

Teaching the Use of Resin Composites in Canadian Dental Schools: How Do Current Educational Practices Compare with North American Trends?

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ABSTRACT

The placement of resin composites in posterior teeth is now a common procedure in dental practice. The aim of this study was to investigate current teaching of this procedure in Canadian dental schools and to compare trends in teaching with those in the United States. This study complements other investigations in which we examined teaching of the use of posterior resin composites in dental schools in the United States, Ireland and the United Kingdom. A questionnaire was distributed by email to the faculty member in each of the 10 dental schools in Canada with responsibility for teaching the operative dentistry curriculum, including the placement of posterior resin composites. The response rate was 100%. More teaching of posterior resin composites was noted since the time of a survey in the late 1990s. The amount of teaching and clinical experience in the use of posterior resin composites in Canadian dental schools seems to be higher than in dental schools in the United States. As noted in surveys of other countries, variation among Canadian teaching programs was found to persist in relation to techniques and technologies used.

MeSH Key Words: composite resins; curriculum; dental restoration, permanent/methods; dentistry operative/education

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In recent years, there has been a substantial change in the ways dentists practise operative dentistry, including an increase in the use of resin composites for the restoration of posterior teeth.¹ This has been driven by increased predictability of the performance of resin composites in posterior teeth; the development of improved resin composite materials, bonding systems and techniques; and increased demand by patients for more esthetic restorations in preference to silver amalgam.¹⁻⁵ Evidence now exists in the dental literature to support the use of resin composite as a direct restorative material in occlusal and

occlusoproximal cavities.^{3,4} When placed correctly, posterior resin composite restorations may be as serviceable as those using silver amalgams.² Compared with silver amalgam, resin composite has a more esthetic appearance,⁶ obviates the need to remove sound tooth tissue for retention, which reduces the subsequent risk of tooth fracture, and reinforces the remaining tooth substance.⁷ Disadvantages of resin composites include greater technique sensitivity, longer time to place a posterior restoration and higher cost than silver amalgam.^{2,4,8}

There is growing evidence of the increased use of resin composites in posterior teeth. In a 2003 survey of dentists in the United Kingdom, half the respondents reported placing direct resin composites in load-bearing situations in permanent molars.⁹ Clearly, dental educators have a responsibility to ensure that their students gain competence in the use of resin composites, both in anterior and posterior teeth.

A recent survey of the teaching of the use of silver amalgams and posterior resin composites in 8 adult operative departments and 10 pedodontic departments in Canada¹⁰ revealed an increase in attention devoted to resin composites since the time of the last such survey in the late 1990s.¹¹ One of the authors of the present study completed the latter investigation, along with similar investigations in the United States,¹¹ Europe¹² and Japan¹³ at that time. Each of these surveys demonstrated increased teaching in the use of resin composites in posterior teeth compared with 10 years previously; however, the increase was greater in European dental schools than in North American dental schools.^{11,12} In the late 1990s, most graduates of North American dental schools had minimal clinical experience in the placement of Class I and Class II composite restorations.¹¹

Surveys of educational practices are valuable to dental education. Data on current teaching practices and trends can

- inform teachers and schools of both national and international curriculum trends
- highlight contemporary education needs that will best prepare today's students for clinical practice
- provide evidence to press for change in dental education programs at local, national and international levels
- stimulate debate on curriculum development
- demonstrate the need for agencies, such as state examination boards, to keep up to date.

Recent surveys by the authors found an increase in the amount of teaching of posterior resin composites in Irish, U.K. and U.S. dental schools, although the increase in the U.S. was not as great as in Ireland and the U.K.^{14,15} The reasons for this were not entirely clear, but were considered, at least in part, to be due to the curriculum requirements for licence examinations in the U.S. The primary aim of the present study was to investigate the teaching of the use of posterior resin composites in dental schools in Canada in 2005. A secondary aim, not addressed in a recently published study,¹⁰ was to compare findings with those of contemporary teaching practices in dental schools in the U.S.

Methods

A questionnaire was distributed by email to the faculty member in each of the 10 dental schools in Canada who has responsibility for the operative dentistry curriculum. The questionnaire sought information pertaining to the

teaching of posterior resin composites in each school. It included 19 closed statements (where respondents were given a number of possible responses to a statement and asked to identify the most appropriate one) and 10 open-ended statements (where respondents were given some space in which to write a response). Information received was entered into a Microsoft Excel spreadsheet.

