©Operative Dentistry, 2021, **46-06,** 621-630

Composite versus Amalgam Restorations Placed in Canadian Dental Schools

L Alreshaid • W El-Badrawy • HP Lawrence • MJ Santos • A Prakki

Clinical Relevance

The misalignment between the amounts of time devoted to teaching each restorative material (composite and amalgam) and numbers of posterior restorations placed in Canadian faculty clinics urges revision, to help optimize the learning, training, and clinical outcomes for dental students.

SUMMARY

Objectives: To investigate the latest teaching policies of posterior composite placement versus amalgam and to determine the actual numbers of posterior composites versus amalgam restorations placed in Canadian dental schools, over the years from 2008 to 2018.

Methods: Emails were sent to Chairs/Heads of Restorative Departments and Clinic Directors of all 10 Canadian dental schools to collect data in the forms of: 1) Questionnaire on current teaching policies of posterior composite and amalgam restorations; 2) data entry form to collect the actual numbers of posterior composite and amalgam restorations placed in their clinics.

Results: For the teaching questionnaire, the response rate was 90% (n=9). Seven (78%) of the responding schools reported that they assign 25%-50% of their preclinical restorative teaching time towards posterior composite placement. While, three (33%) of the responding schools allocated 50%-75% of their restorative teaching towards amalgam placement. Data entry response rate was 80% (n=8). Amalgam material was dominant in the restoration distribution from 2008 to 2012. While from 2013 to 2018, resin composite material was dominant in all eight responding schools. Linear regression analysis revealed a significant increasing trend in placing posterior

Lulwah Alreshaid, BDS, PhD candidate, Department of Clinical Sciences, Faculty of Dentistry, University of Toronto, Toronto M5G 1G6 ON, Canada; Department of Restorative Dental Sciences, College of Dentistry, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

Wafa El-Badrawy, BDS, MSc, Department of Clinical Sciences, Faculty of Dentistry, University of Toronto, Toronto, ON, Canada

Herenia P Lawrence, DDS, MSc, PhD, Department of Dental Public Health, Faculty of Dentistry, University of Toronto, Toronto, ON, Canada

Maria J Santos, DDS, MSc, PhD, Department of Restorative Dentistry, Schulich School of Medicine & Dentistry, University of Western Ontario, London, ON, Canada

*Anuradha Prakki, DDS, MSc, PhD, Department of Clinical Sciences, Faculty of Dentistry, University of Toronto, Toronto, ON, Canada

*Corresponding author: Room 547, 124 Edward Street, Toronto M5G 1G6, Ontario, Canada; e-mail: Anuradha.Prakki@dentistry.utoronto.ca

https://doi.org/10.2341/20-212-C

composites in all the responding schools over time ($p<0.05$).

Conclusions: Data analysis revealed a clear trend towards an increase of posterior composite restoration placement and a decrease in the number of amalgam restorations placed. However, the teaching time assigned for posterior composite is not aligned with quantity placed. Review and adjustment of time allocated for teaching and training of each material are recommended.

INTRODUCTION

In the last two decades, an ongoing shift towards the use of resin-based composite materials instead of dental amalgam in posterior restorations has been noted. This increase in resin composite use is a result of increased esthetic awareness and apprehension about mercury within the population.[1,2] A myriad of factors is behind the popularity of resin composite restorations today, such as esthetic properties as well as the micromechanical bonding to tooth structure through adhesive bonding agents.[1] In addition, the improvements in oral hygiene practices and use of fluoride have resulted in many patients with less susceptibility to caries. Therefore, these patients are more likely to benefit from minimally invasive restorative procedures used for tooth-colored resin composite restorations,[3,4] where the unnecessary removal of sound tooth structure required for amalgam restorations is eliminated.[1,4] Another reason for the popularity of resin composite restorations is the reduced need for total replacement of failing restorations because in certain cases failing resin composite restorations can be more easily repaired.[3-5] Moreover, studies have shown that the use of resin composite restorations may increase tooth fracture resistance.[1,3]

Tooth-colored restorations have undergone remarkable and constant progress over recent decades and have revolutionized dental practice. Clinicians and academicians have become more comfortable including resin composites in their practices as well as in the teaching curricula of dental schools.[6-8] A Norwegian study showed that resin composite has become the material of choice in posterior restorations in Norway.[9] In this study, 99% of dentists agreed to using resin composite when treating primary mesio-occluso-distal (MOD) cavities confined to the outer-half of the dentin.[9-11] Similar results were found in other studies internationally. Eklund (2010) looked into trends in dental treatment in the United States (US), showing that patients received approximately 50% fewer amalgam restorations in 2007 compared to 1992; also the increase in use of resin composite was 50%.[12] More studies in other countries such as the Netherlands, Croatia, France, the US, Finland, Germany, Sweden, Canada, Ireland, and the United Kingdom also reported that the use of amalgam has declined rapidly.[12-19] A study conducted in Brazil concluded that direct resin composite is the material of choice for posterior restorations.[20]

With the established increase in clinical placement of posterior composite restorations, there is also a parallel worldwide increase in the teaching of posterior composite.[21] Many surveys have been conducted to determine the approach in teaching posterior composite in North American dental schools;[6-8,22,23] A variation in the teaching approaches has been observed, ie, some institutions have adopted the amalgam-free curriculum, others are considering the removal of amalgam from their teaching, while a large number of schools are still in favor of teaching amalgam placement today.[24]

The latest survey that investigated the teaching of posterior composite placement in North American dental schools concluded that "teaching the placement of posterior resin-based composites in the US and Canadian dental schools has increased, since the previous survey was conducted in 2004-2005, albeit not as much as in other parts of the world."[6] None of the previous surveys have looked into the actual numbers of posterior restorations placed by students in North American faculty clinics based on teaching policies.[6-8,22,23] The present study is the first ever to consider the count of posterior restorations (composite and amalgam) placed in dental schools around North America.

