

State-of-the-art techniques in operative dentistry: contemporary teaching of posterior composites in UK and Irish dental schools

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VERIFIABLE CPD PAPER

Aim Advances of composite systems and their application have revolutionised the management of posterior teeth affected by caries, facilitating a minimally invasive approach. Previous surveys have indicated that the teaching of posterior composites within dental schools was developing, albeit not keeping pace with clinical evidence and the development of increasingly predictable techniques and materials. Concurrently, surveys of dental practice indicate that dental amalgam still predominates as the 'material of choice' for the restoration of posterior teeth within UK general dental practice. In light of such considerations, the aim of this study was to investigate current teaching of posterior composites in Irish and UK dental schools. **Methods** An online questionnaire which sought information in relation to the current teaching of posterior composites was developed and distributed to the 17 established Irish and UK dental schools with undergraduate teaching programmes in late 2009. **Results** Completed responses were received from all 17 schools (response rate = 100%). All 17 schools taught the placement of occlusal and two-surface occlusoproximal composites in premolar and permanent molar teeth. Two schools did not teach placement of three-surface occlusoproximal composites in either premolars or molars. In their preclinical courses, ten schools taught posterior composites before teaching dental amalgams. Fifty-five percent of posterior restorations placed by dental students were of composite (range = 10-90%) and 44% amalgam (range = 10-90%), indicating an increase of 180% in the numbers of posterior composites placed over the past five years. Diversity was noted in the teaching of clinical techniques and students at different schools are trained with different composites and bonding systems. Some cause for concern was noted in the teaching of certain techniques that were not in keeping with existing best evidence, such as the teaching of transparent matrix bands and light-transmitting wedges for occluso-proximal composites (eight schools) and the teaching of bevels on the cavosurface enamel margins of both the occlusal and proximal box margins (three schools). **Conclusion** The teaching of posterior composites in the Irish and UK dental schools has substantially increased over the last five years. Dental students in these schools often gain more experience in the placement of posterior composites than amalgam. However, practice trends indicate that a majority of GDPs continue to place amalgam in preference to composite, thereby suggesting a source of tension as current dental students emerge into the dental workforce over the coming years. There is, as a consequence, a challenge to the dental profession and its funding agencies in the UK to encourage more of a shift towards the minimally interventive use of composite systems in the restoration of posterior teeth, in particular among established practitioners.

IN BRIEF

- Provides the reader with details of advances in the teaching of restoration of posterior teeth in UK and Irish dental schools.
- Enables an appreciation of the experience and training of new dental school graduates in the restoration of posterior teeth.
- Outlines the projected changes in education and training of dental students over the next five years.

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INTRODUCTION

One of the greatest innovations to change the practice of operative dentistry in recent times has been the introduction of reliable and predictable adhesive techniques to bond restorations to remaining tooth tissues. The use of such techniques in the provision of extracoronary restorations, such as veneers and resin-retained bridgework, is to be encouraged to limit the use of traditional invasive techniques such as full coverage crowns and conventional

bridgework, in particular when conservative techniques, ranging from tooth whitening to implant supported restorations, cannot be applied. In the provision of intracoronary restorations adhesive techniques have a significant role to play in the application of minimally invasive, state-of-the-art operative dentistry.

As a consequence of improvements in oral health practices, and the prevention of caries, modern diagnostic techniques and improved access to dental care - among