The results of this survey are presented in 2 sections: current practices in the teaching of posterior resin composites in Canadian dental schools and comparison of these findings with contemporary practices in the U.S. Although the results are primarily descriptive, statistical tests were used to examine the differences between Canadian and U.S. responses to some key questions. The tests used were the chi-squared test for examining the association between 2 qualitative variables and a 2-sample hypothesis test of the difference between percentages of 2 populations. A 5% level of significance was used for all tests. In total, 31 tests were carried out and no adjustment was made for multiple testing. It should be noted that 1 in 20 tests will be significant by chance. The tests were carried out in the Statistical Package for the Social Sciences database, version 11 (SSPS Inc., Chicago, Ill.).

Results

Ten completed questionnaires were returned, giving a response rate of 100%. Questionnaires were completed by either the head of the department, or equivalent, or by a senior member of the teaching staff with specific responsibility for teaching posterior resin composites.

Current Practices in Canadian Dental Schools

Procedures Taught — All schools reported that they teach the placement of resin composite in occlusal and 2-surface occlusoproximal cavities in premolars and permanent molars. Nine schools teach the placement of 3-surface occlusoproximal resin composites in premolars and molars. The remaining school does not intend to introduce the teaching of 3-surface resin composites within the next 5 years.

Preclinical and Clinical Teaching of Posterior Resin Composite and Silver Amalgam — Seven schools reported that they teach the placement of silver amalgam restorations before the placement of resin composites. In 5 years time, 5 schools expect the teaching of resin composite to precede the teaching of silver amalgam. Respondents expected that preclinical teaching of the use of posterior resin composites would increase, on average, to 1.5 times the current level over the next 5 years. Conversely, they expected that preclinical teaching of the use of silver amalgam would decrease to 75% of the current level within 5 years. It was reported that, on average, 49% of posterior restorations placed by Canadian dental students were of resin composite, while 51% were silver amalgam.

Table 1 Number of survey respondents reporting various contraindications to the placement of posterior resin composites

Contraindication	Occlusal cavities in premolars	Occlusal cavities in molars	Occluso-proximal cavities in premolars	Occluso-proximal cavities in molars
Inability to place rubber dam	6	6	9	9
Parafunctional activity	3	3	4	4
Pathologic wear	5	5	6	6
Poor oral hygiene	4	4	5	5
Replacement of a large amalgam restoration	3	5	4	5
History of allergy to resin composites	7	7	7	7
Atypical diet	1	1	1	1
Large pulp	2	2	2	2
Proximity to the pulp	1	1	1	1
Denture abutment	2	2	4	4
Subgingival margins			7	7
Temporomandibular dysfunction	1	1	1	1
No valid esthetic requirement	3	3	3	3
Endodontically treated tooth	1	1	1	1
Opposition to resin composite restoration	0	0	0	0
Susceptibility to caries	5	5	6	6
Poor patient cooperation	6	6	8	8
History of postoperative pain with posterior composite restorations	5	5	5	5
Poor enamel quality	4	4	4	4
Buccolingual width of occlusal portion less than a third of intercuspal width	0	0	0	0
Buccolingual width of occlusal portion half the intercuspal width	3	3	3	3
Buccolingual width of occlusal portion more than two-thirds the intercuspal width	7	7	7	7
Buccolingual width of proximal box more than half intercuspal width			2	2

Differences in Cavity Preparations — In contrast with posterior silver amalgam cavity preparations, 8 schools teach minimally invasive (“slot-type”) preparations, 7 schools teach the rounded internal line angles technique and 6 schools teach bevelling of proximal box margins. Bevelling of the occlusal margin is not taught at any school.

Contraindications — Reported contraindications to the placement of resin composites are summarized in **Table 1**.

Moisture Control — All schools teach their students that a rubber dam should be used in most cases in which posterior resin composites are to be placed. Alternative forms of moisture control taught include cotton wool rolls (5 schools) and dry guards (4 schools).

Linings and Bases — Total etching is taught by all schools for shallow cavities (outer third of dentin), by 7 schools for moderate cavities (middle third of dentin) and by 3 schools for deep cavities (inner third of dentin). Three schools teach the use of a glass-ionomer cement base when restoring moderate cavities. For deep cavities, 7 schools teach the use of a glass-ionomer cement base; 3 of these also teach the use of calcium hydroxide liners.

Matrix and Wedging Techniques — Eight schools teach the use of a sectional or circumferential metal matrix band and wooden wedge. Two schools teach the use of transparent matrix bands only, in combination with either a wooden or light-transmitting wedge.

Commercial Brands of Resin Composite and Bonding Systems Taught — All schools teach the use of hybrid or microhybrid resin composites for restoration of posterior cavities. One school also teaches the use of a macrofilled resin composite for occlusoproximal cavities. Common commercial brands of resin composite used are Z250 (3M ESPE, London, Ont.) (4 schools) and Filtek Supreme (3M ESPE) (3 schools). Common commercial bonding systems are Singlebond (3M ESPE) (4 schools) and Scotchbond Multipurpose (3M ESPE) (3 schools).