In order to validate teaching policies and quantify current trends of posterior restoration placement in Canada, the objective of this study was twofold: 1) To investigate the latest teaching policies of posterior composite placement versus amalgam in Canadian dental schools, and 2) to determine the actual numbers of all posterior composites versus amalgam restorations placed by undergraduate students in Canadian schools, over the years from 2008 to 2018. The null hypotheses were: 1) There will be no difference in the time allocated for teaching posterior composite and amalgam within Canadian dental schools and 2) There will be no difference in the number of posterior composite and amalgam restorations placed in Canadian dental school clinics.

METHODS AND MATERIALS

An online search was conducted to locate the contact information of the invited schools. Electronic mails were sent to Chairs/Heads of Restorative Departments and Clinic Directors of all 10 Canadian dental schools to collect data in the provided forms. Invitations to participate in the study were sent in early 2019, followed by three reminders with a period of 6 weeks between each reminder.

Questionnaire on Current Teaching Policies of Posterior Resin Composite and Amalgam Restorations

The questionnaire (Supplemental Table 1) consisted of 10 questions in closed-ended format; the invited schools were asked about the percentage of teaching time devoted to each type of restoration and which technique is taught first (composite or amalgam) in preclinical teaching. One of the questions inquired about competency tests conducted for each type of restoration and at what level, ie, preclinical and clinical. Invited schools were asked about the contraindications considered and taught for each type of restoration as well as the differences in cavity design taught for posterior resin composite compared to amalgam preparations. The questionnaire included questions about the matrix system recommended for resin composite restorations, light curing unit used in each school, and whether an etch-and-rinse or self-etch adhesive system is used for bonding posterior composites. The questionnaire also sought information of whether the school teaches the cusp-cap and cusp build-up techniques using resin composite materials, and if bulk-fill composite materials are used for posterior restorations. A data entry form (Supplemental Table 2) was provided to register the actual numbers of posterior composite and amalgam restorations placed by undergraduate students in faculty clinics over 10 years (2008-2018).

Statistical Analysis

Descriptive statistical analysis was performed to summarize the questionnaire results as well as the ratios of posterior composite versus the total number of posterior restorations (posterior composites and amalgam restorations) performed at each responding school. The ratio was calculated as follows:

$$\textit{Ratio of Composite Restorations} = \frac{\text{Number of Composite Restorations}}{\text{Number of Total Restorations}}$$

The ratios were calculated for each school separately at each calendar year. Line and bar graphs were used to visualize year-by-year trends in data. Linear regression analysis was used to determine annual growth rates for total number of posterior restorations, with year being the independent variable. The slope of the regression line represents the growth rate. Chi-square test of independence was used to compare proportions of posterior composite restorations in the first and last year of available data (2008 and 2018 for the most schools). All inferential analysis was performed with level of significance at 0.05. Data was organized in a Microsoft Excel 2016 spreadsheet. Inferential statistical analysis was performed using IBM SPSS Statistics for Windows, version 26 (IBM Corp, Armonk, NY, USA).

RESULTS

Questionnaire Results

Completed questionnaires were received from 9 out of the 10 invited Canadian dental schools, with a response rate of 90%. Responses were received after sending three reminders, with a 6-week period between each reminder.

In regard to posterior composite preclinical teaching, seven (78%) of the responding schools indicated that they assign 25%-50% of their preclinical restorative teaching time towards posterior composite placement. The remaining schools (22%) spend more than 50% of teaching time on the same subject. Over 50% of the responding schools anticipated that more time will be devoted to teaching the placement of posterior composites in the next 5 years. With respect to amalgam preclinical teaching, five (56%) of the responding schools allocated 25%-50% of their restorative teaching towards amalgam placement. While, three (33%) of them indicated that 50%-75% of their preclinical restorative teaching is devoted to teaching amalgam. One school assigned less than 25% of teaching time on the same subject. Only one school anticipated that less time will be allocated to teaching amalgam placement in the next 5 years. Competency tests are found to be indicted for both resin composite and amalgam equally in 67% of the schools (n=6). Only one out of the nine responding schools indicated that competency tests are only required for posterior composite restorations.

