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Repair versus replacement of defective composite restorations in dental schools in Germany.

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Abstract - *The aim of this paper was to review the current teaching of repairs to direct composite restorations in dental schools in Germany, last surveyed ten years ago. Based on an 83% response rate, the findings indicate that most, but not all, dental schools included teaching of repair techniques; however marked variations were found to exist regarding clinical indications and repair techniques of the teaching. It is suggested that certain aspects of the existing teaching in some schools should be reviewed, specifically the lack of use of a bonding agent and the issue of flowable composites to complete repairs.*

KEY WORDS: Direct composite resin restorations, repair, minimally invasive

INTRODUCTION

Notwithstanding the ever-increasing sophistication of resin composite systems and dental practitioner's ability to place high quality, aesthetically pleasing restorations, restorations of composites cannot be considered to be permanent as they suffer different forms of deterioration in prolonged clinical service[1-3]. This can occur as a consequence of less than ideal operative technique and associated errors at the time of placement, including incomplete etching and bonding, polymerisation shrinkage and stresses causing marginal defects, and less than ideal finishing. In other situations, composite restorations may deteriorate over time in clinical service as a consequence of, for example, wear, marginal chipping and marginal ridge fractures under occlusal loading, or be compromised by secondary caries, which typically takes the form of a new lesion of caries in the remaining tooth tissues immediately adjacent to the margin of the restoration, most often the gingival margin[4]. Whatever the circumstances a patient presenting with an existing composite restoration which exhibits signs of marginal deterioration and discolouration, secondary caries, fracture, wear or other non-catastrophic signs of deterioration, poses a dilemma: should the restoration be removed in its entirety, or should the localised areas of concern be managed by means of a repair? [5]. This dilemma should be considered against a backdrop of the following considerations:

The most common reason for the replacement of composite restoration is secondary caries as diagnosed clinically; [6,7]

The cost to directly paying patients and to third-party funders of oral healthcare – of restoration replacement, both immediate and subsequent, greatly exceeds that of a repair procedure; [8]

The repeated replacement of restorations, in particular resin composite restorations, in which it is difficult to distinguish between restoration and the surrounding tooth tissue, invariably results in unnecessary loss of sound tooth tissue and increased risk of subsequent tooth fracture and pulpal damage [9].

In recent years, predictable composite repair techniques have been developed for managing deteriorating composite restorations[10-12]. The principle behind such techniques is that a localised repair is less invasive than complete restoration replacement, helping to preserve remaining tooth tissues. The evidence for repair techniques was previously based on laboratory studies that demonstrated considerable interfacial bond strength between 'new' and 'old' composite[13-17]. More recent evidence, in the form of clinical follow-up studies[10,11], has been published, including one which examined the success of localised composite repairs over a seven year period[12]. This latter study found that repair was a reliable, predictable technique, and when compared to total restoration replacement outcomes, was reported to be advantageous in terms of restoration quality and survival[12].

Despite the advantages of repair techniques, there is evidence that such techniques have not been embraced in general dental practice[18,19]. Furthermore, while the manufactures of resin-based composite materials favour repair techniques, there is variation between companies in respect to the indications and techniques to successfully complete repairs[20]. Surveys conducted approximately 10 years ago indicated that the teaching of repair techniques to manage deteriorating composite restorations was included in the curricula of many European and North American schools[21-24]. At that time it was noted that one-half of German dental schools surveyed did not include the teaching

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of direct composite repairs in their curricula with most of these schools reporting that they did not intend including this teaching over the subsequent five years[24]. Given recent advances in composite materials, the increasing care of minimally invasive techniques[2,3], and the recent publication of clinical studies justifying the use of repair techniques[10-12], this study was undertaken to re-examine the teaching of composite repair techniques in dental schools in Germany.

MATERIALS AND METHODS

A prepiloted questionnaire (prepared in German) was mailed together with a covering letter to the person identified as responsible for the teaching of Operative/ Restorative Dentistry teaching programmes in each of the 30 fully established dental schools in Germany. This questionnaire was mailed in October 2009, and a stamped addressed envelope for return. In December 2009, a reminder letter, including a copy of the questionnaire, was sent to the dental schools that had not responded. By February 2010, no further responses were received. The findings were collated on spreadsheets and then reported as descriptive data.

Information requested in this questionnaire included:

- the nature and extent of teaching of composite repair techniques;
- the rationale for this teaching;
- tooth-and restoration-based reasons for considering the repair rather than replacement of direct composite restorations;
- techniques taught for composite repair procedures.

Questions were of both 'open' and 'closed' styles. In the former respondents were given some space in which to write a textual response. In the latter respondents were given a number of possible responses to a statement and asked to identify the most appropriate.

RESULTS

Completed responses were received from 25 of the 30 schools surveyed (response rate= 83%).

Composite repair: teaching and experience

Twenty-four of the 25 respondents (96%) reported that they performed composite repairs in their clinical practice. Each of these respondents indicated that they had found composite repair techniques to be satisfactory and to have successfully extended the clinical service of restorations which had suffered different forms of deterioration in clinical service.

Twenty-two of the 25 respondent schools (88%) reported that they taught the repair of defective composite restorations to their students. When asked to list the reasons for including this teaching in their curriculum, the responses included:

- Clinical experience with composite repairs
  22 schools
- Existing evidence
  15 schools
- Information from case reports
  8 schools
- Outcome of local audit
  1 school

Three respondent schools (12%) did not teach repair as an alternative to the replacement of defective composite restorations. One school indicated that it does not include this teaching in its curriculum given lack of sufficient clinical evidence; the other two schools gave no reason for not including this teaching. Of the three schools which did not teach composite repair techniques, two planned to introduce this teaching within the next five years.