Curing Lights — All 10 schools teach the use of traditional quartz–halogen curing lights. The use of plasma-arc or light-emitting diode (LED) curing lights is not taught.

Finishing Techniques — All schools teach immediate finishing techniques for posterior resin composites, with 6 schools teaching the use of water-cooling for this purpose. Popular instruments included finishing strips (9 schools), finishing diamonds (8 schools), finishing discs (8 schools) and diamond-impregnated rubber points (7 schools).

Fees — All schools charge fees for posterior restorations placed by students. On average, they charge \$36 for an occlusal silver amalgam, \$39 for an occlusal resin composite, \$54 for an occlusoproximal silver amalgam and \$62 for an occlusoproximal resin composite.

Indirect Resin Composite Restorations — Nine Canadian dental schools teach their students the use of indirect resin composites. Of these schools, 6 provide didactic teaching only and 3 include practical or clinical teaching.

Comparison of Contemporary Practices in Dental Schools in Canada and the United States

Differences were noted between current educational practices in Canadian and U.S. dental schools in relation to posterior resin composites.

In contrast with the extensive teaching of placement of resin composites in 2- and 3-surface occlusoproximal cavities in premolar and permanent molars in Canada, 10% of U.S. dental schools do not teach 2-surface placement and almost 25% do not teach 3-surface placement of resin composites.

Although the amount of time available for preclinical teaching about posterior resin composites is expected to increase in U.S. dental schools at a similar rate to that in Canadian schools (to 1.5 times its current amount in 5 years), statistically significant differences ($p < 0.05$) were noted in relation to the proportion of silver amalgams and posterior resin composites placed by dental students. Canadian dental students place more posterior resin composites than their U.S. counterparts (49% vs. 31%, respectively) and fewer silver amalgam restorations than U.S. dental students (51% vs. 62%, respectively). It was expected that in 5 years time, Canadian dental students would continue to place more posterior resin composites

than silver amalgams (60% posterior resin composites vs. 40% silver amalgams), whereas half of posterior direct restorations placed by U.S. dental students would be resin composites.

Although there were similarities in the principles of cavity preparation taught in U.S. and Canadian schools, a quarter of U.S. schools teach their students to bevel the occlusal margin of cavities before placement of the resin composite — a technique that is not taught in Canadian dental schools. Disagreement was also found in relation to contraindications to the placement of posterior resin composites taught in U.S. and Canadian schools. In U.S. dental schools, the contraindications most commonly taught are a history of allergy to resin composites and the presence of subgingival margins for occlusoproximal cavities.

Both similarities and differences were noted in relation to the techniques taught for lining and basing cavities. Nearly all dental schools in both countries teach total etching for shallow cavities and 70% teach this technique for moderate cavities. However, significantly more schools in Canada teach total etching for deep cavities than in the U.S. (30% vs. 9%; $p < 0.05$).

In contrast with Canadian dental schools, the most popular resin composites taught in U.S. schools were Point 4 (Kerr Corp., Orange, Calif.) and Esthet-X (Dentsply, York, Penn.), while popular bonding agents taught were Optibond Solo (Kerr) and Prime & Bond (Dentsply).

A significant difference ($p < 0.05$) was noted in relation to teaching the use of curing lights. In contrast with Canadian schools, where only the traditional quartz–halogen light is demonstrated, 40% of U.S. dental schools teach the use of LED curing lights and half of these teach the use of LED curing lights only.

Discussion

Resin composites are now a feature of contemporary dental practice.^{1,2} Along with recent developments in resin composite technologies, there is evidence to support the use of resin composite as a direct restorative material for occlusal and occlusoproximal cavities.^{3,4} There is also increased demand for resin composites by patients.^{1,2} Because of this, dental educators have a clear responsibility to ensure that their students receive suitable exposure to the use of resin composites. Failure to do so will result in graduating dental practitioners who lack essential competencies in the placement of posterior resin-based composites. Given that the graduating class of 2005 will continue to practise dentistry until the mid-2040s, their incompetence in the use of resin composites would be significant. Has dental education in Canada developed to meet the demand in this area?

Students graduating from Canadian dental schools in the 1980s and early 1990s received little or no education in the placement of posterior resin composites.¹⁶ A 1997

survey revealed that the situation had improved somewhat, with increased teaching and training in posterior resin composites; however, most graduates had “minimal clinical experience with Class I and Class II composite restorations.”¹¹ A recently published survey by McComb¹⁰ confirmed an increase in the teaching of posterior resin composites in Canada, although not as great as that found in this investigation. These results reflect the trend in Ireland and the U.K.¹⁴ and are ahead of current trends in U.S. dental schools.¹⁵ The reasons for the difference between Canadian and U.S. dental schools probably depend on a number of factors, but may relate to the strong emphasis still placed on silver amalgam in U.S. state licensure examinations¹⁵ and to discussions surrounding a Health Canada report¹⁷ on the safety of silver amalgam.