Order of Teaching

Eighty nine percent of the responding schools (n=8) teach the amalgam placement techniques before posterior composite techniques in the preclinical courses. While the remaining 11%, which is equiv-

Table 1: *Posterior Restoration Contraindications Taught in Canadian Dental Schools*

Contraindications to Posterior Restoration Placement According to Questionnaire Respondents	Number of Responding Schools	
Contraindications	Amalgam	Composite
Poor oral hygiene /high caries risk	0	8
Cavity gingival margin on root surface	0	5
Inability to place a rubber dam	0	8
Parafunctional activity (bruxism)	1	2
Tooth acting as removable partial denture abutment	1	3
Patient mercury concerns	8	0
Contact with dissimilar metal	6	0
Pregnant patient	1	1

alent to only one school, is teaching resin composite prior to amalgam.

Contraindications of Posterior Composite and Amalgam Placement

Table 1 lists the contraindications of posterior composite and amalgam placement as taught by responding schools. Almost all the responding schools (n=8) identified "poor oral hygiene and high caries risk" as a contraindication for placing posterior composite restorations, and "patient mercury concerns" for placing amalgam restorations.

Cavity Design Differences

Cavity design differences taught for posterior composite compared to amalgam preparation are shown in Table 2. According to the questionnaire responses, 89% of the responding schools (n=8) taught the "slot-type" cavity preparation for resin composite, whereas two of them (22%) taught the same design for amalgam cavity preparation. Beveling of the proximal gingival margin in composite and amalgam preparation was taught in four and three schools, respectively. Moreover, two schools indicated that they teach full-scale Class II composite preparations featuring "reverse curve." Whilst eight of the responding schools taught the same feature when preparing for amalgam restoration.

Table 2: *Cavity Design Differences Taught in Canadian Dental Schools for Posterior Composite Compared to Amalgam*

Cavity Design Feature Taught	Number of Responding Schools	
Technique	Amalgam	Composite
Beveled occlusal margins?	0	1
Beveled gingival margin of proximal box?	3	4
"Slot-type" cavities? (i.e., no occlusal component?)	2	8
Retention grooves in full-scale Class II	7	0
Retention grooves in slot-type Class II	4	0
Reverse curve	8	2

Matrix and Wedge Techniques Used

All participated dental schools (n=9) preferred to teach the "sectional matrix and separating ring" technique when restoring Class II composite restorations; four schools also taught using other techniques like "circumferential matrix and wedges" (n=2) and "circumferential matrix with wedges and separating ring" (n=2).

Curing Lights Used

Seventy eight percent of the responding schools (n=7) reported that the LED curing system is the system of choice in their faculty clinics when curing posterior composite restorations. The use of traditional quartz-halogen light was used in two schools (22%).

Adhesive Systems and Composite Materials

Fifty six percent of responding schools (n=5) taught the students to use only the three-step adhesive system (etch-prime-bond) for bonding posterior composites. While, the remainding schools used a two-step adhesive system only. Fifty six percent of schools surveyed (n=5) did not include teaching of bulk-fill composite materials for posterior restorations; four schools reported that they teach the students using bulk-fill composites.

Sixty seven percent of the schools (n=6) indicated that they teach cusp-capping or cusp-build up techniques using resin composite material.

Posterior Restorations Quantitative Data

The response rate for this part of the study was 80%. Eight schools provided the numbers of posterior restorations (composite and amalgam) placed in their faculty clinics over a 10-year period from 2008 to 2018. A total of 181,791 (101,813 composites and 79,978 amalgams) posterior restorations were performed by Canadian undergraduate students in the eight responding schools over the period from 2008 to 2018 (Figure 1). The placement of amalgam material was dominant in the posterior restoration distribution from 2008 to 2012. While from 2013 to

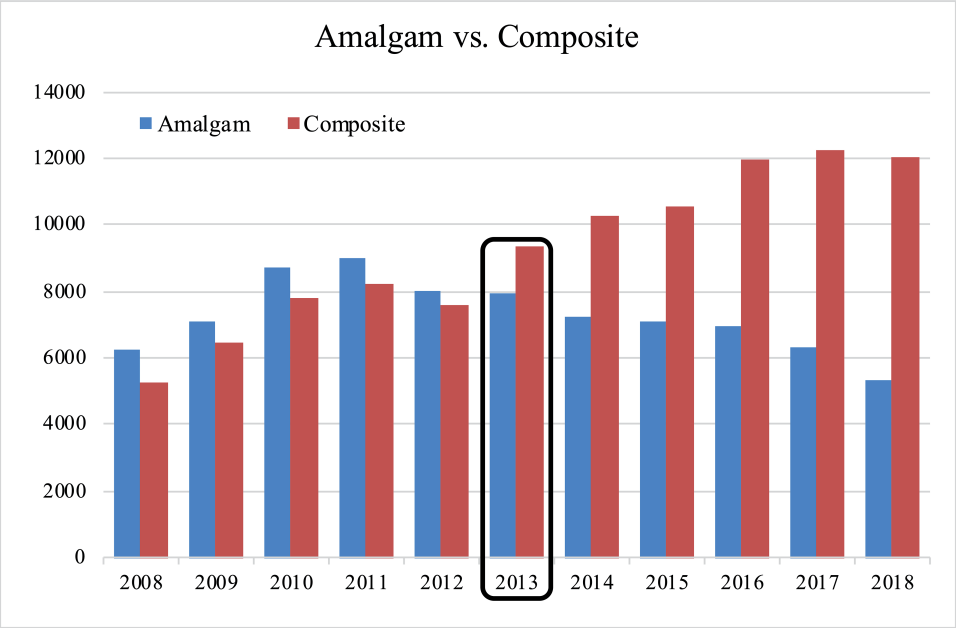

Figure 1. *Actual numbers of posterior restorations placed at the eight Canadian university clinics over a 10-year period.*

2018, the resin composite material was dominant in the restoration distribution. After 2013, a steady increase in the number of posterior composite restorations placed in all faculty clinics was observed.

