

Pulp protection protocols under posterior composite restorations: A survey of dentists in Palestine

Naji Ziad Arandi

Department of Conservative Dentistry, Faculty of Dentistry, The Arab American University, Jenin, Palestine

Abstract

Introduction: This study aimed to assess the knowledge and practice of dentists in Palestine toward pulp protection protocols under composite restorations and to find any associations with age, years of experience, and gender.

Materials and Methods: A questionnaire was randomly distributed among 500 licensed dentists. It included six questions. The first three focused on demographic variables (gender, years of experience, and type of practice). The others focused on the protocols followed in three different Class I cavity scenarios: shallow (remaining dentine thickness [RDT] >1.5 mm), moderate (1.5 >RDT >0.5 mm), and deep (RDT <0.5 mm). For all scenarios, the questions were about using calcium hydroxide, resin-modified glass ionomer (RMGI), flowable composite, and dentin bonding agents under composites as the final restoration.

Results: The response rate was 61%. There was a significant difference in the protocols the respondents chose for restoring shallow ($P < 0.001$) and deep ($P < 0.001$) cavities. However, there was no significant difference in the protocols the respondents chose for moderate cavities ($P = 0.576$). There was a significant association between the time since graduation and the protocol used for all cavity scenarios ($P < 0.001$). There was significant association between the gender and the protocol used in shallow ($P = 0.001$) and deep ($P = 0.002$) cases, but there was no association between gender and the protocol chosen in moderate cases ($P < 0.418$). There was no significant association between the protocol used and the type of practice in shallow ($P < 0.236$) and moderate ($P < 0.055$) cavities, but there was a significant association between the protocol used in deep cavities and the type of practice ($P < 0.001$).

Conclusion: Irrespective of the cavity depth, there was an inconsistent implementation of pulp protection protocols among the respondents.

Keywords: Bases, liners, posterior composites, pulp protection

Address for correspondence: Dr. Naji Ziad Arandi, Department of Conservative Dentistry, Faculty of Dentistry, The Arab American University, P. O. Box: 240, 13, Zababdeh, Jenin, Palestine.


E-mail: arandi@gmail.com

Submission: 29-12-18 **Revision:** 09-01-19 **Acceptance:** 23-02-19 **Web Publication:** 27-12-19

INTRODUCTION

Restorative treatment procedures have played a very important role in the retention and restoration to function

of defected teeth by numerous surgical and nonsurgical procedures.^[1] Yet, maintaining pulp vitality should be the primary objective of restorative treatments provided to

Access this article online	
Quick Response Code:	Website: www.saudiendodj.com
	DOI: 10.4103/sej.sej_146_18

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Arandi NZ. Pulp protection protocols under posterior composite restorations: A survey of dentists in Palestine. Saudi Endod J 2020;10:15-20.

defective vital teeth. The use of materials to protect the pulp during restorations has been common practice for many years and continues to be promoted in operative dentistry textbooks.^[2,3] The concepts related to pulp protection have been constantly revisited, and contemporary pulp protection protocols have evolved. The present concepts focus on the remaining dentine thickness (RDT), which is defined as the thickness of dentin between the pulpal or axial walls of the prepared cavity and the pulp. The need for pulp protection is highly dependent on the RDT; the capacity of the pulp to defend itself and maintain its vitality is dependent on the odontoblast survival. It is reported that odontoblast damage increased as the RDT decreased.^[4] Therefore, RDT should be always taken into consideration as a critical factor when selecting the appropriate protocol of pulp protection.^[5] Various dental materials have been used for this purpose, and they have been generally classified into bases, liners, varnishes, sealers, and dentin bonding agents.^[6] The use of pulp protection materials is one of the most controversial and problematic topics in restorative dentistry, especially when it comes to choosing which protocol to follow.^[7-10]

