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Super Dentin and 10-MDP Functional Monomer, Does they Really Prevent Postoperative Patients Complains? A Systematic Review

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Abstract

Objectives: This systematic review was conducted to detect the clinical performance of "10-Methacryloyloxydecyl Dihydrogen Phosphate" functional monomer added to self etch adhesives. And their impact on postoperative hypersensitivity. **Methods and Analysis:** Prisma guidelines for reporting systematic reviews were followed as much as possible in this work. Relevant mesh terms and entry terms were searched in three databases, Medline (PubMed), Cochrane (Wiley) and Science Direct (Elsevier). Search has no date limitations but only English language articles were included. In vitro studies and conference abstracts were excluded as only Randomized Clinical Trials (RCTs) were included in the search. **Findings:** According to the set inclusion and exclusion criteria search results were secondarily filtered to result only in one randomized clinical trial, it was filtered among 56 search result. Qualitative assessment of the included study was done after its risk of bias evaluation. While quantitative assessment meta analyses was not possible by using single RCT. **Improvement:** These findings are strongly suggesting a call for conducting a high quality randomized clinical trials concerning the clinical postoperative hypersensitivity following to resin composite restorations bonded with 10-MDP functional monomer.

Keywords: Functional Monomer, Postoperative Hypersensitivity, Self Etch Adhesives, Super Dentin, 10-MDP

1. Introduction

Prevention of postoperative hypersensitivity and recurrent caries following to resin composite restorations has been widely researched in the field of adhesive dentistry and hybridization of dental hard tissues. How to overcome the pitfalls of clinical work and manufacturer challenges to out get long standing functioning resin composite restorations?

Hybrid layer is synthetic layer which serves as acid resistant zone reduces the penetration of acids into hybridized tissues. On the other hand, on mechanical aspect the hybrid layer is the weakest link in the tooth restorative system. Many attempts have been introduced by clinicians and manufacturers to overcome the weak bond at the tooth restoration interface.

The characteristics of dentin tissue is already difficult substrate for initial bonding to dental adhesives, so it is more logic to say that it will also be difficult to maintain a strong established bond. Clinical longevity and durability of resin composite restorations have been a debate is it either that we need a high Mega Pascal bond (Mpa) or a biochemically modified adhesive to prevent bond degradation or even more worthy to detect post operative hypersensitivity?

One of the available chemically modified adhesives in the market are those ones containing 10-MDP Functional monomer added to self etch adhesives, which increase monomer penetration[1] and also improve the chemical adhesion to dental tissues[2]. 10-Methacryloyloxydecyl Dihydrogen Phosphate (10-MDP) is one of the most commonly used functional monomers[3]; it is the

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hydrophilic phosphate monomer that increases resin diffusion and adhesion by causing acidic decalcification and binding to calcium ions or amino groups of dentin collagen meshwork[4].

10-MDP functional monomer is capable to form strong ionic bonds with hydroxyapatite of tooth structure and remaining calcific globules after partial decalcification during bonding. This makes the bond more resistant to hydrolysis thus more clinically durable. This newly formed layer by such functional monomer is said to be called 'super dentin' due its superior characteristics compared to normal dentin bonded tissues regarding bond longevity and clinical performance.

2. Rational

The aim of conducting this study is to review the literature concerning the role of 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) in improving postoperative hypersensitivity following to tooth colored restorations. And to show weather if there are clinical studies investigating the clinical performance of 10-MDP bonded resin composite restorations especially concerned with postoperative hypersensitivity.

2.1 Research Question

Is postoperative hypersensitivity in teeth restored with resin composite restorations using 10-MDP containing adhesive will be reduced compared to using conventional adhesives?

2.2 PICOTS

Problem: Adult middle age patient with carious tooth restored withresin composite.

Intervention: Resin composite restorations using 10-MDP containing adhesive.

Comparator: Conventional adhesives not containing 10-MDP.

Outcome: Postoperative hypersensitivity following to resin composite restorations using 10-MDP containing adhesive.

Time interval: 24 hours, 2 weeks.

Setting: Dental clinics or outpatient hospitals.