Linear regression analysis revealed a significant increasing trend in placing posterior composites in all responding schools over time ($p<0.05$). Overall proportion of posterior composite restorations has increased from 46% in 2008 to 69% in 2018, while amalgam restorations proportion has decreased from 54% in 2008 to 31% in 2018, representing an annual average increase of 2.5% for posterior composite placement (Figure 2). When a Chi-square test was performed for each school individually (Figure 3), it showed significantly higher proportions of posterior composite restorations in 2018 compared to the earliest available year. This reveals an overall increasing trend in placement of posterior composites for all Canadian dental schools.

DISCUSSION

Questionnaire Results

One of the objectives of this study was to investigate the latest teaching policies of posterior composite placement versus amalgam in Canadian dental

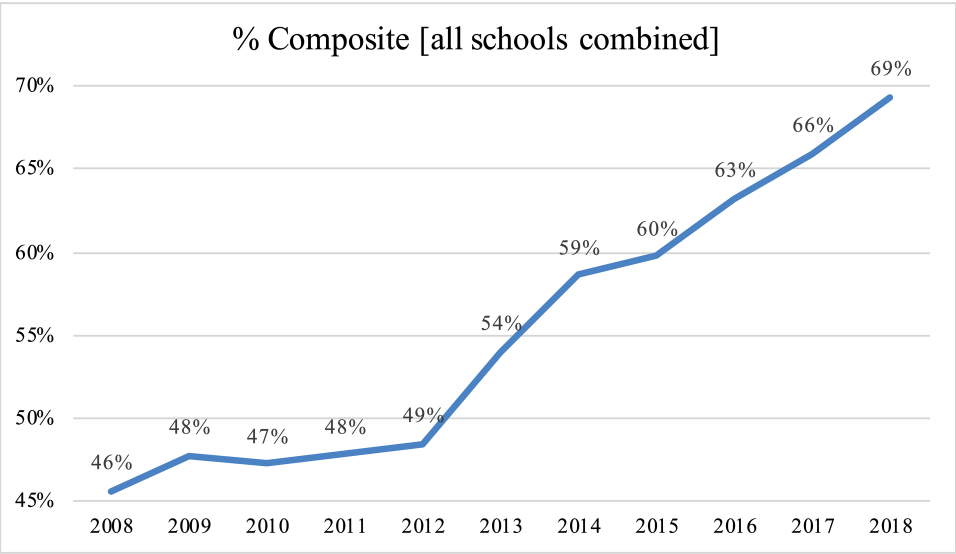

Figure 2. *Overall proportion of posterior composite restorations in all eight responding schools.*

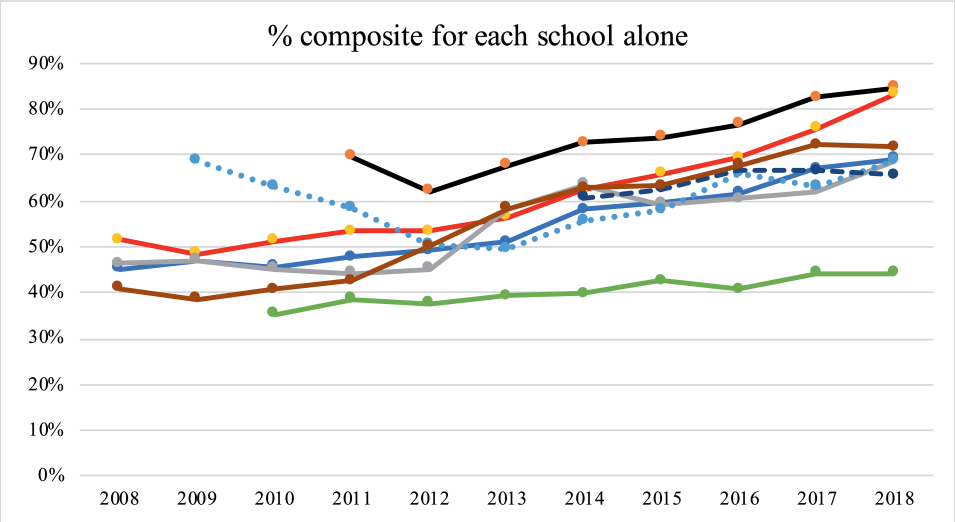

Figure 3. *Individual trends of posterior composite placement for the eight responding schools.*

schools. The findings of the current questionnaire indicate that the time assigned for teaching posterior composite in Canadian dental schools has not changed since 2005. Most (78%) of the responding schools allocated 25%-50% of their restorative teaching towards posterior composite placement, rejecting the first null hypothesis. Surprisingly, this was the same proportion (25%-50%) assigned for teaching posterior composite in Canadian dental schools, as reported by McComb in 2005.[22] On the other hand, Lynch and others reported that the time devoted to teaching posterior composite was found to match the time devoted to teaching amalgam in UK and Ireland dental schools in 2010.[25] Five years later, the average percentage of time allocated to teach posterior composite was increased to 36% (range: 10%-75%) and decreased to 25% (range: 10%-45%) for amalgam in 2015,[26] meaning that there was a transitional increase in the time percentage allocated to teach posterior composite placement with time in UK and Ireland schools.