other reasons - many lesions of caries are now being detected at a much earlier stage than in previous times.^{1,2} The management of such lesions should be by means of a minimally invasive approach, avoiding unnecessary removal of intact dental tissues.¹⁻⁴ Historically, dental amalgam has been the material of choice for the restoration of posterior teeth affected by caries. While this material suffers from several negative attributes, such as its unaesthetic appearance and lingering, albeit unfounded, concerns regarding its safety, its main disadvantage lies in the fact that it does not adhere to remaining tooth tissue, and the bonding of amalgam offers no tangible benefits.⁵ Placement of an amalgam typically requires sacrifice of caries-free tooth tissue to provide mechanical retention. In contrast, composite restorations, while not an ideal replacement for natural tooth tissue, are aesthetic, readily bonded with positive benefits and perform best in situations in which preparation is limited to removal of irreversibly damaged tooth tissue. When managing a posterior tooth that has been affected by caries, it is important to be mindful that the service afforded to the patient goes far beyond the completed restoration placed that day. The decision to surgically intervene in the management of a lesion of caries commits a patient to a lifetime of restoration maintenance and periodic replacement, the only restorations which are 'permanent' being the ones remaining in clinical service to the time of death. The trend in the lifetime of most restored teeth is towards further loss of tooth tissue, irreversible pulpal damage, and increasing risk of tooth loss. Clearly keeping the surgical intervention as minimally invasive as possible is advantageous and desirable. This, together with biomechanical considerations, favours the selection of composite resins rather than dental amalgam in the restoration of posterior teeth damaged by caries.

The first light-activated posterior composite restorations were placed in the United Kingdom nearly 30 years ago. Since then, various studies have charted the development of the teaching of posterior composites to dental students. In 1989, a worldwide survey noted that there was very limited teaching of posterior composites to dental students - in more than 90% of schools, there was no teaching of posterior

composites. In those schools that included this teaching (<10%), it was mainly pre-clinical in nature with a small minority of schools providing limited clinical experience.⁶ This was followed by further surveys carried out in 1998 which showed little change in this teaching, with a survey of North America schools noting that most dental school graduates of that time had '*limited clinical experience in the placement of Class I and Class II composites*.'⁷ Similar amounts of teaching were noted in European schools with '*considerable variation in the principles taught and in the clinical experience gained by undergraduate students*'.⁸ During this era, posterior composites were viewed with some scepticism. A seminal paper published in 1997 advised that the use of composite in load-bearing posterior cavities be '*limited to the occlusal surfaces of premolars, and preferably those with limited occlusal function*'.⁹ Similar sentiments were expressed by the American Dental Association Statement on posterior composites which was published around the same time.¹⁰ A change in attitudes to posterior composites occurred, however, around the turn of the century, driven in the main by a desire to practise minimally invasive treatments in the management of caries, pursue a biological-approach rather than surgically-driven dogma to the treatment of caries, and the development of increasingly predictable techniques for placing posterior composite restorations. Concerns were expressed that dental school teaching programmes in respect of posterior composites were 'lagging behind' developments in clinical practice, with an implication that dental students were graduating with a lack of competence in relevant, albeit emerging techniques.^{11,12} Surveys of the teaching of posterior composites in 2004/2005 found that this element of teaching had increased from the time of the surveys in 1998, with approximately 30% of posterior restorations placed by dental students of that time being of composite, with most of the remainder of amalgam.¹³⁻¹⁶ Studies examining the survival of posterior restorations, such as a review of clinical outcome studies published in the period 1990-2004, demonstrated an aggregate annual failure rate of 2.2% for posterior direct composites, in comparison to 3.0% for amalgam restorations.¹⁷ In addition, an extensive primary

care based study demonstrated a ten-year survival rate of 82.2% for posterior direct composites compared with 79.2% for amalgam restorations.¹⁸ Evidence to the contrary stemmed largely from studies in which composites were used as a substitute ('white amalgam') rather than as an alternative to dental amalgam in, for example, cavities of essentially traditional rather than minimally invasive design and, as such, is of little, if any, relevance to the use of composites in the restoration of posterior teeth in present day practice.

In 2007, the British Association of Teachers of Conservative Dentistry (BATCD) published a consensus document which recommended that composite should be taught to dental students as the 'material of choice' when restoring posterior teeth, in particular when managing teeth with an initial lesion of caries.¹⁹ Contrary to this expert opinion, recent surveys on the use of restorative materials in posterior teeth in clinical practice indicate that within the UK amalgam still predominates over posterior composites.²⁰⁻²² The reasons for the apparent disconnect between clinical practice and expert opinion are considered to be multifactorial, including custom and practice being perpetuated, issues in respect of costs and fees, a failure of the profession at large to embrace minimally interventive dentistry, and the long lag time between changes in teaching and impact on clinical practice.