Recently, direct resin-based composite materials are increasingly being used for the restoration of permanent posterior teeth.^[11] Composite restorations might have good clinical performance. According to the systemic literature review by Alvanforoush *et al.*,^[12] the clinical survival rate of composite restorations for studies in 1995–2005 was 89.41% and for 2006–2016 was 86.87%. Opdam *et al.*,^[13] in their systematic review of 2014, identified a failure rate of 2.4% at 10 years. The clinical success of posterior resin composite restorations can be attributed not only to improved material properties but also to the skills and knowledge of the clinician who places the restoration. One of the most important ongoing dilemmas for the general dentist is the decision of whether to bond a posterior resin composite directly to the prepared cavity floor or to first place a liner or base.^[14] The decision to place a liner or base before placing a posterior resin composite appears to follow the traditional techniques used in the placement of a dental amalgam. Resin composites do not conduct heat in the same way as a metallic restoration, so it is advantageous not to place an insulating layer between the restorative material and the tooth structure, which will maximize the surface area of dentin available for bonding. Postoperative sensitivity is an issue that might also confuse the dentist. There is evidence that no difference exists in postoperative sensitivity when a resin composite is “bonded” or “based.”^[15,16] The findings of a 2016 Cochrane review state that there is inconsistent, low-quality evidence regarding the difference in postoperative hypersensitivity

subsequent to placing a dental cavity liner under Class I and Class II posterior resin-based composite restorations in permanent posterior teeth in adults or children 15 years or older. Furthermore, no evidence demonstrates a difference in the longevity of restorations placed with or without dental cavity liners.^[17]

Confusion in pulp protection protocols among dental practitioners perhaps is a reflection of the inconsistency in teaching the management of dentin after cavity preparation. Studies on teaching of posterior composite restorations in dental schools across Europe,^[18] Ireland, United Kingdom,^[19] Canada,^[20] United States,^[21] Japan,^[22] and Spain^[23] reported notable differences in teaching the use of liners and bases under posterior composite restorations.

There is a clear agreement among the surveyed schools that without the placement of any base or liner under the composite, “total etching” should be used when restoring “shallow” cavities. However, a lack of uniformity can be noted in teaching the management of moderate and deep cavities within and between the surveyed countries. Disagreement on pulp protection protocols among dental schools perhaps is a reflection of the lack of consensus in the research community on the appropriate management of dentin after cavity preparations. This, in turn, might give rise to confusion among dental students and dental practitioners, with inappropriate application of certain clinical techniques.

In general, there is a lack of studies evaluating the attitudes and practices of dentists toward protocols for pulp protection. The attitudes of dentists toward pulp protection protocols in Palestine have not been studied; hence, the objective of this survey is to evaluate their knowledge toward pulp protection protocols.

MATERIALS AND METHODS

A questionnaire was designed, validated, and distributed by E-mail to 500 randomly selected general dentists registered with the Palestinian Dental Association. Among the 500 dentists who were solicited for the online survey, 305 completed the questionnaire ($n = 305$). The survey was carried out from May 2017 to September 2017. The questionnaire used in this study was adapted from a similar study.^[9] Pretesting of the questionnaire was carried out by initially administering it to ten dentists. Feedback was obtained from participants about any difficulty they had interpreting questions, and any ambiguity in their responses was checked. The questionnaire was then modified

accordingly and administered to all the participants. These dentists were not included in the final study sample. Ethical approval for the study was obtained from the Institutional Review Board committee at the faculty of dentistry in The Arab American University-Palestine (2017/April/B/1).

The questionnaire included six questions. The first three focused on demographic variables such as gender, years of experience (<5 years, between 5 and 9, 10 or more), and the type of practice (private, public). The rest of the questions focused on the protocol followed by the respondent to protect pulp in three Class I cavity scenarios: a shallow cavity (RDT >1.5 mm), a moderate cavity $1.5 > \text{RDT} > 0.5$ mm, and a deep cavity when the $\text{RDT} < 0.5$ mm. For all the three situations, the questions were about using calcium hydroxide (CH), resin-modified glass ionomer (RMGI), and flowable composite and dentin bonding agents under resin composites used as the final restoration. The data were recorded to carry out descriptive analysis. All statistical analysis was done using the Statistical Package for the Social Sciences (SPSS version 16.0 IBM, Armonk, NY: IBM Corp, USA). Association between various variable categories was investigated using the Chi-square test of association. For association between variables studied with at least one cell in cross-tabulations with a count of <5, Fisher's exact test was used to investigate such association.