In this present study, the teaching of amalgam placement was found to precede the teaching of posterior composite in most schools surveyed (89%). This is unlike in the majority of Japan and United Kingdom dental schools, where teaching the placement of posterior composites is before teaching amalgam placement since 2005.[2,27,28] The rational for preceding resin composite teaching to amalgam is that it is easier for dental students to base their approach to restorative dentistry on a preventive, minimally invasive approach to the treatment of caries, rather than on invasive and mechanical retentive principles that the students can transition to, gradually at a later stage.[6]

In the present study, competency tests are indicated for both resin composite and amalgam equally in 67% of the schools (n=6) compared to five schools in the Canadian study 15 years ago.[22] An exam of competency is a tool of assessment that has a critical role to evaluate the efficiency of provided education and whether the students have achieved the expected learning outcomes. Preclinical competency tests are meant to simulate real clinical scenarios to be considered valid. As mentioned above, only six schools (67%) currently mandate competency tests in their teaching curricula for both types of restorations, resin composite, and amalgam. However, successful dental education requires both teaching and assessment tools to be paralleled with clinical situations.[29]

Regarding contraindications for posterior restorations placement, almost all responding schools (n=8) identified "poor oral hygiene and high caries risk" as well as "inability to place a rubber dam" as contraindications for placing posterior composite restorations. And when placing amalgam restorations, responding schools (n=8) identified "patient mercury concerns" as a contraindication in the present study as well as in the previous one (2005).[22] These results are also similar to studies in Oceania, Japan, Spain, UK, and Ireland, where rubber dam was preferred in the most cases.[2,26,30,31] Considering that placement of resin composite material is technique-sensitive by nature, rubber dam placement is crucial to avoid moisture contamination and to ensure successful bonding.[32] Moreover, although there is no scientific evidence to support that the release of low levels of mercury vapor associated with dental amalgam restorations are hazardous, almost all schools in the current

study and the previous one (2005) identified "patient mercury concerns" as a contraindication for placing amalgam restorations.[33]

Five out of nine responding schools (55%) identified "cavity gingival margin on root surface" as a contraindication to the placement of resin composite in posterior teeth. On the other hand, all responding schools (n=8) from the previous Canadian study taught not to place composite when the cavity gingival margin is on root structure.[22] Comparatively, this finding "considering subgingival margin is contraindication to place posterior composites" was only regarded by 9% of dental schools in Austria, Germany, and Switzerland.[34] Advances in bonding systems and techniques have resulted in reduced polymerization shrinkage, microleakage, and recurrent caries in posterior composite restorations, which can explain a shift towards higher acceptability for placement of posterior composite in cavities with root and subgingival margins.[35]

Additionally, in the present study, only two schools considered "parafunctional activity (bruxism)" as a contraindication to restore posterior dentition with resin composite materials, compared to six schools in the previous study (2005).[22] The reasons why some schools avoid teaching the placement of posterior composite in bruxing patients is the fear of restoration fracture and wear.[36] According to Ferracane (2011), wear is considered to be a lesser problem for current materials as compared to those that were the standard of care a decade ago, in large part due to refinement in the size of the reinforcing fillers that significantly reduced the magnitude of abrasive wear.[36] In addition, resin composite material properties have improved to simulate the physical characteristics of enamel and dentin, alongside with growing evidence that supports the placement of composite in posterior teeth.[37] This resulted in a substantial increase in the placement of posterior composite restorations even for patients with bruxism or heavy occlusion.[27,37] Another point to consider is that bruxism diagnosis is not easy, and the criteria for diagnosis are not well-established, as reported by Demarco and others.[4] They also concluded that no validated criteria to assess bruxing habits, either for grinding or clenching, are yet available. Thus, conclusions regarding a direct relationship between bruxism and restoration failure are still not possible.[4]

In relation to preparation techniques of posterior restorations, 44% of the responding schools (n=4) are still teaching the beveling of the proximal gingival margin in resin composite preparation. In comparison, beveling the proximal box margin was taught by 45% of Japanese schools,[28] by 60% of Spanish schools,[31] and by 40% of dental schools in Oceania.[30] Beveling the gingival margin of proximal box could challenge the operator to achieve good marginal adaptation and compromise marginal integrity;[3] the beveling technique is required when placing anterior composite restorations but not posterior composites.[3] Based on the findings of this study, it seems that there is no consensus on preparation techniques for posterior composites among Canadian schools, possibly due to the lack of well-established restorative guidelines in North America.