Posterior resin composites command a strong position in Canadian operative dentistry teaching programs, with all 10 schools teaching occlusal and 2-surface occlusoproximal restorations and 9 schools teaching 3-surface restorations. Canadian dental students now gain equal experience in the placement of resin composites and silver amalgams, and in 5 years the use of resin composites is expected to dominate. In Canadian dental schools, resin composites have matched, or will soon equal, silver amalgams as the direct restorative material selected for the restoration of posterior teeth. This is appropriate given the current trend to place more posterior resin composites in general dental practice.⁹ This shift in teaching may “drive” further increases in the use of resin composites in posterior teeth.

There was some consistency among Canadian dental schools in the teaching of cavity designs for appropriate placement of posterior resin composites. Most schools teach preparation of rounded internal line angles, bevelled proximal box margins and the removal of remaining tooth tissues in line with the principle of minimally invasive operative dentistry. In keeping with current thinking, no school teaches bevelling of occlusal cavosurface margins. (Such practices are generally contraindicated as thin occlusal extensions of composite may fracture under occlusal loading.²) This was in contrast with the situation in the U.S.,¹⁵ where a quarter of schools teach their students to surface-bevel occlusal cavosurface margins.

Although 7 Canadian schools consider a “history of allergy to resin composites” a contraindication to the use of such materials, the literature contains little evidence of patient allergy to resin composites.¹² However, when an allergic reaction to resin composites occurs, it can be profound. As in U.S. dental schools,¹⁵ a third of Canadian schools do not consider subgingival margins to be a contraindication to the placement of occlusoproximal resin composites.

This study reveals a lack of agreement among Canadian dental schools in teaching about liners and bases for posterior resin composites in moderately deep cavities.

This variation was also noted in reports of surveys of U.S.,¹⁵ Irish and U.K.¹⁴ dental schools. Such inconsistency in teaching is a reflection of the lack of consensus in the research community on the appropriate management of operatively exposed dentin.

There is some concern regarding the teaching of matrix and wedging techniques for occlusoproximal resin composites. A recently published *in vitro* study¹⁸ demonstrated that the use of transparent matrices and light-transmitting wedges could result in the formation of significant proximal overhangs. The detrimental effects on the periodontal tissues are self-evident. Transparent matrix bands are regarded as too thick and stiff for anatomic reproduction of the proximal contour of teeth.^{18,19} It has also been demonstrated that light-transmitting wedges are too stiff to be successfully adapted to the gingival margin. Such wedges tend to make contact limited rather than along the entire gingival margin.¹⁸ Such poor adaptation can lead to the escape of excess material and the formation of undesirable overhangs and marginal excesses.¹⁸

No Canadian school provides clinical teaching of the use of newer forms of curing lights, such as LED lights; instead, all focus on traditional quartz-halogen curing lights. LED curing lights are a recent development in operative dentistry,²⁰ but there is growing evidence to support their use.²¹ Clinical exposure to the newer forms of curing lights, among other technologies, at dental school would encourage familiarity with their use in subsequent practices and would help new graduates interact successfully with members of the dental trade profession and others.

In contrast to findings from previous studies in North America and Canada,^{11,16,22} most Canadian dental students now gain experience in the placement of posterior resin composites. However, there is continuing evidence of diversity in teaching among the schools, especially in relation to the teaching of contraindications to the placement of posterior resin composites, the use of liners and bases and the total-etch technique. In an area where new materials and techniques are continuously being developed, it is important that dental students have a clear understanding of the basic principles of posterior resin composites and adequate exposure to associated technologies such as newer forms of curing light. Teachers of operative and restorative dentistry need to be proactive in adapting teaching programs to ensure that graduating students are best prepared to make the transition to clinical practice and lifelong learning. The extent to which this is happening with posterior resin composites in Canada exceeds current practice in U.S. dental schools.

Conclusions

This study confirms the findings of a recently published survey that demonstrated a clear increase in the

teaching and clinical experience of dental students in Canada in the use of resin composites for the restoration of posterior teeth since previous surveys in the 1980s and 1990s. Although this increase exceeds that noted in U.S. dental schools, there is diversity of teaching with respect to some principles of posterior resin composites, in particular, contraindications to their placement and the use of liners and bases. Canadian dental students also do not receive clinical teaching in newer forms of curing lights, notably LED curing lights.

The challenge to those responsible for dental school curricula is to ensure that graduating students are best prepared to address the expectations of the modern clinical practice of dentistry. ♦

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