RESULTS

Among the 500 dentists solicited for the survey, 305 dentists responded for a rate of 61% ($n = 305$). The average age of the participants was 31.6 years. The 305 respondents consisted of 116 (38.06%) males and 189 (61.97%) females. Considering time since graduation, 192 (62.95%) of the respondents had 5 years or less since graduation, 104 (34.1%) had more than 5 years since graduation, and 9 (2.95%) had more than 10 years since graduation. Thirty-eight of respondents worked in public, while 267 (87.5%) worked in private dental clinics. When asked about the pulp protection protocol, they used under composites in shallow, moderate, and deep cavities, the respondents' choices were significantly different in shallow ($P < 0.001$) and deep ($P < 0.001$) cavities; however, there was no significant difference in the respondents choices for restoring moderate cavities ($P = 0.576$) [Table 1]. There was a significant association between the time since graduation and the restorative protocol the respondents chose in all three cavity depth scenarios [Table 2]. There was significant association between the gender and the protocol used in shallow ($P = 0.001$) and deep ($P = 0.002$) cases, but there was no association

Table 1: Respondents choices of pulp protection protocol regarding different cavity depths

Cavity depth	Pulp protection protocol	Yes, n (%)	No, n (%)	P value
Shallow	RMGI	83 (27.2)	253 (82.96)	Chi-square test ($P < 0.001$)
	CH lining	100 (32.79)	226 (74.1)	
	DBA	122 (40)	183 (60)	
Moderate	RMGI	107 (35.08)	198 (64.91)	Chi-square test ($P = 0.576$)
	CH lining	95 (31.14)	210 (68.85)	
	DBA	103 (33.77)	202 (66.22)	
Deep	Flowable composite	30 (9.83)	275 (90.16)	Chi-square test ($P < 0.001$)
	RMGI	44 (14.42)	261 (85.57)	
	CH	80 (26.22)	225 (73.77)	
	CH + RMGI	139 (45.9)	165 (54.09)	
	DBA alone	12 (3.93)	293 (96.06)	

RMGI: Resin-modified glass ionomer, CH: Calcium hydroxide liner, DBA: Dentin bonding agent

between gender and the protocol chosen in cases, in which the $1.5 < \text{RDT} < 0.5$ mm ($P < 0.418$) [Table 3]. There was no significant association between the protocol used and the type of practice in shallow ($P < 0.236$) and moderate ($P < 0.055$) cavities, but there was a significant association between the protocol used in deep cavities and the type of practice ($P < 0.001$) [Table 4].

DISCUSSION

To the best of our knowledge, this is the first study exploring the knowledge and attitudes of any group of Palestinian dentists regarding pulp protection protocols. Majority of the participants were females which reflects the actual enrollment of females in dental schools.

The RDT is a close estimation of the residual dentin thickness left between the cavity and the pulp after cavity preparation. It is determined using a bitewing radiograph though reported to be an underestimation of the actual caries-free dentin. However, the measurement of the dentin thickness on the radiograph is an approximate indicator whether the cavity is shallow (outer third of dentine), moderate (middle third of dentine), or deep (close to the pulp). Many numerical values for the RDT related to pulp protection are mentioned in the literature. This study was based on numerical values of RDT used in the work of Ritter and Swift.^[5]

Dentin buffers chemical, thermal, or biological threats to the pulp. When the cavity preparation is shallow ($\text{RDT} > 1.5$ mm), no liner or base is needed under a composite restoration if the proper bonding technique is followed.^[5] The results of this study show that 40% of the respondents left shallow cavities unlined, while it is speculated that 60% unnecessarily use liners and bases in a shallow cavity. This speculation seems to be based on the fact that they consider lining/basing procedure

Arandi: Pulp protection protocols: A survey of dentists in Palestine

Table 2: Association between pulp protection protocol and the time since graduation

Cavity depth	Pulp protection protocol	Years, n (%)			P value
		0-5	6-10	>10	
Shallow	RMGI	35 (42.2)	45 (54.2)	3 (3.6)	Chi-square test (Fisher's exact test) ($P<0.001$)
	CH lining	59 (59.0)	37 (37.0)	4 (4.0)	
	DBA	98 (80.3)	22 (18.0)	2 (1.6)	
Moderate	RMGI	38 (35.5)	66 (61.7)	3 (2.8)	Chi-square test (Fisher's exact test) ($P<0.001$)
	CH lining	56 (58.9)	34 (35.8)	5 (5.3)	
	DBA	98 (95.1)	4 (3.9)	1 (1.0)	
Deep	Flowable composite	21	9	0	Chi-square test (Fisher's exact test) ($P=0.001$)
	RMGI	32	10	2	
	CH	62	15	3	
	CH + RMGI	71	65	3	
	DBA alone	6	5	1	

