

ABSTRACT

Teaching of the repair of defective composite restorations

Given increased tooth retention into later years of life, dentists face increasing challenges in maintaining teeth with extensive composite restorations. Accompanying the increase in placement of composite restorations in general practice, there has also been increased evidence that repair, rather than replacement, of composite restorations is being increasingly considered as a treatment option. Previous work has demonstrated that such techniques are often underutilised in practice. The aim of this study was to examine contemporary teaching of composite repair techniques in Scandinavian dental schools. A questionnaire was distributed by email to each of the 12 Scandinavian dental schools in late 2010/early 2011. This questionnaire sought information on the undergraduate teaching of composite repair techniques as well as indications and materials utilised for this technique. A 100% response rate was achieved (12 schools). Eleven of the 12 respondent schools indicated that they included the teaching of composite repair techniques within their dental school programme. The most commonly reported indications for the teaching of the repair of direct composite restorations were tooth substance preservation (11 schools) and reduced risk of harmful effects on the pulp (10 schools). The most commonly taught surface treatment was mechanical roughening of the existing composite restoration, including the removal of the surface layer of material, prior to application of fresh composite (11 schools). Overall, the results of this study showed that the teaching of composite repair techniques is established within Scandinavian dental schools. This may influence the practising habits of dentists graduating from these schools when considering treatment options for defective composite restorations.

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Teaching of the repair of defective composite restorations in Scandinavian dental schools

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The teaching of operative dentistry is undergoing transformational change in many parts of the world. This change stems from developments in tooth-coloured restorative systems, modern approaches to the management of caries, both primary and secondary and a shift to minimal interventive dentistry (1,2). It has also been reported that dental students across the world are gaining as much, if not more experience at posterior composite resin placement, compared with amalgam techniques (3,4). In the course of time, this will result in increased placement of composite resin restorations in general dental practice. With the increasing use of composite resin materials for the restoration of defects in posterior teeth, there is a need to further develop techniques that optimise the performance of posterior composites in clinical service (5). Whilst some restorations will inevitably require replacement, it has been suggested that some deteriorating yet serviceable restorations may be given extended longevity through the use of repair procedures (6). In contrast to restoration replacement, this more conservative minimally interventive approach to the management of defects in restorations offers many advantages (6–8), including:

1. more conservative of tooth tissue,
2. reduced risk of iatrogenic damage,
3. reduced need for the use of local anaesthesia,
4. opportunity for enhanced patient experience, and
5. savings in time and resources.

KEY WORDS

Teaching;
defective composite
restoration;
dental schools

Despite possible risks and limitations in the use of repair techniques (7), it is considered preferable, whenever possible, to perform a repair (i.e. partial replacement of the composite resto-

ration allowing preservation of that portion of the composite restoration that presents no clinical or radiographic evidence of failure) as an alternative to restoration replacement (removal of an entire composite restoration followed by the placement of a new composite restoration). The clinical management of a composite restoration may also include an element of refurbishment – a procedure that should normally preempt and delay repair, let alone replacement. Refurbishment procedures typically involve the refinishing or resurfacing of a restoration, with or without recontouring (7). Refinishing may be limited to the margins of a restoration, whilst resurfacing may involve part or all of the exposed surfaces of the restoration.

The evidence for repair techniques was previously based on laboratory studies that demonstrated considerable interfacial bond strength between ‘new’ and ‘old’ composite resin materials (9-12). Long-term *in vivo* clinical studies have subsequently demonstrated that repair techniques offer viable and non-destructive alternatives to total restoration replacement (13-15). The rationale for repair techniques is reinforced by the evidence that secondary caries is usually a new lesion of caries adjacent to a restoration rather than caries developing in the tooth: restoration interface (16). The utilisation of appropriate repair and refurbishment techniques increases the longevity of the affected restoration, whilst limiting the extent of any operative intervention. In this way, the application of repair techniques increases the chance of a restored tooth being one of patient’s ‘teeth for life’.

Evidence from the period 2002-2003 demonstrated that whilst the teaching of composite restoration repair was included in the undergraduate teaching programmes of Scandinavian dental schools, marked variations were found to exist in respect of the teaching of indications for and the expected long evities of such repairs (17). In consideration of recent advances in composite and adhesive technologies and increased predictability of posterior composites, as well as the drive towards the increasing use of minimally invasive dentistry, the aim of the present study was to examine and thereby update knowledge and understanding on the teaching of direct composite restoration repair in dental schools in the Scandinavian countries.