Given the mounting evidence for the use of composites as the material of choice for the restoration of posterior teeth, the continuing development of materials and techniques of increasing sophistication and predictability, and ample time having elapsed for the introduction of the BATCD guidelines, it was considered timely to re-examine current trends in the teaching of posterior composites in Irish and UK dental schools.

MATERIALS AND METHODS

In autumn 2009, an email invitation was sent to the individual identified as being responsible for the delivery of operative dentistry teaching programmes within the 17 established dental schools in Ireland and the United Kingdom. This invitation was to complete an Internet-based survey (Bristol Online Surveys, Bristol, UK) which sought information pertaining to the teaching of posterior composites in each dental school.

Table 1 Contraindications taught to the placement of posterior composites

	Occlusal cavities premolars	Occlusal cavities molars	Occluso-proximal cavities premolars	Occluso-proximal cavities molars
Inability to place rubber dam	3	3	6	8
Parafunctional activity	0	0	1	1
Pathological wear	1	1	3	4
Poor oral hygiene	6	6	7	7
Replacement of a large amalgam restoration	1	2	1	5
History of adverse reaction to composite materials	14	14	15	15
Atypical diet	0	1	0	1
Large pulp	0	0	0	0
Proximity to the pulp	0	0	0	0
Denture abutment	0	0	1	1
Subgingival margins			12	12
Temporomandibular dysfunction	0	0	0	0
No valid aesthetic requirement	0	0	0	0
Endodontically treated tooth	0	0	0	0
Opposing composite restoration	0	0	0	1
High caries risk	2	2	3	4
Poor patient cooperation	7	7	8	9
History of postoperative pain with posterior composite restorations	3	3	4	4
Poor enamel quality	0	0	1	1
Buccolingual width of occlusal portion is <1/3 of the intercuspal width	0	0	0	0
Buccolingual width of occlusal portion is 1/2 of the intercuspal width	0	0	0	0
Buccolingual width of occlusal portion is >2/3 of the intercuspal width	0	1	3	4
Buccolingual width of proximal box >1/2 of the intercuspal width	0	0	0	0

The information sought included:

- Types of posterior composite restorations taught
- Preclinical teaching - including teaching time devoted to posterior composites and the order in which the use of amalgam and composites were taught in the restoration of posterior teeth
- Clinical experience gained in posterior composites – including the extent to which posterior composites were placed relative to dental amalgams, and the future development of this teaching

- Clinical techniques taught for posterior composite placement, including cavity preparation, contraindications taught, moisture control, the protection of operatively exposed dentine, matrix and wedge selection, commercial brands of composite and bonding agents, light curing techniques, finishing techniques and fees charged, if any.

Information on associated clinical techniques, including indirect composites and bonding of amalgam were also included.

Both ‘open’ questions (where respondents were given some space in which to write a textual response to a question) and ‘closed’ questions (where respondents were given a number of possible responses to a statement and asked to identify the most appropriate one) were used. Non-respondents were followed up by email. Information received was analysed using the Bristol Online Surveys software. Descriptive results are reported.

RESULTS

Completed responses were received from all 17 schools (response rate = 100%).

Types of posterior composites taught

All 17 respondent schools taught the placement of occlusal and two-surface occlusoproximal composite restorations in premolar and permanent molar teeth (molars). Fifteen schools taught the placement of three-surface occluso-proximal restorations in premolars and molars. Of the remaining two schools which did not teach three-surface occluso-proximal composites, one school anticipated introducing this teaching over the next five years.

Preclinical teaching

Ten schools taught posterior composites before teaching dental amalgams. In six schools students received teaching in respect of dental amalgam before teaching in respect of posterior composites. The situation in the seventeenth was not reported. In five years’ time, it was anticipated by four schools that they may still be teaching dental amalgams before posterior composites.