RMGI: Resin-modified glass ionomer, CH: Calcium hydroxide liner, DBA: Dentin bonding agent

Table 3: Association between pulp protection protocol and gender

Cavity depth	Pulp protection protocol	Gender, n (%)		P value
		Male	Female	
Shallow	RMGI	54 (65.1)	29 (34.9)	Chi-square test ($P=0.001$)
	CH lining	39 (39.0)	61 (61.0)	
	DBA	23 (18.9)	99 (81.1)	
Moderate	RMGI	44 (41.1)	63 (58.9)	Chi-square test ($P<0.418$)
	CH lining	31 (32.6)	64 (67.4)	
	DBA	41 (39.8)	62 (60.2)	
Deep	Flowable composite	12 (40.0)	18 (60.0)	Chi-square test (Fisher's exact test) ($P=0.002$)
	RMGI	27 (61.4)	17 (38.6)	
	CH	29 (36.3)	51 (63.8)	
	CH + RMGI	47 (33.8)	92 (66.2)	
	DBA alone	1 (8.3)	11 (91.7)	

RMGI: Resin-modified glass ionomer, CH: Calcium hydroxide liner, DBA: Dentin bonding agent

Table 4: Association between pulp protection protocol and type of practice

Cavity depth	Pulp protection protocol	Type of practice, n (%)		P value
		Private	Public	
Shallow	RMGI	76 (91.6)	7 (8.4)	Chi-square test ($P<0.236$)
	CH lining	103 (84.4)	19 (15.6)	
	DBA	90 (90.0)	10 (10.0)	
Moderate	RMGI	88 (82.2)	19 (17.8)	Chi-square test ($P<0.055$)
	CH lining	83 (87.4)	12 (12.6)	
	DBA	96 (93.2)	7 (6.8)	
Deep	Flowable composite	25 (83.3)	5 (16.7)	Chi-square test (Fisher's exact test) ($P<0.001$)
	RMGI	41 (93.2)	3 (6.8)	
	CH	71 (88.8)	9 (11.3)	
	CH + RMGI	128 (92.1)	11 (7.9)	
	DBA alone	2 (16.7)	10 (83.3)	

RMGI: Resin-modified glass ionomer, CH: Calcium hydroxide liner, DBA: Dentin bonding agent

as an essential part of the restorative procedure even if not supported by scientific evidence. These findings were similar to those of a study conducted in the UK.^[14] The findings of the current study were similar to those reported by a survey investigating whether dentists in the Ha'il region in Saudi Arabia were following contemporary pulp protection protocols.^[9] Around 55% of the respondents used only dentin bonding agents in shallow cavities. Gilmour *et al.*^[24] investigated the techniques used by UK

general dentists when placing posterior composites and reported that 79% of the respondents ($n = 254$) left shallow cavities unlined.

Moderately deep cavities ($0.5 < \text{RDT} < 0.5 \text{ mm}$) should be based with RMGI.^[5] A RMGI base is recommended to replace the lost dentin and to provide volumetric reduction of composite resins to reduce the drawbacks of polymerization shrinkage. RMGI provides adequate sealing and protection to the dental pulp due in part to the chemical adhesion to dental substrates combined with their ability to release fluoride.^[6] However, few data are available on the polymerization shrinkage of RMGIs.^[25] Respondents had a split decision. Only 35.08% of the respondents followed this protocol, while 33.7% did not use any liner or base under the final restoration and relied on the dental bonding agents to provide pulp protection by sealing the tooth-restoration interface. Blum *et al.*^[14] reported that 49% of the respondents to the survey in the UK reported placing a lining, while 51% did not. Around 79% of the respondents to the survey of Gilmour *et al.* reported using a lining material in a moderate cavity.^[24] The findings of this study were similar to those reported by Aljanakh *et al.*, in the Ha'il region in Saudi Arabia.^[9] Their study reported that 30.5% of the respondents followed the contemporary protocols and applied RMGI when the RDT is $< 1.5 \text{ mm}$ and $> 0.5 \text{ mm}$. Furthermore, 31.4% of the respondents to the present survey unreasonably apply CH under composite restorations placed in moderately deep cavities. This percentage is less than that reported by the dentists in Saudi Arabia; 42.1% of those respondents used CH liners directly under restorations for the same clinical case. It can be concluded that the management of moderate cavities is controversial among the respondents, with no clear evidence favoring the placement or nonplacement of a lining.^[14]