With respect to the teaching of bulk-fill composite materials when restoring posterior teeth, interestingly, four schools (44%) reported that they do include bulk-fill composites in their restorative curriculum. It is fair to mention that placement of bulk-fill materials is less time consuming and can possibly be polymerized adequately according to Hickey and others.[38]

Posterior Restorations Quantitative Data

The analysis of data given by the eight responding schools rejects the second null hypothesis, as it revealed that resin composite material surpassed amalgam in the distribution of posterior restorations for the past 5 years (2013-2018) (Figure 1). The placement of posterior composite restorations increased by an average rate of 2.5% every year (Figure 2). A growing transition towards the placement of posterior composite restorations and a continuous reduction in amalgam placement was noted since 2008 (6236 amalgam restorations and 5233 composite restorations were placed in Canadian school clinics in 2008). An Israeli study also noted similar observations in 2018.[39] The total number of posterior restorations placed in the past 10 years (2008-2018) was 181,791 (101,813 composites and 79,978 amalgams), asserting that composite material is the predominant posterior restoration material in the Canadian school clinics. It is noteworthy that the number of posterior composites exceeded the number of amalgam restorations in the period from 2013 to 2018, marking the year of 2013 as a turning point. The turning point indicates the starting time when posterior composite restorations were placed more than amalgam restorations.

The clear trend that favors resin composite material since 2013 (Figure 1) can be justified by plenty of reasons. Resin composite esthetic and adhesive properties as well as the controversy over

amalgam safety are likely to be the most popular reasons. Other factors that could have led to such trend are advances in resin composite material and armamentarium, patients, and clinical instructors. For example, creating proximal contact in an occlusoproximal restoration was a real problem before 2008, until sectional matrix systems were introduced, and provided more anatomical and stronger contact areas than a circumferential matrix.[40] Alongside the continued development of new resin composite materials, like bulk-fill that can be polymerized adequately and more quickly,[38] patient preference of restorative material also can play a major role; resin composite esthetic properties can be very appealing to patients, as well as the fear of mercury in amalgam allowed the increase of patients' demand towards resin composite material. The increased number of posterior composite restorations in faculty clinics during the last 5 years of data collection (2013-2018) could indicate that clinical instructors favored using resin composite over amalgam in clinical courses. Clinical instructor preference for resin composite material could be due to gained confidence in posterior composite materials and their several years of clinical experience that led to mastering resin composite placement techniques.

Amalgam material has an undeniable long-standing history of service in dentistry for over 150 years. Amalgam has been the material of choice for many decades due to its strength, durability, resistance to heavy occlusal loads, and the ability to be very effective in otherwise challenging scenarios such as subgingival margins, poor oral hygiene, and moisture control. However, amalgam cavity preparation requires unnecessary removal of sound tooth structure to ensure sufficient resistance and retention forms, which can be avoided with the use of composite material.[1]

Principles of posterior composite cavity design depend on minimally invasive techniques that allow micromechanical bonding to the tooth structure without sacrificing sound tissue to achieve resistance and retention forms.[1] The advantage of minimally invasive approach when restoring posterior teeth is by far the most important reason behind the substantial increase in the posterior composites placement in the last 5 years, as shown in Figure 1 (in 2018 alone, 12,033 posterior composites and 5320 amalgam restorations were placed in Canadian schools clinics).[21,24] Although the overall proportion of posterior composite restorations has increased from 46% in 2008 to 69% in 2018 (Figure 2), our questionnaire results revealed that in the majority of responding schools (78%, n=7) the restorative teaching devoted to resin composite can be as low as 25%. Only two schools allocated more than 50% of their restorative teaching towards posterior composite placement. The same disconnection was also found in the data provided about amalgam material. Overall proportion of amalgam restorations has dropped from 54% in 2008 to 31% 2018 (Figure 2), yet there are seven Canadian schools who are allocating the same percentage (25%-50%) of the restorative teaching towards resin composite and amalgam equally. The misalignment between the amounts of time assigned to teaching each restorative material and numbers of posterior restorations placed in faculty clinics urges revision of teaching policies.

Restorative teaching should be dynamic and able to renovate over time to meet the requirements of the evolving world of dentistry. Graduating students should be the best prepared to match the expectations of modern dentistry, since students who are graduating in 2018 are expected to practice dentistry till 2050 or even more. Decision makers are responsible to ensure that graduating dentists are confidant and ready to address the requirements of modern practice.

CONCLUSIONS

The results of this study quantified a definite trend towards an increase of posterior composite restorations placed in Canadian dental schools in the years from 2008 to 2018. This increase was not paralleled by a similar increase in the time allocated for preclinical teaching. A similar opposite trend towards a decrease in the number of amalgam restorations placed was also observed in all Canadian dental schools. Based on the findings of this study, it is suggested that:

- The time devoted for teaching each restorative material in preclinical courses should be revised and adjusted.
- A national guideline should be developed to help overcome inconsistencies in teaching policies among Canadian schools.

Acknowledgements

This study did not receive any external financial support directed to its development, aside from the author's support and human and facilities' resource.