3. Data Collection and Search Strategy

In order to formulate a systematic review of literature we need to do an exhaustive intelligent search, this was done by searching three different databases [Medline (PubMed), Cochrane (Wiley) and Science Direct (Elsevier)], Related Mesh terms and Index terms were used to formulate this search strategy. Mesh terms where suggested by two means, the first was using PubMed Mesh database drop list and the second one was by the 2016 Version of MeSH on demand Used to Generate Recommendations (alphabetical order) from the formulated research question. There were no date restrictions of the search; the search was performed on fifth of December 2015. Only English language was used. Regarding the study design, only randomized clinical trials were included in the systematic review since it was logic to exclude In-Vitro studies because we cannot test postoperative hypersensitivity outside patient's mouth.

4. Materials and Methods

The PRISMA (Preferred Reporting Items for Systematic Reviews) statement was followed as much as possible. After search, strategy was performed and primary screening of results in titles and abstracts was performed; then studies were either included or excluded into the relevant literature. The titles and abstracts of potential studies were evaluated by two independent reviewers. All abstracts that appeared to meet inclusion criteria were selected based on a consensus agreement between two reviewers and full articles or full theses were obtained. Conference abstracts were excluded. Following the electronic search, a manual search was performed across the reference list of the included studies. First step of advanced search is to list the relevant entry terms (Index terms) Table 1. Search must include Mesh terms (Medical Subject Headings) it is the NLM controlled vocabulary thesaurus used for indexing articles for PubMed. Table 2. Search method in Pub Med was done with every entry term and mesh term separately, then the search results were combined using Boolean terms [and, or, not] to get the final number of articles of combined search. Table 3.

Table 1. Entry terms used in the search strategy

	Entry terms
#1	Post operative hypersensitivity
#2	Postoperative hypersensitivity
#3	Dental Filling, Permanent
#4	Dental Fillings, Permanent
#5	Dental Permanent Filling
#6	Dental Permanent Fillings
#7	Dental Restorations, Permanent
#8	Filling, Dental Permanent
#9	Filling, Permanent Dental
#10	Fillings, Permanent Dental
#11	Fillings, Dental Permanent
#12	Permanent Dental Filling
#13	Permanent Dental Fillings
#14	Permanent Dental Restoration
#15	Permanent Dental Restorations
#16	Permanent Filling, Dental
#17	Permanent Fillings, Dental
#18	Restoration, Permanent Dental
#19	Restorations, Permanent Dental
#20	Resin composite restorations
#21	Resin composite

Table 2. Mesh terms used in the search strategy

	Mesh terms
#1	"methacryloyloxydecyldihydrogen phosphate" "Tri S Bond"
#2	Adhesives
#3	Composite Resins
#4	Dental Restoration, Permanent

5. Results

Databases Search yielded 19 articles from Medline (PubMed), 17 from Cochrane (Wiley) and Science Direct (Elsevier) yielded 19 **c**results. Reference list titles search yielded 2 articles. After application of inclusion and exclusion criteria of study only one randomized clinical trial was included in the systematic review (Figure 1).

6. Inclusion and Exclusion Criteria

After search result were primarily screened from the articles titles, they were divided into two subgroups either included studies or excluded studies according to some clinically relevant criteria shown in Table 4. Included shown in Table 6. While the excluded studies listed with their reason of exclusion in Table 5.

Table 3. Search strategies used with PubMed database

Database	Dates of coverage	Search keywords
Medline (PubMed)	Till 5 December 2015	Search ((((("methacryloyloxydecyldihydrogen phosphate" [Supplementary Concept] OR "Tri S Bond" [Supplementary Concept])) AND ("Adhesives"[Mesh] OR "Dental Bonding"[Mesh] OR "Dental Cements"[Mesh] OR "Light-Curing of Dental Adhesives"[Mesh])) OR (("Composite Resins"[Mesh]) AND postoperative hypersensitivity)) AND randomized clinical trials