The average amount of preclinical time devoted to the teaching of posterior composites was found to match the time devoted to teaching the use of amalgam (posterior composite = 33% of pre-clinical course, range = 5-75%; posterior amalgam = 31% of preclinical course, range = 5-50%). It was anticipated, over the next five years, that the amount of preclinical time devoted to the teaching of amalgam will decrease while that devoted to posterior composites will increase such that the amount of time devoted to these techniques will be 2:1- posterior composite: amalgam.

Clinical placement

On average, 55% of posterior intracoronal restorations placed by dental students are of composite (range = 10-90%) and 44% of posterior restorations placed by dental students are amalgam (range = 10-90%).

The respondents to the present survey anticipated in five years time that, on average, 72% of posterior restorations placed by dental students will be of composite (range = 40-95%) with, on average, 27% of the remaining restorations being of amalgam (range = 0-55%). In the reporting of this range, it is of particular note that it is anticipated that certain students may not place posterior amalgam restorations in five years' time.

Principles of cavity design

In comparison to traditional cavity design features for occlusal and occlusoproximal amalgams, respondent schools taught the following for posterior composite restorations:

- No 'extension for prevention'
 - 10 schools
- 'Slot-type' cavities (ie no occlusal component) - eight schools
- Rounded internal line angles
 - eight schools
- Bevelled occlusal margins
 - three schools
- Bevelled box margins - three schools.

Contraindications

A full description of the contraindications taught for the placement of posterior composites is reported in Table 1. From this table, it is to be noted that the top three most frequent contraindications taught for the placement of posterior occlusal composites were:

- A history of adverse reaction to composite materials - 14 schools
- Poor patient cooperation
 - seven schools
- Poor oral hygiene - six schools.

The top three most frequent contraindications taught for the placement of posterior occlusoproximal composites were:

- A history of adverse reaction to composite materials - 14 schools
- Subgingival cavity margins
 - 12 schools
- Poor patient cooperation
 - nine schools.

Table 2 Teaching in respect of the management of operatively exposed dentine before the placement of posterior composites

	None ('total-etch')	Glass ionomer cement only	Calcium hydroxide + glass ionomer cement
Shallow cavities (outer third of dentine)	15	1	0
Moderate cavities (middle third of dentine)	13	3	0
Deep cavities (inner third of dentine)	7	4	7

Table 3 Techniques and instruments taught for finishing posterior composites (n = 17)

	Occlusal restorations	Occluso-proximal restorations
Immediate finishing	16	16
Delayed (>24 hours) finishing	1	1
Water cooling	9	9
Finishing diamonds	15	15
Finishing discs	11	14
Finishing strips	9	14
Finishing points	10	10
Finishing pastes	8	8
Finishing stones	4	4
Finishing glaze/surface sealants	4	4

Moisture control

Ten schools taught the use of rubber dam as necessary when placing posterior composites - five schools taught it was necessary in most situations (approximately 75% of cases) and one school indicated that the students were taught that it was required in approximately 50% of cases. One school did not teach the use of rubber dam to be necessary when placing posterior composites. Interestingly, another school commented that rubber dam was taught preclinically, but not in clinics.

In terms of alternative forms of moisture control, 11 schools taught the use of cotton wool rolls, nine schools taught the use of a 'dry guard' and one taught the use of gauze. Two schools did not teach alternative forms of moisture control, as they noted that there is no alternative to rubber dam.

Management of operatively exposed dentine

The techniques taught for the management of operatively exposed dentine before the placement of posterior composites are detailed in Table 2. The use of a 'total-etch' technique was clearly favoured by the respondent schools in

cavities involving the outer one-third of dentine (15 schools) and the middle one-third of dentine (13 schools). The situation was different for the management of 'deep cavities' involving the inner one-third of dentine. While 11 schools taught the use of a base cement, either with (four schools) or without (seven schools) a calcium hydroxide liner, seven schools taught the use of a 'total-etch' approach in such situations.