Materials and methods

The person identified as being responsible for the delivery of operative dentistry teaching programmes within the 12 dental schools in the Scandinavian countries (Norway, Denmark, Sweden and Finland) was contacted by email in October 2010 and invited to complete an internet-based survey (Bristol Online Surveys, Bristol, UK) on the teaching of direct composite restoration repair in their dental school. Where it was not possible to identify the person responsible for the delivery of the teaching of operative dentistry, the email was addressed to the relevant head of department with the request to forward it to the appropriate person. The recipients were initially given 8

weeks to complete the questionnaire. In January 2011, reminder emails were sent to the schools that had not responded. The online questionnaire requested information on the following topics:

1. inclusion of composite repair techniques teaching within the dental school primary dental degree programme,
2. the nature of this teaching,
3. indications taught for restoration repair, rather than replacement,
4. views on the perceived longevity of composite repairs,
5. techniques taught for composite restoration repair.


Respondents were advised that the results would be anonymous in that no individual school would be identified in any report or publications emanating from the study. Both ‘open’ questions (whereby respondents were given some space in which to write a textual response to a question) and ‘closed’ questions [whereby respondents were given a number of possible responses to a statement and asked to identify the most appropriate one(s)] were included in the questionnaire. The information received was analysed using the Bristol Online Surveys software to provide descriptive results.

Results

Completed responses were received from all four Swedish, three Norwegian, three Finnish and two Danish dental schools, giving a response rate of 100%. It was assumed that the questionnaires had been completed by the senior faculty member responsible for the delivery of the teaching of operative dentistry in the school.

Extent and nature of teaching

Eleven of the 12 schools indicated that they included the teaching of repair of defective direct composite restorations in their primary dental degree programme. The school that did not teach such techniques indicated that it did not include this teaching because of lack of personal clinical experience for performing composite restoration repairs. It was noted, however, that this school planned to include such teaching in its undergraduate curriculum within the next 5 years.

Whilst all respondents reported that personal clinical experience influenced their decision in respect of the teaching of composite repairs, 10 respondents reported existing literature and three respondents reported case reports as reasons for teaching repair procedures. All schools that included the teaching of the repair of direct composite restorations in their primary dental degree programme curriculum reported that this teaching was both didactic and clinical, with six schools having reported that the relevant clinical teaching was predominantly based on clinical case scenarios arising in student clinics. One school reported that its teaching of composite repairs was ‘didactic only’, with no clinical experience. 

Restoration-related indications	Number of schools
Marginal defects	10
Abrasion/attrition/erosion	9
Secondary caries	9
Partial loss of restoration	8
Marginal discolouration	5
Superficial/surface colour correction	3
Restoration discolouration labial/buccal	6
Restoration discolouration cervical	4
Restoration discolouration occlusal	2
Restoration discolouration proximal	2
Discolouration involving more than one surface	1
Bulk fracture of a posterior restoration (marginal ridge fracture)	9
Bulk fracture of a posterior restoration (occlusal)	9
Bulk fracture of a posterior restoration (isthmus fracture)	8
Bulk fracture of a posterior restoration (box fracture)	7
Bulk fracture of an anterior restoration (incisal)	4
Bulk fracture of an anterior restoration (proximal-incisal)	4
Bulk fracture of an anterior restoration (proximal)	3

Table 1. Teaching of restoration-related indications considered appropriate for repair rather than replacement of direct composite restorations (maximum possible number of responses = 11).

Indications for repair rather than replacement

The most commonly reported indications for the teaching of the repair of direct composite restorations were tooth substance preservation (11 schools) and reduced risk of harmful effects on the pulp (10 schools). Other indications included reduced costs to the patient (six schools) and reduction in treatment time (three schools). One respondent noted that ‘... repairs of composite allow for reduced restoration complexity and improved control of restoration anatomy’, whilst another respondent noted that such repairs ‘decrease the effects of polymerisation stress on the tooth substance’.

Whilst there was general agreement amongst the schools regarding marginal defects (10 schools) as an indication for the repair of composite restorations, some variation was found to exist regarding other clinical indications. A summary

of the information pertaining to the indications reported for the repair of composite restorations is set out in Table 1.

