B	Non penetrating marginal discoloration which can be polished away.
	C	Discoloration has penetrated margin in pulpal direction.

Statistical Analysis:

Data were analyzed using Medcalc software, version 22 for windows (MedCalc Software Ltd, Ostend, Belgium). Categorical data was described as frequency and percentage, intragroup comparisons between interventions was performed using the Chi-Squared test with statistical significance level set at ($P \leq 0.05$) and intragroup comparison within each intervention was performed using Cochran's Q test with statistical significance level set at ($P \leq 0.05$). Relative risk was used to assess the clinical significance.

Results

Demographic data

This present study was conducted on 30 patients with 30 cervical carious lesions. After 6 months 29 restorations were assessed with 96.6% retention rate. Mean age of the participants in the current trial was 28.5±5.7 years; mean age within Scotchbond Universal Plus group was 29.3±6.3 years, while within Single Bond Universal group mean age was 27.8±5.1 years, there was no statistically significant difference between both groups regarding age ($P = 0.511$). Additionally, there was no statistically significant difference between both groups regarding gender ($P = 0.6713$).

Clinical evaluation:

Comparison between adhesives revealed no statistically significant difference within different follow-up periods regarding all tested outcomes (P > 0.05). Intragroup comparison within both adhesives has shown no statistically significant change in scores between different follow-up periods regarding all tested outcomes (P > 0.05). **Tables (5)**

Table (5): Frequency and percentage for modified USPHS criteria outcomes for the intergroup comparison between materials within each follow-up and intragroup comparison within each material between different follow-up periods:

	Follow-up	Scotchbond Universal Plus			Single Bond Universal			P value
		A	B	C	A	B	C	
Marginal adaptation	Baseline	15(100%)	0(0%)	0(0%)	15(100%)	0(0%)	0(0%)	P = 1.0000
	6 months	15(100%)	0(0%)	0(0%)	14(100%)	0(0%)	0(0%)	P = 0.8527
	P value	P = 1.0000			P = 0.317			
Marginal discoloration	Baseline	15(100%)	0(0%)	0(0%)	15(100%)	0(0%)	0(0%)	P = 1.0000
	6 months	15(100%)	0(0%)	0(0%)	14(100%)	0(0%)	0(0%)	P = 0.8527
	P value	P = 1.0000			P = 0.317			
Retention	Baseline	15(100%)		0(0%)	15(100%)		0(0%)	P = 1.0000
	6 months	15(100%)		0(0%)	14(100%)		0(0%)	P = 0.8527
	P value	P = 1.0000			P = 0.317			
Postoperative hypersensitivity	Baseline	14(93.3%)		1(6.7%)	13(86.7%)		2 (13.3%)	P = 0.5496
	6 months	15(100%)		0(0%)	13(92.9%)		1(7.1%)	P = 0.3006
	P value	P = 0.317			P = 1.0000			
Secondary caries	Baseline	15(100%)		0(0%)	15(100%)		0(0%)	P = 1.0000
	6 months	15(100%)		0(0%)	14(100%)		0(0%)	P = 0.8527
	P value	P = 1.0000			P = 0.317			

Discussion

The null hypothesis that there is no difference in the clinical performance of the modified universal adhesive (Scotchbond Universal Adhesive Plus) and the comparator (Single Bond Universal adhesive) cannot be rejected. The two adhesives performed similarly with regard to marginal adaptation, marginal discoloration, retention, postoperative sensitivity, and secondary caries. This may be attributed to the similarity of functional monomers and application protocol used ***Van Meerbeek et al. (2020)***. Both adhesives contain 10-MDP monomer, polyalkenoic acid copolymer (Vitrebond), HEMA hydrophilic monomer, non-settling silica filler, ethanol / water solvent and photoinitiators

based on camphorquinone. Their pH is 2.7 and therefore are classified as mild adhesives ***Alam et al. (2024)***.

The MDP monomer improves adhesion to tooth structure by chemical adhesion to hydroxyapatite in a process known as nano-layering. In addition, the Vitrebond copolymer is responsible for the ionic interaction between the carboxyl groups in the polyalkenoic acid and hydroxyapatite in enamel and dentin. It has been stated that this chemical reaction is essential to their bonding mechanism. The presence of HEMA monomer renders the adhesive hydrophilic improving its wettability when applied to the tooth surface ***Ruschel et al. (2018)***.

Previous in vitro studies suggested that the pH of universal adhesives affected their ability to bond to dentin strongly. It is possible to improve the effectiveness of mild universal adhesive bonding by employing a selective enamel-etch approach. Using mild universal adhesives in both self-etch and etch-and-rinse techniques seems to provide better stability in dentin ***Cuevas-Suarez et al. (2019)***.