Matrices and wedges

Fifteen schools taught the use of a circumferential metal band and wooden wedges when placing occlusoproximal posterior composite restorations. Eight schools taught the use of a sectional metal band and a wooden or flexible plastic wedge. A further eight schools taught the use of transparent (cellulose-acetate) matrix bands and light-transmitting plastic wedges, of which two schools teach this technique as the only means of placing an occlusoproximal composite. One respondent school noted that they 'prefer to use a clear matrix'; while another noted that 'they had just moved to a metal sectional matrix system from a clear circumferential matrix'.

Composites and bonding systems

The most commonly taught brands of composite were 'Herculite XRV' (Kerr Corporation, Orange, CA, USA) – seven schools, 'Spectrum TPH' (Dentsply DeTrey GmbH, Konstanz, Germany) – six schools, and 'Ceram- X' (Dentsply DeTrey GmbH, Konstanz, Germany) – four schools. The most commonly taught bonding systems were 'Prime & Bond NT' (Dentsply DeTrey GmbH, Konstanz, Germany) – eight schools, 'Optibond Solo' (Kerr Corporation, Orange, CA, USA) – eight schools, followed by 'Clearfil SE' (Kuraray Dental, New York, USA) – one school and 'Bond 1' (Pentron Clinical Technologies, CT, USA) – one school.

Respondents were asked if they included the teaching of flowable resins in their teaching of posterior composites. Only two schools indicated that they did – one noting that it was *'...placed in cavities before placement of heavily filled resin...'* while the other noted: *'...Opinion varies!! If taught, it is as a thin layer for improved adaptation to tricky cavity shapes ... followed by stiff consistency (packable) composites to reduce wall voids. Some teach the elastic wall concept...'*

Light curing

Fifteen schools taught the use of light emitting diode (LED) light curing units (LCUs), – an increase from four schools at the time of the 2004 survey. Eight schools taught the use of quartz-tungsten halogen (QTH) LCUs – a decrease from 11 schools at the time of the 2004 survey.

Finishing techniques

The range of finishing techniques and instruments taught are outlined in Table 3. Sixteen schools taught 'immediate finishing' of posterior composites. Popular finishing instruments included finishing diamonds (15 schools), finishing discs (14 schools) and finishing strips (14 schools). Nine schools taught water-cooling when contouring with finishing diamonds held in other than slow speed handpieces.

Fees

Patient treatments performed by dental students, including posterior composites, are free within all of the UK dental schools, bar one. In this school, it was noted that their patients pay *'full NHS rates'* and that the fee levied *'depends on the Band'*. Patients

pay for treatments received from students in the two schools in Ireland. The average fee for a posterior composite within these schools was €21.25 (approximately £19) at the time of writing.

Indirect composites

Ten schools reported that they provided instruction in indirect posterior composite restorations to their students. Of these ten schools, teaching was didactic only in seven schools and included both didactic and clinical experience in placing indirect posterior composites in three schools.

Amalgam bonding

Fourteen schools included teaching of amalgam bonding within their curriculum and three did not. The most commonly taught materials for this purpose was 'Panavia' (Kuraray Dental, New York, USA) – 11 schools, followed by 'Optibond Solo' (Kerr Corporation, Orange, CA, USA) – one school, 'Rely X ARC' (3M ESPE, St Paul, MN, USA) – one school, and 'Permite C' (SDI, San Francisco, USA) – one school.