When asked about the protocols used they used in deep cavities ($\text{RDT} < 0.5 \text{ mm}$). The results of this survey show

Arandi: Pulp protection protocols: A survey of dentists in Palestine

that 26.22% of the respondents used CH liners directly under composite restorations in deep cavities. Similarly, 11.1% of the respondents to the survey in Southern Brazil reported using CH liners directly under composite restorations. 17% of the respondents to the survey in Ha'il also reported using CH liners under composite restorations directly.^[9] Using CH liners directly under composite restorations compromises the adhesion of the restorative material to the floor of the cavity.^[4,26] Exposing CH liners to phosphoric etchants, primers and bonding agents cause degradation of the liner and contamination of the bonding agent due to the solubility of the CH liners.^[26-29] Hence, the contemporary pulp protection protocols impose a protective RMGI base to compensate for the drawbacks of CH liners placed in deep cavities. This protocol was followed by 45.9% of the respondents and was comparable to the percentage (52%) reported in Saudi Arabia^[9] but less than the percentage (69.2%) reported by the survey done in Brazil.^[30]

In this survey, 14.42% of the respondents reported using RMGI as liners in deep cavities. Around 16% of the respondents to the survey by Chisini *et al.*^[30] in Brazil also reported using GIC liners directly in the deepest portions of the cavity. RMGI liners are widely promoted as the next best thing to match CH liners in deep cavities.^[31,32] Liners or bases of low-viscosity and low-elastic modulus such as RMGIs and flowable composites are promoted as stress-absorbers that reduce the stresses at the adhesive interface. RMGI is reported to have better antibacterial properties compared to CH liners.^[33,34] However, no definite statements can be made about either type when comparing the pulpal inflammatory cell response, hard/soft-tissue repair, bacterial leakage, and changes in odontoblast numbers beneath either.^[35]

Around 9.83% of the respondents use flowable resin composites as cavity liners in deep cavities. The use of flowable composite as a liner is controversial in literature.^[36,37] Their use is technique-sensitive and relies mainly on the performance of the bonding agent. Therefore, flowable composites are considered more an "adaptive" initial composite layer rather than a true liner in deep cavities. Oliveira *et al.*^[38] found that using a flowable composite as liner or base material under composite resin restoration increases the polymerization shrinkage stresses at the adhesive interface, leading to a possible adhesive failure. Such failure may result in poor sealing of dentin. These results reflect the fact that the respondents do not have a uniform understanding of the proper application of pulp protection protocol in deep cavities. 70% respondents still believe that applying a cement base under amalgam or composite restoration is absolutely essential, whereas

current understanding on this issue is that all cavities do not require cement liners or bases.

A low percentage of the respondents (3.93%) reported using a dentin bonding agent without the use of an intermediate material, which was comparable to the percentage (1.1%) reported by the study sample in Brazil. Likewise, 11% of 821 of German dentists who participated in a survey that investigated attitudes and behaviors regarding deep dentin removal reported not using any liner but placing the bonding directly onto the dentin. The percentages reported by these studies might depict the dentists' belief that an intermediate material is necessary for pulp protection and to avoid any potential insult from restorative procedures.

The findings of this study indicated a general agreement among the respondents in the placement of a lining in deep cavities and leaving shallow cavities unlined. However, it was obvious that there was wide difference in the use of lining materials in moderate cavities. As in the case of previous surveys of this nature, the quantitative evidence provided in the study is estimates given by participating dentists rather than actual figures.^[39,40] Therefore, the results must be analyzed according to the limited dimension of the sample. The study gives us an insight into the protocols that dentists are currently using to protect the pulp when placing posterior composite restorations and could represent a starting point for more extensive investigations.