With regard to different types of composite restoration fractures amenable to repair procedures, one school reported that ‘we do not specify and differentiate between different types of fractures in our teaching, it’s more like when possible – repair!’

The other respondents, when considering some clinical scenarios involving the fracture of tooth tissue adjacent to an existing direct composite restoration, provided the responses set out in Table 2. The most commonly agreed scenario considered appropriate for repair rather than restoration replacement was a cusp fracture of a posterior tooth restored with a direct composite restoration (11 schools), whilst the least commonly agreed scenario for repair was a proximal fracture in an anterior tooth (five schools). Lack of agreement between respondents was found with respect to the management of a cracked tooth (seven schools).

Clinical techniques

Techniques reported for surface treatments of existing direct composite restorations and the materials selected for use in repair and finishing techniques are summarised in Table 3. The most commonly taught surface treatment was mechanical roughening of the existing composite restoration, including removal of the surface layer of material (11 schools). Ten schools reported teaching acid etching of the existing composite surface with phosphoric acid, whilst one school taught the use of hydrofluoric acid. Eleven schools taught the application of an adhesive bonding system to the prepared and etched surface of composite. The most commonly taught material for completing repairs was a hybrid composite resin (nine schools). One school reported the occasional teaching of surface silicatisation using the CoJet system™ (3M ESPE, Seefeld, Germany) for challenging repair procedures on anterior teeth. Popular finishing devices included diamond finishing instruments (11 schools) and finishing discs (nine schools).

Patient acceptance and treatment outcome

With one exception, all schools reported that patients were receptive to the repair of less than ideal composite restorations as an alternative to restoration replacement. With regard to what was considered to be the acceptable longevity of a repair to an existing composite restoration, responses were received from six schools. The responses were as follows:

3-5 years	1 school
6-10 years	3 schools
> 10 years	2 schools

Of these six schools, five respondents estimated that repairs increased the longevity of the direct composite restoration by

30% and one respondent estimated that repairs increased the longevity of the repaired restoration by 50%. Three of the respondent schools reported monitoring repaired composite restorations as part of a recall system.

Discussion

In reporting the findings of the present study, the inherent limitations of data collection by means of a survey, albeit with a 100% response, are fully acknowledged. Such limitations must, however, be viewed against the need to have information on contemporaneous arrangements and views on, for example, approaches to teaching available in the public domain. To have dental schools in a region, let alone across the world working in isolation in the further development of primary dental degree programmes in nonsensical. To minimise the inherent limitations of surveys of the type reported, great care, as in the case of the present study, must be taken in the preparation of survey questionnaires to avoid ambiguous and otherwise misleading questions. In the present study, most of the questions used had been tested and found to be fit for purpose in related studies (17-19). Thus, the findings of the present study are considered to provide an important insight into the teaching of defective direct composite restorations in the Scandinavian countries.

Whilst the data collected provide information on the nature of the teaching, indications, materials and techniques taught in relation to the repair of composite restorations, it provides only limited insight into the extent of students' experience with composite restoration repairs. From the various responses and comments, it would appear, however, that most dental students in the Scandinavian countries gain considerable clinical experience of repairing defective composite restorations. This is comparable to developments in German (18) and UK and Irish (19) dental schools, where repair techniques form a growing part of the clinical instruction of dental students. The situation in relation to North American schools is somewhat different, where

lingering suspicions over the effectiveness of repair techniques, and perhaps concerns of practising 'defensive dentistry' have resulted in a small, albeit still significant, proportion (12%) of schools not teaching composite repair techniques (20). This situation is at odds with evidence available from a number of clinical follow-up studies supporting the use of repair techniques rather than total restoration replacement (13-15).

The results of the present study suggest that the teaching of repair techniques in 11 (92%) Scandinavian dental schools has been developed and expanded since the time of a previous survey undertaken in 2002-2003 and may be considered to be in line with best available evidence. This conservative ideology of tooth preservation by means of the repair of defective composite restorations is taught in almost every Scandinavian dental school and is considered to be in agreement with the concepts of minimally invasive dentistry (6). The willingness of patients to accept the repair of existing defective composite

Type of tooth fracture	Number of schools
Anterior tooth (tooth fracture from incisal region)	8
Anterior tooth (tooth fracture from proximal-incisal region)	7
Anterior tooth (tooth fracture from proximal region)	5
Posterior tooth (cusp fracture)	11
Posterior tooth (cracked tooth)	7

Table 2. Teaching of clinical scenarios involving tooth fracture adjacent to existing direct composite restorations considered appropriate for repair rather than replacement of direct composite restorations (maximum possible number of responses = 11).