Other comments

Respondents were invited to provide additional comments on what they taught in respect of the teaching of posterior composites. Only one chose to do so: *'The biggest barrier to teaching posterior composites on clinic are the preconceptions of part time staff and general dental practitioners (GDPs). There is a general belief that all posterior teeth must be restored with amalgam, because it is 'stronger'. This is (incorrect), modern posterior composites have very impressive wear rates and low shrinkage values. After ten years, a posterior composite may wear a bit more than an amalgam, but at least, in most cases the tooth is still there and cusps have not fractured off as they would do with a passive obturating material such as amalgam. We need to continue teaching amalgam, simply so that students can make a living in the ... system that awaits for them upon graduation ... the placement of amalgam in a wet, contaminated cavity, sloping in saliva does not do the patient any favours ... It is interesting to note, that in Holland (The Netherlands) they no longer teach amalgam restorations, but then they don't have to contend with... dentistry (as funded in the UK).'*

DISCUSSION

The findings from this survey provide interesting 'food for thought' for dental practitioners, dental educators and third party funders of dental care in the United Kingdom and Ireland. Moving from a time when dental schools were criticised for 'lagging behind' developments in general practice in terms of the application of posterior composites and relevant minimally invasive techniques,^{11,12} and considering the results of related surveys over 10 years ago when most graduating students had limited, or no, clinical teaching in the placement of posterior composites,^{7,8} it is apparent that most dental students in Ireland and the UK are now gaining substantial, predominantly state-of-the-art training in the use of posterior composites. The results of the present survey indicate that, on average, 55% of direct posterior restorations placed by students are now composite, acknowledging that there is a wide range (10–90%) with a low bottom end level. In contrast, the placement of posterior composites and the practice of appropriate minimally invasive techniques have not continued to progress as quickly in general dental practice.^{20–22} This is a cause for concern as large numbers of patients in the UK must be subjected on a daily basis to procedures which involve the unnecessary sacrifice of intact tooth tissue when receiving an amalgam rather than minimally invasive composite restorations. A similar sentiment was expressed in the recent review of the dental services provided by the NHS, in which the development of a further 'heavy metal generation' of patients was discouraged.²³ The modern management of caries, with a focus on minimally invasive restorative procedures, coupled with appropriate preventive treatments, should be encouraged to a much greater extent than at present in preference to the traditional surgical model of caries management. That said, it is acknowledged that the placement of posterior composites, as presently practised, may be found to be more demanding and time consuming, and therefore more costly than the placement of amalgam restorations in similar situations; however, as reported in studies from The Netherlands the health economies of posterior composites, with their capacity to be refurbished and repaired to extend longevity may, over time, be found to be

more favourable than those for dental amalgams, in particular, once practitioners become more familiar and comfortable practising minimally invasive dentistry than traditional techniques.^{4,18} The transition occurs when practitioners stop using composites as 'white amalgam' and adopt approaches and techniques found to maximise the benefits and life expectancies of composites in the restoration of posterior teeth. Drivers for change include moving on from traditional concepts, including Black's principles for cavity preparation, the adoption of modern approaches to the art and science of operative dentistry and, above all else, a change to thinking more about maintaining healthy rather than treating disease, notably in respect of failing restorations and, in particular, secondary caries, which is much less common than indicated by, for example, studies on reasons for the replacement of restorations.^{24,25}

At the time of the present survey 44% of posterior restorations placed by dental students were of amalgam (range = 10–90%). At the time of the last surveys (2004) the corresponding finding was 67%.¹³ This indicates that over the past five years, the numbers of amalgam restorations placed by dental students in Irish and UK dental schools has fallen by 33%, while the numbers of posterior composites have increased by 180%. At the time of the last survey (2004) it was anticipated by 2009 that the proportions of amalgam and composite restorations placed would be 51% amalgam : 44% posterior composites. As can be seen from the actual results reported (44% amalgam : 55% posterior composites), the shift towards posterior composite placement has exceeded that anticipated in 2004. Furthermore, the respondents estimated that in five years' time (2014) the proportion of posterior composites placed would increase to 72%, with some schools no longer teaching the placement of dental amalgams, other than for amalgam replacement therapy. These findings are in keeping with those from other regions of the world, including Japan²⁶ (presently, 45% posterior composites), Iran²⁷ (presently, 42% posterior composites) and soon to be published results for North American schools (presently, 48% posterior composites). On the basis of these data, it is likely that the clinical practice of dental students,