Current evidence supports that universal adhesives should be preceded by etch-and-rinse protocol in cervical lesions, which was proven by a previous systematic review to achieve the best clinical outcomes. The etch-and-rinse mode for universal adhesives can provide enhanced clinical outcomes such as retention, marginal adaptation, and marginal discoloration compared with self-etch mode ***Hong et al. (2021)***. According to ***Rodriguez et al. (2021)***, there was no difference between the two adhesive strategies, therefore the clinical operator's preference and the precise clinical scenario are the major determinants of the technique to be used**.**

Etched enamel surface with exposed hydroxyl groups has high surface energy. As a result, there is a high compatibility between the hydrophilic adhesive agents and the etched enamel, and a strong bonding interface is formed by penetrating the etched surface directly without the need for priming. When bonding to etched dentin, the most crucial bonding mechanism is the creation of a hybrid layer with demineralized dentin to support the adhesive layer ***Frassetto et al. (2015), Tsujimoto et al. (2022)***.

The effect of etching prior to Single Bond Universal application was tested in a previous study and results revealed that the penetration of resin into the dentin lattice significantly improved, but the bond strength was not increased ***Jayasheel et al. (2017)***. On the contrary, ***Tsujimoto et al. (2022)*** demonstrated a positive correlation between the adhesive layer thickness and its bond strength. The adhesive layer in the Scotchbond Universal Plus Adhesive was generally less than 10 μm thick, and that the dentin fatigue strength was higher when compared to other adhesives of greater thickness**.**

Similarly, the results obtained by ***Alam et al. (2024)*** revealed that both the Scotchbond Universal Plus and the Single Bond Universal adhesives, produced thinner adhesive layers when applied on etched dentin. In contrast to the self-etch protocol, the resin micro tags formed after the etch-and-rinse protocol were more numerous, longer and with lateral branching. Scotchbond Universal Plus obtained a thinner adhesive layer (2.9 ± 0.2 μm for etch-and-rinse; 6.1 ± 0.8 μm for self-etch) compared to Single Bond Universal (6.1 ± 0.4 μm for etch-and-rinse; 10.6 ± 2.7 μm for self-etch). Scotchbond Universal Plus applied in etch-and-rinse mode displayed the thinnest layer.

Marginal adaptation, which was the study main finding, is regarded as one of the key indicators of dental restorations durability. Multiple complications, such as gap formation with subsequent microleakage and recurrent caries, postoperative hypersensitivity, and ultimately pulp involvement, can result from the lack of marginal integrity ***Gerula-Szymańska et al. (2020)***. In our study, both materials have shown no statistically significant difference within the different follow-up periods.

The relatively satisfactory adaptation scores can be attributed to the etching protocol and the strong chemical reaction produced by the 10-MDP monomer and the presence of the Vitrebond copolymer as proposed by ***Jayasheel et al. (2017), Morsy et al. (2018), Ruschel et al. (2018), Atalay et al. (2020)*** and ***Alam et al. (2024)*** before. Additionally, the bond strength and thus, the clinical performance might have been improved by a number of factors including the etching protocol used and the active rubbing of the adhesive, as explained by ***Hardan et al. (2021)***. Some universal adhesives, including Single Bond Universal, benefit from their active application providing efficient penetration of the resin tags irrespective of the adhesion protocol ***Moritake et al. (2019)***, ***Saito et al. (2020)***.

The discrepancies in adhesive thickness between Scotchbond Universal Plus and the Single Bond Universal adhesives could have also contributed to their distinct behavior as reported by ***Alam et al. (2024)*** who found a significant difference in viscosity between the two adhesives. Scotchbond Universal Plus showed a mean viscosity of 50.2 ± 0.3 MPa, compared to Single Bond Universal, with a mean value of 115.5 ± 0.6 MPa, demonstrating lower viscosity of Scotchbond Universal

Plus. The lower viscosity can enhance the wettability of the adhesive over the tooth surface improving its adaptation ***Sadr et al. (2009)***. While high viscosity is generally responsible for improved mechanical qualities of resinous materials, the Scotchbond Universal Plus Adhesive exhibited superior mechanical properties despite its lower viscosity, which may be influenced by its modified composition ***Alam et al. (2024)***.

As for marginal discoloration, no statistically significant difference was present between the two groups at different intervals. This was in accordance with ***Lawson et al. (2015), Morsy et al. (2018), Oz et al. (2019)*** and ***Atalay et al. (2020)***.

This may be clarified by the good marginal integrity of the tested adhesive systems during the evaluation period. Marginal discoloration is frequently due to microleakage with the subsequent ingression of oral fluids and bacteria ***Priyalakshmi & Ranjan (2014).*** However, ***Kim et al. (2017)*** mentioned that marginal discoloration is not necessarily associated with marginal microleakage. Only penetrating discoloration denotes the presence of microleakage but in case of superficial discoloration, marginal chipping with no evidence of microleakage may be the cause. In such cases, repair or refurbishment can be a conservative treatment option for a defective restoration instead of total replacement.