Table 4. Criteria of included and excluded studies

Criteria of included studies	Criteria of excluded studies
Randomized clinical trials	In vitro studies and all other types of studies
Human permanent teeth	Animal teeth or deciduous teeth.
Clearfil SE bond (CSE) used for bonding	Used dental cements
S3 bond (S3) used for bonding	Dental cements
Universal scotch bond or any adhesive with 10-MDP functional monomer in its composition.	Other types of adhesives no containing 10-MDP
Dentin tissue after cavity preparation	Enamel tissue after cavity preparation
Direct resin composite restorations	Indirect restorations
Sound tooth structure Remaining after tooth preparation.	Carious tooth tissue
Class I or II cavities prepared in posterior teeth.	Carious and non carious cervical lesions

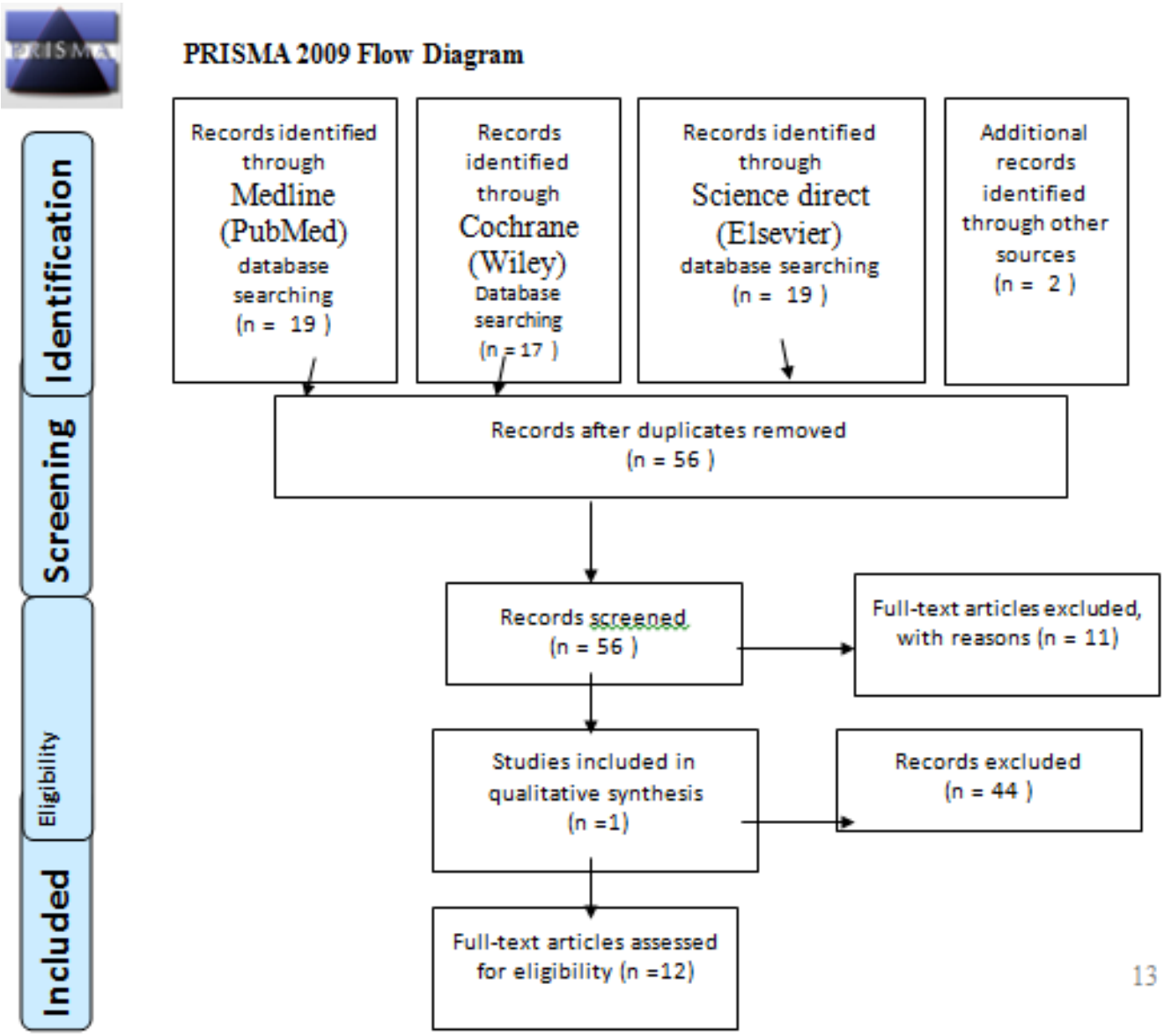

Figure 1. Prisma flow chart 2009.