and hence the emerging dental workforce of the 2010s, will be 'out of step' with arrangements for the restoration of posterior teeth in general dental practice, unless these are subject to sudden change, possibly as a consequence of environmental concerns affecting the availability of elemental mercury for use in dental amalgam. Furthermore, if there is not an acceptance of the need to encourage an early move towards increased placement of posterior composites over dental amalgams in general practice, mainstream dental practice in the UK will, it is suggested, fall behind arrangements in most developed countries in the world. Presently, a reluctance to move forward among established practitioners is evidenced by a recent survey of contemporary clinical practice in the UK in which the response by 750 GPs to 'the most common restorative material for Class II cavities in premolar and permanent molar teeth' indicated 60% amalgam/31% direct composites for premolars and 75% amalgam/15% direct composite for permanent molars.²² Such divergence between dental school teaching and the dentistry practised by established practitioners may lead to criticisms by established dental practitioners that dental graduates are not as good as they used to be.²⁸ The converse argument may, however, hold some truth – dental school curricula in the UK and Ireland are moving forward with evolving evidence and in step with trends internationally, and it is the established dental practitioners and the system they operate in that is 'lagging behind'. A change in mindset is required, extending to regulatory bodies – it is of note that the current General Dental Council's (GDC's) examination for the registration of overseas trained dentists (the 'ORE') includes a test of competence in preparing a Class II amalgam cavity preparation in a posterior tooth rather than a minimally invasive occlusoproximal preparation in which the clinical service of a composite restoration will be optimal.²⁹

In fairness to those working in contemporary general dental practice in the UK, there is a recognition that they operate under significant pressures, not least of which are current NHS funding arrangements.¹² For example, a recent publication reported how the current NHS contract does not always encourage

'ideal' treatments for the replacement of missing teeth, with many patients being offered acrylic removable partial dentures instead of bridgework.³⁰ In the same way that a partial denture, although capable of resolving the immediate problem, may be found to have more medium to long-term negative effects than bridgework, an amalgam restoration should increasingly be viewed as a less favourable solution than a minimally interventive posterior composite, notwithstanding the greater acceptance of a tooth coloured restoration by, in particular, younger patients. In considering the pros and cons of posterior composites and amalgam restorations, it is suggested that a factor which requires further attention is the biomechanical advantages of minimally invasive posterior composites over amalgams, in particular, when bonding of amalgam has not been shown to offer any clinical advantage⁵ – evidence which teachers may wish to reflect on in continuing to teach amalgam bonding (14 schools).

From an educational viewpoint, it is clear that the current teaching of posterior composites to dental students in Ireland and the UK has the potential to satisfy the relevant guidelines of the General Dental Council that new dental graduates must '*be competent at completing... tooth-coloured restorations*'.³¹ Concerns must, however, be expressed in relation to the continued teaching of certain techniques which lack an appropriate evidence base, or worse have been discredited. These included:

- The need for bevels on the cavosurface enamel margins of both the occlusal and proximal box margins (three schools): While bevelling of the occlusal cavosurface margin was at one time considered advantageous when placing posterior composites, this is no longer the case.³² Additional bevelling of the occlusal cavosurface margins results in the creation of thin extensions of composite on the occlusal enamel (over contouring). These extensions may fracture under subsequent repeated occlusal loading and, as a consequence, will result in steps along the cavosurface margin.⁴ Also, the presence of occlusal bevels may cause confusion as to the extent of the restoration during its refurbishment, repair or eventual

replacement with consequent and unnecessary loss of adjacent sound enamel. Bevels on the cavosurface margin of the proximal box are also to be discouraged. Notwithstanding a lack of evidence to support this approach, the placement of bevels on margins below the maximum convexity of the tooth can compromise marginal adaptation even in the presence of a well-adapted matrix or, in other circumstances, marginal flash which is very difficult to remove during finishing. Also, if the remaining enamel is very thin, it may be pulled away from the underlying dentine during polymerisation shrinking of the composite. Placement of an additional bevel on proximal margins above the maximum convexity of the tooth, is associated with problems akin to those observed with additional bevels on occlusal surfaces