Surface treatments of existing composite restoration	Number of schools
Mechanical roughening of existing composite with removal of exposed surface	11
Acid etching with phosphoric acid	10
Cleaning with slurry of pumice	3
Acid etching with hydrofluoric acid	1
Aluminium oxide air abrasion	1
Other	1*
No mechanical surface treatment	0
Materials utilised in the repair technique	
Adhesive bonding system	11
Hybrid composite	9
Nanohybrid composite	8
Flowable composite	6
Silane coupling agent	3
Glazing resin	0
Finishing techniques for the placed repair	
Diamond finishing instruments	11
Finishing discs	9
Composite polishing points	8
Tungsten carbide finishing instruments	4
Composite polishing paste	2

Table 3. Techniques taught for the repair of direct composite restorations.

restorations, rather than restoration replacement, may reflect a preference for minimally invasive treatment as part of growing dental awareness. Other associated factors, such as a reduction in costs and treatment times, together with the limited need for local analgesia, may also play a role in patient acceptance of restoration repair over replacement procedures.

Of the six schools that reported following up repaired composite restorations, all reported considering composite repairs to last more than 3 years, with five schools indicating an expectation that composite repairs last at least 5 years. Such views of anticipated longevity will, in all probability, be adjusted upwards in years to come, based on findings such as those reported by Gordan et al. (14) which indicate successful outcomes to composite repairs after a 7-year follow-up.

A review of the clinical techniques taught for restoration repair was in the main, in keeping with current best available evidence (13,14). Laboratory-based studies indicate that some form of mechanical roughening of the exposed composite restoration surface is appropriate prior to the application of the repair composite material (21,22). This technique was taught in all the Scandinavian schools teaching composite restoration repair techniques. Etching and bonding of the exposed tooth and resin composite surfaces is indicated when performing a repair, as is associated with increased bond strength between old and new composite (10-12). This technique was taught in all schools teaching composite restoration repair techniques. It is of note, however, that whilst 10 schools taught the widespread regimen of acid etching with phosphoric acid, one school taught acid etching with hydrofluoric acid. Given the highly caustic nature of hydrofluoric acid and the lack of evidence to support its efficacy in composite repairs, the use of hydrofluoric acid in performing composite repairs is to be strongly discouraged. Whilst most schools favoured the use of both hybrid- and nanocomposites, six schools taught the use of flowable composites. The increase in the use of hybrid composite since the previous survey in 2002-2003 (17) for performing repair procedures is indicative of the now widespread confidence in using this type

of composite material. Notwithstanding the advantages offered by flowable materials, including ease of placement, they have a low filler loading. As such, flowable composites suffer relatively high polymerisation shrinkage and surface porosity (23). As a consequence, it is suggested that flowable composites, if used at all, should be applied away from margins and in thin section increments, possibly to help wet the internal features of the repair preparation prior to applying increments of a more heavily filled composite system.

The practice of minimally invasive dentistry, including restoration repair, is in the best interests of patients and the desire to give patients 'teeth for life' – tooth retention into later years of life is associated with better food quality choices, better nutritional status and increased self-confidence (24). Incorporation of teaching of such techniques in dental school programmes is desirable as it will lead to increased familiarity and confidence in the use of repair techniques amongst future generations of graduating dental students.

Conclusion

This study has demonstrated that the teaching of the repair of defective composite restorations, rather than their replacement, is well established in primary dental degree programmes in the Scandinavian countries. Such teaching is to be applauded and encouraged, as it is in the best interests of patients, amongst other benefits, minimising unnecessary loss of tooth tissue and limiting pulpal trauma. The results of the present survey, together with recently published long-term clinical outcome data, should encourage dental schools not presently providing such teaching to review their position in such matters. Teachers of operative dentistry should continue to develop and refine the teaching of the repair of direct composite restorations. It is suggested that to inform teaching of best practice, future research should focus on establishing the optimal techniques for the repair of direct composite restorations. This should in turn strengthen the evidence base for the application of repair techniques in clinical practice.

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