The protocols and concepts of pulp protection should be highlighted in under- and post-graduate education to promote better clinical practice for future dentists. The absence of postgraduate programs in operative dentistry and continuing education courses in addition to economic restrictions may further explain the results of this survey. There is a need to expose the dentists in Palestine to recent research and philosophies published on this topic and to update them with the emerging concepts based on the latest scientific publications.

CONCLUSION

Dentists performed procedures that often deviated from those acknowledged in the literature. General practitioners do not seem to keep up with recently introduced techniques but rather used more traditional concepts. Dentists need to update and adhere to the current concepts to improve their clinical practice by engaging in continuous dental education activities.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Saad A, AlShareef A. Endodontic therapy and restorative rehabilitation versus extraction and implant replacement. *Saudi Endod J* 2013;3:107.
2. Heymann H, Swift EJ, Ritter AV, Sturdevant CM, editors. *Sturdevant's Art and Science of Operative Dentistry*. 6th ed. St. Louis: Elsevier/Mosby; 2013. p. 548.
3. Hilton TJ, Ferracane JL, Broome JC, editors. *Summitt's Fundamentals of Operative Dentistry: A Contemporary Approach*. 4th ed. Hanover Park: Quintessence Publishing Co.; 2013. p. 600.
4. About I, Murray PE, Franquin JC, Remusat M, Smith AJ. The effect of cavity restoration variables on odontoblast cell numbers and dental repair. *J Dent* 2001;29:109-17.
5. Ritter AV, Swift EJ Jr. Current restorative concepts of pulp protection. *Endod Top* 2003;5:41-8.
6. Weiner R. Liners and bases in general dentistry. *Aust Dent J* 2011;56 Suppl 1:11-22.
7. Weiner RS, Weiner LK, Kugel G. Teaching the use of bases and liners: A survey of North American dental schools. *J Am Dent Assoc* 1996;127:1640-5.
8. Weiner R. Teaching the use of liners, bases, and cements: A 10-year follow-up survey of North American dental schools. *Dent Today* 2006;25:74, 76, 78-9.
9. Aljanakh M, Mirza AJ, Siddiqui AA, Al-Mansour M, Asad M. Do dentists in ha'il region follow contemporary pulp protection protocols? A Saudi based study. *Int J Dent Sci Res* 2016;4:68-71.
10. Javaid A, Asad M, Khan S, Berkth M. Practice of dental pulp protection methods among various teaching institutions in Pakistan. *J Pak Dent Assoc* 2016;25:16-20.
11. Lynch CD, Opdam NJ, Hickel R, Brunton PA, Gurgan S, Kakaboura A, *et al*. Guidance on posterior resin composites: Academy of operative dentistry – European section. *J Dent* 2014;42:377-83.
12. Alvanforoush N, Palamara J, Wong RH, Burrow MF. Comparison between published clinical success of direct resin composite restorations in vital posterior teeth in 1995-2005 and 2006-2016 periods. *Aust Dent J* 2017;62:132-45.
13. Opdam NJ, van de Sande FH, Bronkhorst E, Cenci MS, Bottenberg P, Pallesen U, *et al*. Longevity of posterior composite restorations: A systematic review and meta-analysis. *J Dent Res* 2014;93:943-9.
14. Blum IR, Younis N, Wilson NH. Use of lining materials under posterior resin composite restorations in the UK. *J Dent* 2017;57:66-72.
15. Burrow MF, Banomyong D, Harnirattisai C, Messer HH. Effect of glass-ionomer cement lining on postoperative sensitivity in occlusal cavities restored with resin composite – A randomized clinical trial. *Oper Dent* 2009;34:648-55.
16. Strober B, Veitz-Keenan A, Barna JA, Matthews AG, Vena D, Craig RG, *et al*. Effectiveness of a resin-modified glass ionomer liner in reducing hypersensitivity in posterior restorations: A study from the practitioners engaged in applied research and learning network. *J Am Dent Assoc* 2013;144:886-97.
17. Schenkel AB, Peltz I, Veitz-Keenan A. Dental cavity liners for class I and class II resin-based composite restorations. *Cochrane Database Syst Rev* 2016;10:CD010526.