This study was supported by the Saudi Arabian Cultural Bureau to Lulwah Alreshaid and by NSERC (Natural Sciences

and Engineering Research Council of Canada) Discovery Grant (#2018-06489) to Anuradha Prakki.

Regulatory Statement

The author represents that the study was performed in compliance with author's institution's appropriate policies related to the use of animal and/or human subjects and human-derived material.

Conflict of Interest

The authors of the present study certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in the present article.

(Accepted 13 February 2021)

References

1. Lynch CD & Wilson NHF (2008) *Successful posterior composites* Quintessence London.
2. Hayashi M, Seow LL, Lynch CD, & Wilson NH (2009) Teaching of posterior composites in dental schools in Japan *Journal of Oral Rehabilitation* **36(4)** 292-298. 10.1111/j.1365-2842.2008.01935.x
3. Lynch CD, Opdam NJ, Hickel R, Brunton PA, Gurgan S, Kakaboura A, Shearer AC, Vanherle G, & Wilson NH (2014) Guidance on posterior resin composites: Academy of Operative Dentistry - European Section *Journal of Dentistry* **42(4)** 377-383. 10.1016/j.jdent.2014.01.009
4. Demarco FF, Corrêa MB, Cenci MS, Moraes RR, & Opdam NJ (2012) Longevity of posterior composite restorations: not only a matter of materials *Dental Materials* **28(1)** 87-101. 10.1016/j.dental.2011.09.003
5. Brunton PA, Ghazali A, Tarif ZH, Loch C, Lynch C, Wilson N, & Blum IR (2017) Repair vs replacement of direct composite restorations: A survey of teaching and operative techniques in Oceania *Journal of Dentistry* **59** 62-67. 10.1016/j.jdent.2017.02.010
6. Lynch CD, Frazier KB, McConnell RJ, Blum IR, & Wilson NH (2011) Minimally invasive management of dental caries: contemporary teaching of posterior resin-based composite placement in U.S. and Canadian dental schools *Journal of American Dental Association* **142(6)** 612-620. 10.14219/jada.archive.2011.0243
7. Wilson NH & Setcos JC (1989) The teaching of posterior composites: A worldwide survey *Journal of Dentistry* **17 (Supplement 1)** S29-33; discussion S47-52. 10.1016/0300-5712(89)90160-7
8. Mjör IA & Wilson NH (1998) Teaching Class I and Class II direct composite restorations: results of a survey of dental schools *Journal of American Dental Association* **129(10)** 1415-1421. 10.14219/jada.archive.1998.0076
9. Kopperud SE, Staxrud F, Espelid I, & Tveit AB (2016) The post-amalgam era: Norwegian dentists' experiences with composite resins and repair of defective Amalgam Restorations *International Journal of Environmental Research and Public Health* **13(4)** 441. 10.3390/ijerph13040441
10. Vidnes-Kopperud S, Tveit AB, Gaarden T, Sandvik L, & Espelid I (2009) Factors influencing dentists' choice of amalgam and tooth-colored restorative materials for Class II preparations in younger patients *Acta Odontologica Scandinavica* **67(2)** 74-79. 10.1080/00016350802577800
11. Vidnes-Kopperud S, Tveit AB, & Espelid I (2011) Changes in the treatment concept for approximal caries from 1983 to 2009 in Norway *Caries Research* **45(2)** 113-120. 10.1159/000324810
12. Eklund SA (2010) Trends in dental treatment, 1992 to 2007 *Journal of American Dental Association* **141(4)** 391-399. 10.14219/jada.archive.2010.0191
13. Opdam NJ, Bronkhorst EM, Roeters JM, & Loomans BA (2007) A retrospective clinical study on longevity of posterior composite and amalgam restorations *Dental Materials* **23(1)** 2-8. 10.1016/j.dental.2005.11.036
14. Baraba A, Domejean-Orliaguet S, Espelid I, Tveit AB, & Miletic I (2010) Survey of Croatian dentists' restorative treatment decisions on approximal caries lesions *Croatian Medical Journal* **51(6)** 509-514. 10.3325/cmj.2010.51.509
15. Doméjean-Orliaguet S, Tubert-Jeannin S, Riordan PJ, Espelid I, & Tveit AB (2004) French dentists' restorative treatment decisions *Oral Health and Preventive Dentistry* **2(2)** 125-131.
16. Forss H & Widström E (2001) From amalgam to composite: selection of restorative materials and restoration longevity in Finland *Acta Odontologica Scandinavica* **59(2)** 57-62. 10.1080/000163501750157090
17. Friedl KH, Hiller KA, & Schmalz G (1995) Placement and replacement of composite restorations in Germany *Operative Dentistry* **20(1)** 34-38.
18. Sunnegårdh-Grönberg K, van Dijken JW, Funegård U, Lindberg A, & Nilsson M (2009) Selection of dental materials and longevity of replaced restorations in Public Dental Health clinics in northern Sweden *Journal of Dentistry* **37(9)** 673-678. 10.1016/j.jdent.2009.04.010
19. Lynch CD, McConnell RJ, & Wilson NH (2007) Trends in the placement of posterior composites in dental schools *Journal of Dental Education* **71(3)** 430-434.
20. Nascimento GG, Correa MB, Opdam N, & Demarco FF (2013) Do clinical experience time and postgraduate training influence the choice of materials for posterior restorations? Results of a survey with Brazilian general dentists *Brazilian Dental Journal* **24(6)** 642-646. 10.1590/0103-6440201302361
21. Wilson NH & Lynch CD (2014) The teaching of posterior resin composites: planning for the future based on 25 years of research *Journal of Dentistry* **42(5)** 503-516. 10.1016/j.jdent.2014.02.014
22. McComb D (2005) Class I and Class II silver amalgam and resin composite posterior restorations: Teaching approaches in Canadian faculties of dentistry *Journal of the Canadian Dental Association* **71(6)** 405-406.
23. Lynch CD, McConnell RJ, & Wilson NH (2006) Teaching the placement of posterior resin-based composite restorations in U.S. dental schools *Journal of American Dental Association* **137(5)** 619-625. 10.14219/jada.archive.2006.0257
24. Alexander G, Hopcraft MS, Tyas MJ, & Wong RH (2014) Dentists' restorative decision-making and implications for