Another explanation may be the use of the etch-and-rinse mode. The rates of marginal discoloration were especially high in restorations placed with universal adhesives in self-etch mode, which was explained by the poorer ability of the self-etch adhesives to bond to etched enamel as compared to unetched enamel ***Oz et al. (2019)***. In contrast to our findings, ***Cuevas-Suárez et al. (2019)*** stated that a less satisfactory performance was documented with universal adhesives relative to marginal discoloration over time. Therefore, additional clinical trials with longer follow-up periods are still required.

Regarding secondary caries, this study demonstrated no statistically significant difference between the two materials at several follow-up periods. For both universal adhesives, there were no reports of secondary caries. Longer-term follow-up is usually necessary to monitor the recurrence of caries due to the fact that secondary carious lesions develop relatively late in the life span of a restoration ***Askar et al. (2021)***.

In terms of postoperative sensitivity, our study results showed no statistically significant difference in both groups. This is consistent with the results of ***Lawson et al. (2015), Morsy et al. (2018), Oz et al. (2019), Atalay et al. (2020),*** and ***de Paris Matos et al. (2020)***. At the baseline, one case in the intervention group and two cases in the comparator group showed postoperative sensitivity. The sensitivity related to one of the comparator restorations persisted up to 6 months. This postoperative sensitivity may have been associated to a number of reasons, other than the adhesive material, such as dentin etching, desiccation, gingival retraction with possibility of root surface exposure, which happens right after a restoration is installed, finished and polished or operational stress ***Perdigão et al. (2014), Sabbagh et al. (2018).***

Concerning retention, there was no loss among restorations of both groups throughout the trial. The 100% retention rate of Single Bond Universal Bond that was observed was also reported by ***Perdigão et al. (2014), Lawson et al. (2015)*** and ***Morsy et al. (2018)***, when using the etch-and-rinse mode. The excellent retention of the restorations was justified by the presence of the chemical bonding produced by the 10-MDP monomer and the Vitrebond copolymer as previously mentioned. This was in agreement with ***Carvalho et al. (2012)*** who examined the bond durability of a mild two-step self-etch adhesive that contains 10-MDP as a functional monomer and obtained satisfactory results. Furthermore, ***Alam et al. (2024)*** stated that the survival probabilities of Scotchbond Universal Plus Adhesive and Scotchbond Universal Adhesive were similar, regardless of the etching method. The high survival rate is coincident with the adequate bond strength and good adaptation of the adhesives

Conversely, ***(Chen et al., 2022)*** noted that certain risks are likely to occur so the long-term bonding performance of the etch-and-rinse mode cannot be guaranteed. Several in-vitro studies have demonstrated the effectiveness of universal adhesives for immediate bonding. However, bonding performance of all adhesives will decrease with aging. Despite great advancements in adhesive procedures, the most delicate component of resin restoration is still the hybrid layer. Numerous processes, including biodegradation, thermocycling, mechanical cycles, can cause the bonding interface to deteriorate.

The restorative material used in this trial was 3M™ Filtek Z350 XT, a nano-filled resin composite. Nano-filled resin composites have shown superiority in surface finishing providing better color stability and esthetics ***Nair et al. (2016).*** Finishing and polishing was done using TOR VM discs. Among different finishing and polishing systems tested in a previous study by ***Barakat & Abbas (2019)***, the TOR VM discs presented sufficiently smooth surfaces and minimal color change.

To our knowledge, the current study was pioneer in assessing the clinical performance of Scotchbond Universal Adhesive Plus with its modified formula**.** One of its limitations is the relatively small sample size. A sufficient sample size is recommended to detect any differences between both test groups with proper power and external validity. Moreover, the short follow up period of 6 months can be insufficient to evaluate the durability of the adhesive systems. A longer follow-up period for at least three years is recommended in order to grant the full acceptance for adhesive materials.

Conclusions

Given the study's predetermined limitations, the following conclusions were drawn:
The newly upgraded version, Scotchbond Universal Plus Adhesive, demonstrated clinically successful performance, comparable to its predecessor Single bond Universal Adhesive, despite its modified composition.

Recommendations

Larger sample size to confirm the findings of this study and longer follow up periods to detect any medium-term or long-term failures related to both adhesives.

Funding

No funding was obtained for this study.

Declarations

The authors declare that they have no financial and non-financial conflicts of interest.

Compliance with Ethical Standards

The protocol of the present study was registered in (www.clinicaltrials.gov) with a registration no. NCT05509127. The study was approved by Research Ethics Committee, Faculty of Dentistry, Cairo University with identification number 181122. This was in accordance with the ethical standards of Helinski.

Informed consent

An informed consent with an easy Arabic language was signed by the recruited participants.

Data availability statement

The data supporting this study are available from the corresponding author upon reasonable request.

Authors contribution

B.D. and E.A. contributed to the study's concepts, design, intellectual content, literature search, data acquisition, and manuscript preparation, editing, and review. O.S. additionally contributed to the sample size calculation, served as the principal investigator, performed data and statistical analysis, and was involved in all other aspects of the study.

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