- Teaching of transparent matrix bands and light-transmitting wedges for occlusoproximal composites (eight schools). The restoration of the proximal contact areas in posterior composites has often been cited as problematical. While various techniques have been proposed for the recreation of the proximal contact area, evidence suggests that this is best achieved using techniques involving the use of a thin metal band – either circumferential or preferably sectional – and a flexible wedge of wood, plastic or elastic material.^{33,34} Transparent matrix bands and light-transmitting wedges were introduced at a time when it was thought that composite contracted towards the direction of the incident curing light – hence this system was thought to allow incident light to access polymerising composite along the gingival seat and thereby limit gap formation, as would occur if the light was directed from the occlusal surface when a metal band was applied. It was demonstrated some time ago that this concept is erroneous; composite does not shrink towards the incident curing light, but instead towards wherever there is greatest adhesion.³⁵ Furthermore, evidence suggests that the use of a clear matrix band (due to its thicker and stiff nature) and a light

transmitting wedge (given its rigidity and inability to adapt the matrix band to the floor of the proximal box) result in an increased number of proximal overhangs, flat proximal surfaces, and open proximal contacts.³⁶ It is surprising, given research published in 2003,³⁶ the highlighting of this issue in the report on the teaching of posterior composites in 2004¹³ and the BATCD consensus statement¹⁹ that there was an increase in the number of schools – from six to eight – teaching this technique over the 2004–2009 period. Such backsliding is most disappointing, if not worrisome, in particular given positive developments in all other aspects of the relevant teaching, albeit some of them less marked than should have been the case.

Happily since the time of the last surveys, there have been positive developments in techniques for the protection of operatively exposed dentine, with a greater emphasis on the use of ‘total-etch’ approaches for managing dentine in all but the deepest of cavities. Teaching the placement of a glass-ionomer cement base under a posterior composite in a moderately deep – let alone a shallow cavity seems to have faded away since the time of the last surveys and, given best evidence, is to be welcomed.^{13,16} There is now little, if any, justification for the placement of a glass-ionomer cement base under a posterior composite – a technique which it is suggested will come to be viewed as a ‘hangover’ from amalgam placement techniques,²¹ emphasised by a recent study which highlights that the placement of a glass-ionomer base is of no real benefit in avoiding post-treatment sensitivity in posterior composite patients.³⁷ Apart from serving no real purpose, a cement base greatly reduces the surface area available for bonding and, in turn, limits the extent to which a posterior composite may restore the biomechanical properties of the affected tooth. It is suggested that the placement of a glass-ionomer cement base is only of benefit when used to protect a pulp cap, typically of calcium hydroxide which is of benefit only when the remaining dentinal thickness is less than 0.5 mm or a pulpal exposure has occurred. As a further note, it is of interest that no school indicated

that they continued to teach fourth generation dentine bonding systems ie, those with separate etching, priming and bonding steps, despite some studies continuing to report that such systems remain the gold standard in laboratory-based studies of dentine bonding systems.³⁸

CONCLUDING REMARKS

This study has demonstrated that the teaching of posterior composites to dental students in UK and Irish dental schools is accelerating, and within the schools surveyed, there has been a greater than anticipated shift over the last five to six years to the teaching of composites in the restoration of posterior teeth. Within some schools there are elements of this teaching which should be reviewed, notably the teaching of certain techniques which lack an evidence base, in particular the teaching of clear matrix bands and light transmitting wedges and the additional bevelling of cavity cavosurface margins.

The results of this survey present challenges for the dental profession and its funding agencies in the UK, notably in respect of encouraging more of a shift towards the minimally interventive use of composite systems in the restoration of posterior teeth, in particular, among established practitioners. As in all such matters, the interests of patients must be paramount and, where needs must, the profession must adapt and change, albeit away from traditional concepts and the use of materials which have largely served their purpose.

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