an 'amalgamless' profession. Part 1: A review *Australian Dental Journal* **59(4)** 408-419. 10.1111/adj.12209

25. Lynch CD, Frazier KB, McConnell RJ, Blum IR, & Wilson NH (2010) State-of-the-art techniques in operative dentistry: contemporary teaching of posterior composites in UK and Irish dental schools *British Dental Journal* **209(3)** 129-136. 10.1038/sj.bdj.2010.674
26. Lynch CD, Blum IR, McConnell RJ, Frazier KB, Brunton PA, & Wilson NHF (2018) Teaching posterior resin composites in UK and Ireland dental schools: do current teaching programmes match the expectation of clinical practice arrangements? *British Dental Journal* **224(12)** 967-972. 10.1038/sj.bdj.2018.446
27. Lynch CD, McConnell RJ, & Wilson NH (2006) Teaching of posterior composite resin restorations in undergraduate dental schools in Ireland and the United Kingdom *European Journal of Dental Education* **10(1)** 38-43. 10.1111/j.1600-0579.2006.00394.x
28. Hayashi M, Yamada T, Lynch CD, & Wilson NHF (2018) Teaching of posterior composites in dental schools in Japan - 30 years and beyond *Journal of Dentistry* **76** 19-23. 10.1016/j.jdent.2018.02.002
29. Koole S, Van Den Brulle S, Christiaens V, Jacquet W, Cosyn J, & De Bruyn H (2017) Competence profiles in undergraduate dental education: a comparison between theory and reality *BioMed Central Oral Health* **17(1)** 109. 10.1186/s12903-017-0403-4
30. Loch C, Liaw Y, Metussin AP, Lynch CD, Wilson N, Blum IR, & Brunton PA (2019) The teaching of posterior composites: A survey of dental schools in Oceania *Journal of Dentistry* **84** 36-43. 10.1016/j.jdent.2019.01.005
31. Castillo-de Oyagüe R, Lynch C, McConnell R, & Wilson N (2012) Teaching the placement of posterior resin-based composite restorations in Spanish dental schools *Medicina Oral Patologia Oral y Cirugia Bucal* **17(4)** e661-668. 10.4317/medoral.17656
32. Mala S, Lynch CD, Burke FM, & Dummer PM (2009) Attitudes of final year dental students to the use of rubber dam *International Endodontic Journal* **42(7)** 632-638. 10.1111/j.1365-2591.2009.01569.x
33. U.S Food and Drug Administration (2009) Addendum to the Dental Amalgam, White Paper: Response to 2006 Joint Advisory Panel Comments and Recommendations In: Health CfDaR (ed).
34. Kanzow P, Büttcher AF, Wilson NHF, Lynch CD, & Blum IR (2020) Contemporary teaching of posterior composites at dental schools in Austria, Germany, and Switzerland *Journal of Dentistry* **96** 103321. 10.1016/j.jdent.2020.103321
35. Ritter AV (2001) Posterior resin-based composite restorations: Clinical recommendations for optimal success *Journal of Esthetic and Restorative Dentistry* **13(2)** 88-99.
36. Ferracane JL (2011) Resin composite–state of the art *Dental Materials* **27(1)** 29-38. 10.1016/j.dental.2010.10.020
37. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, & Eden E (2012) Minimal intervention dentistry for managing dental caries - a review: Report of a FDI task group *International Dental Journal* **62(5)** 223-243. 10.1111/idj.12007
38. Hickey D, Sharif O, Janjua F, & Brunton PA (2016) Bulk dentine replacement versus incrementally placed resin composite: A randomised controlled clinical trial *Journal of Dentistry* **46** 18-22. 10.1016/j.jdent.2016.01.011
39. Zabrovsky A, Mahmoud R, Beyth N, & Ben-Gal G (2018) Direct posterior restorations: A 13-year survey of teaching trends and use of materials *Operative Dentistry* **43(6)** E273-E279. 10.2341/17-361-C
40. de la Peña VA & García RP (2016) Sectional matrix: Step-by-step directions for their clinical use *British Dental Journal* **220(1)** 11-14. 10.1038/sj.bdj.2016.18