Table 5. List of excluded studies

List of excluded studies	Reason of exclusion
A New Universal Simplified Adhesive: 6-Month Clinical Evaluation.[5]	Non carious cervical lesions
A randomized controlled study evaluating the effectiveness of a two-step self-etch adhesive with and without selective phosphoric-acid etching of enamel. [6]	Not evaluating postoperative hypersensitivity.
Eight-year clinical evaluation of a 2-step self-etch adhesive with and without selective enamel etching. [7]	Non carious cervical lesions
Improving Clinical Retention of One-Step Self-Etching Adhesive Systems With an Additional Hydrophobic Adhesive Layer. [8]	Non carious cervical lesions
A new universal simplified adhesive: 36-Month randomized double-blind clinical trial.[9]	Non carious cervical lesions
Influence of cavity lining and remaining dentin thickness on the occurrence of postoperative hypersensitivity of composite restorations. 2009.[10]	Class II cavity preparation.
Post-operative sensitivity in glass-ionomer versus adhesive resin-lined posterior composites.[11]	Adhesive not containing 10-MDP
Clinical assessment of postoperative sensitivity in posterior composite restorations. [12]	Adhesive not containing 10-MDP
Double-blind randomized clinical trial of posterior composite restorations with or without bevel: 6-month follow-up.[13]	Adhesive not containing 10-MDP
A randomized double-blind clinical trial of posterior composite restorations with or without bevel: 1-year follow-up[14]	Adhesive not containing 10-MDP
Randomized Clinical Trial of Four Adhesion Strategies in Posterior Restorations—18-Month Results[15]	Adhesive not containing 10-MDP

Table 6. Included study

Included study
Posterior resin composite restorations with or without resin-modified, glassionomer cement lining: a 1-year randomized, clinical trial[16]

7. Data Extraction Table

Data extraction was made in duplicates by authors. Details of the included study was extracted in Table 7 in terms of type of adhesive used, cavity design and Method

Table 7. Data extraction of the included study

Parameter of clinical comparison	Included Study: [16]	
Number of restorations	26 in Clearfil SE group	
Type of adhesive used	Clearfil SE bond (Kuraray Medical)	
Prepared cavity design	Class I cavities	
Method of assessment of postoperative hypersensitivity	Scoring from (1-5)	
	Score	**Post-operative sensitivity**
	1 = Clinically excellent	No hypersensitivity; normal vitality
	2 = Clinically good	Low and limited hypersensitivity; normal vitality
	3 = Clinically satisfactory	Slightly intense and/or delayed hypersensitivity; no complaint; no treatment needed
	4 = Clinically unsatisfactory	Very intense hypersensitivity or extremely delayed; treatment necessary (not replacement)
	5 = Clinically poor	Severe hypersensitivity or pulpitis/non-vital; replacement and/or endodontic treatment needed
Presence of sensitivity	Score 1=100%	
Time of follow up	1 year recall period (4 patients didn't attend).	

of assessment of postoperative hypersensitivity. It is very important step to assess the risk of bias of the included study during the synthesis of evidence concluded from the systematic review so the included study was assessed in Table 8 according to the Cochrane collaboration tool for assessing risk of bias. To increase the quality and the scientific adherence of systematic reviews it is preferred to stick to Prisma checklist for systematic reviews as shown in Table 9.