18. Wilson NH, Mjör IA. The teaching of class I and class II direct composite restorations in European dental schools. *J Dent* 2000;28:15-21.
19. Lynch CD, McConnell RJ, Hannigan A, Wilson NH. Teaching the use of resin composites in Canadian dental schools: How do current educational practices compare with North American trends? *J Can Dent Assoc* 2006;72:321.
20. Lynch CD, McConnell RJ, Wilson NH. Teaching of posterior composite resin restorations in undergraduate dental schools in Ireland and the United Kingdom. *Eur J Dent Educ* 2006;10:38-43.
21. Lynch CD, McConnell RJ, Wilson NH. Teaching the placement of posterior resin-based composite restorations in U.S. dental schools. *J Am Dent Assoc* 2006;137:619-25.
22. Hayashi M, Yamada T, Lynch CD, Wilson NH. Teaching of posterior composites in dental schools in Japan – 30 years and beyond. *J Dent* 2018;76:19-23.
23. Castillo-de Oyagüe R, Lynch C, McConnell R, Wilson N. Teaching the placement of posterior resin-based composite restorations in Spanish dental schools. *Med Oral Patol Oral Cir Bucal* 2012;17:e661-8.
24. Gilmour AS, Latif M, Addy LD, Lynch CD. Placement of posterior composite restorations in United Kingdom dental practices: Techniques, problems, and attitudes. *Int Dent J* 2009;59:148-54.
25. Attin T, Buchalla W, Kielbassa AM, Helwig E. Curing shrinkage and volumetric changes of resin-modified glass ionomer restorative materials. *Dent Mater* 1995;11:359-62.
26. El-Araby A, Al-Jabab A. The influence of some dentin primers on calcium hydroxide lining cement. *J Contemp Dent Pract* 2005;6:1-9.
27. Burke FJ, Watts DC. Weight loss of four calcium hydroxide-based materials following a phosphoric acid etching and washing cycle. *J Dent* 1986;14:226-7.
28. Phillips RW, Crim G, Swartz ML, Clark HE. Resistance of calcium hydroxide preparations to solubility in phosphoric acid. *J Prosthet Dent* 1984;52:358-60.
29. Titus HW, Draheim RN, Murrey AJ. The effect of enamel etchant on the solubility of three calcium hydroxide bases. *J Prosthet Dent* 1988;60:178-80.
30. Chisini LA, Conde MC, Correa MB, Dantas RV, Silva AF, Pappen FG, *et al*. Vital pulp therapies in clinical practice: Findings from a survey with dentist in Southern Brazil. *Braz Dent J* 2015;26:566-71.
31. Ruiz JL, Mitra S. Using cavity liners with direct posterior composite restorations. *Compend Contin Educ Dent* 2006;27:347-51.
32. Weston JF. Use of a resin-modified glass-ionomer (RMGI) liner in conservative direct treatment of deep caries. *Compend Contin Educ Dent* 2015;36:42-5.
33. Coogan MM, Creaven PJ. Antibacterial properties of eight dental cements. *Int Endod J* 1993;26:355-61.
34. Eli I, Cooper Y, Ben-Amar A, Weiss E. Antibacterial activity of three dental liners. *J Prosthodont* 1995;4:178-82.
35. Mickenautsch S, Yengopal V, Banerjee A. Pulp response to resin-modified glass ionomer and calcium hydroxide cements in deep cavities: A quantitative systematic review. *Dent Mater* 2010;26:761-70.
36. Braga RR, Hilton TJ, Ferracane JL. Contraction stress of flowable composite materials and their efficacy as stress-relieving layers. *J Am Dent Assoc* 2003;134:721-8.
37. Christensen GJ. Direct restorative materials. What goes where? *J Am Dent Assoc* 2003;134:1395-7.
38. Oliveira LC, Duarte S Jr., Araujo CA, Abrahão A. Effect of low-elastic modulus liner and base as stress-absorbing layer in composite resin restorations. *Dent Mater* 2010;26:e159-69.
39. Bogari DF, Alzebiani NA, Mansouri RM, Aljiaid FG, Alghamdi MA, Almalki M, *et al*. The knowledge and attitude of general dental practitioners toward the proper standards of care while managing endodontic patients in Saudi Arabia. *Saudi Endod J* 2019;9:40.
40. AlQahtani S, Aziz S, Garni HA, Alaenazi MS. What opinions do Saudi endodontic residents hold about regenerative endodontics? *Saudi Endod J* 2019;9:1.