8. Discussion

This systematic review aimed to evaluate specific functional monomer 10-MDP present in some self etch adhesives constituents and their effect on postoperative hypersensitivity of their resin composite restorations. Unfortunately, after the meticulous search it was found that only one Randomized clinical trial focused on this point of research. On the other hand it is well known that many in vitro studies supported the hypothesis of super dentin formation by 10-MDP and its being a barrier and acid resistant layer against acid attack after restoration in service. In[4] has concluded for the clinical performance of more than one method of lining the prepared cavities. Among them was Clearfil SE bond which many of the in vitro studies claimed it is the best commercially available self etch adhesive for its clinical longevity. In the claimed study, Class 1 cavities were prepared and restored by nano filled resin composite following to the adhesive procedure. Postoperative hypersensitivity was assessed using scoring grades from 1-5.

Assessment was done at baseline after restoration and at recall periods 6 month and 1 year. Clearfil SE scored excellent results score 1 = 100% absence of sensitivity and normal vitality. Although it is only one Randomized clinical trial but according to its assessment of risk of bias it was considered to have low risk of bias except for the small number of sample size.

Table 8. The Cochrane collaboration tool for assessing risk of bias

Domain	Risk of bias	Review author's judgment
Sequence generation	Low risk of bias	Computer generated blocking randomization list.
Allocation concealment	Low risk of bias	Serial number list used to replace patients names
Blinding of participants, personnel and	Low risk of bias	Each participant was unaware by the restoration type placed.
Blinding outcome assessors	unclear	Blinding of the operator was was not possible
Incomplete outcome data	Unclear risk of bias	Dropped off patients in the 1 year follow up
Selective outcome reporting	Low risk of bias	Reporting all outcomes
Other sources of bias	Small sample size	

Table 9. Prisma checklist for systematic reviews.[47]

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4

Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	2
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	-
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	3
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	-
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	3
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	-
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	7
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	8

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Self etch adhesives have radical progressed all through the past decades toward advanced chemical modifications in order to simplify the clinical application steps. Also to reduce technique sensitivity and patients post operative hypersensitivity. This made self etch adhesives clinically superior compared to the etch and rinse adhesives. The added chemically active acidic functional monomers can interact with calcium and phosphate compounds in natural tooth structure. These functional monomer groups, such as the dihydrogen phosphate group in 10-MDP monomer[5].

The super dentin or acid base resistant zone formative mechanism was chemically explained, then it was proposed that the deep passage of monomers through the hybrid layer to the underlying tooth structure and the reactivity between the functional monomer and tooth calcium and phosphates compounds may contribute to the formation reinforced dentin tissue. Its name is super dentin due to its superior properties of resistance to acid attack and bond failure compared with sound bonded dentin to resin restorations.

The mechanism of ABRZ or super dentin formation is still clinically not covered or nearly all the available hypothesis is supporting its superior quality and its acid resistant performance due the ionic bond with bounded and unbounded calcium. Consequently, it is more solubility resistant, but the question remains if it is a real barrier layer preventing postoperative hypersensitivity and caries recurrence or it is a fortified modification to the hybrid layer?

9. Conclusions

The effectiveness potential of 10-MDP to prevent postoperative hypersensitivity have been proved by a number of in vitro simulating intraoral condition by acid base challenge protocols[18–32]. Still after this systematic review was conducted we are making a call for clinical controls for a period starting from 2 weeks till 1 year to formulate clinical judgment of the status of the concept of super dentin and ABRZ formation and its actual real benefits to the patient's community.

10. Recommendations

It seems that in our field of restorative dentistry we have a gap in the clinical impact of our daily practice of adhesive restorations on our patients. In spite that as dentistry is a branch of medicine which is concerned with the humans wellbeing as for example of these studies [33–35] focusing on a person's health and behavior in response to pain. Studies have to move at a rapid path from being conventional clinical trials towards being more creative in research ideas and hypothesis. As for example in further chemical modification[36–40] in the adhesives by addition of modified functional group monomers, Bioactive particles and innovated shock absorbent components. Testing the postoperative clinical performance by recent diagnostic tools is highly recommended[41–44]. All these attempts in order to achieve successful bonding of both direct and indirect aesthetic restorations[45,46].

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12. Conflict of Interest

None of the authors reported any conflict of interest.

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