Nineteen respondent schools indicated that their students received teaching in respect of composite repair techniques in the clinical situation with no formal didactic teaching. Three schools reported that they provided preclinical and clinical teaching in respect of composite repair techniques.

Indications

A summary of the responses in respect of indications taught for the repair rather than the replacement of direct composite restorations is shown in Fig. 1. The most commonly reported consideration was 'tooth tissue preservation' (21 schools).

A summary of the findings in respect of indications for the repair of direct composite restorations is reported in Table 1. The defects considered appropriate for repair by most schools were marginal defects (20 schools) and partial loss of a restoration (19 schools). The restoration defect considered inappropriate for repair by all schools was restoration discolouration involving more than one surface.

Regarding the appropriateness of a composite repair in situations where there had been fracture of tooth tissue adjacent to an existing direct composite restoration, the responses are illustrated in Fig. 2. The most commonly agreed scenario was a cusp fracture in a posterior tooth adjacent to an existing direct composite restoration (18 schools). In contrast, there was limited agreement in respect of the management of, in particular, a cracked posterior tooth (four schools).

Clinical techniques

Respondents were asked to outline the techniques taught for performing a repair of a defective composite restoration. The responses are summarised in Table 2. The most commonly taught surface treatment was acid etching with phosphoric acid (17 schools). Nineteen schools taught the application of a dentine/ enamel bonding agent to the prepared surfaces. The material most commonly taught for affecting repairs was flowable composite (17 schools). The most popular finishing devices were diamond finishing instruments (19 schools).

Success of repair techniques

Twenty of the respondent schools consider repair techniques to be a 'definitive' measure. Two schools consider a repair to be a 'transitional' measure with a likely survival of up to 12 months.

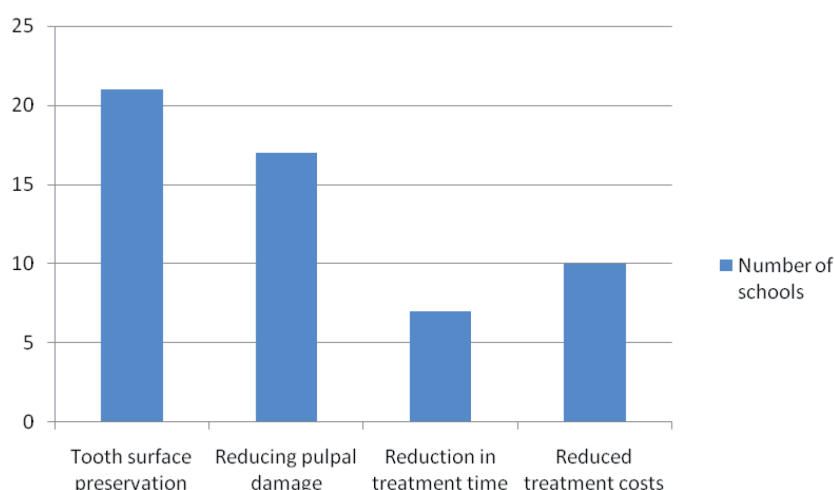

Figure 1. *Summary of the responses in respect of indications taught for repair rather than replacement of direct composite restorations (maximum possible number of responses = 22).*

Table 1. *Indications for the repair rather than the replacement of direct composite restorations (maximum possible number of responses = 22).*

Restoration related failure	*Number of schools*
Secondary caries	13
Marginal defects	20
Marginal discolouration	10
Superficial/ surface colour correction	11
Restoration discolouration labial/ buccal	8
Restoration discolouration occlusal	4
Restoration discolouration cervical	4
Restoration discolouration proximal	3
Discolouration involving more than one surface	0
Partial loss of restoration	19
Abrasion/ attrition/ erosion	6
Bulk fracture of an anterior restoration (incisal)	17
Bulk fracture of an anterior restoration (proximal)	4
Bulk fracture of an anterior restoration (proximal-incisal)	11
Bulk fracture of a posterior restoration (occlusal)	12
Bulk fracture of a posterior restoration (isthmus fracture)	9
Bulk fracture of a posterior restoration (box fracture)	14
Bulk fracture of a posterior restoration (marginal ridge fracture)	15

Twenty-one schools reported that they found their patients willing to accept composite repairs as an alternative to restoration replacement. The other schools did not respond to this question.

Regarding acceptable longevity of a repair to a direct composite restoration, the responses were as follows:

- < 3 years: 5 schools
- > 3 years ≤ 5 years: 10 schools
- > 5 ≤7 years: 7 schools
- > 7 years: 0 schools

Twelve of the respondent schools monitored the success of repair treatments as part of their patient recall processes. Of these 12 schools, nine estimated that repairs increased the longevity of the direct composite restoration by 50% and three schools estimated that repairs increased longevity of the repaired restoration by 30%.

DISCUSSION

A postal questionnaire was used in the present study, resulting in an 83% response. Such questionnaires offer many advantages, in particular, respondents usually being free from of peer-bias when completing responses[25,26]. The response rate, while not 100%, should be viewed favourably, given the typical response rate of 64% for such studies[27] and when compared to response rates of other recently-published studies on diverse subjects such as dental nurse education (53%)[28], rubber dam usage (50%)[29] and local anaesthetic teaching programmes (18%)[30]. It is acknowledged, however, that a limitation of the findings is the potential for non-response bias[31], with only those

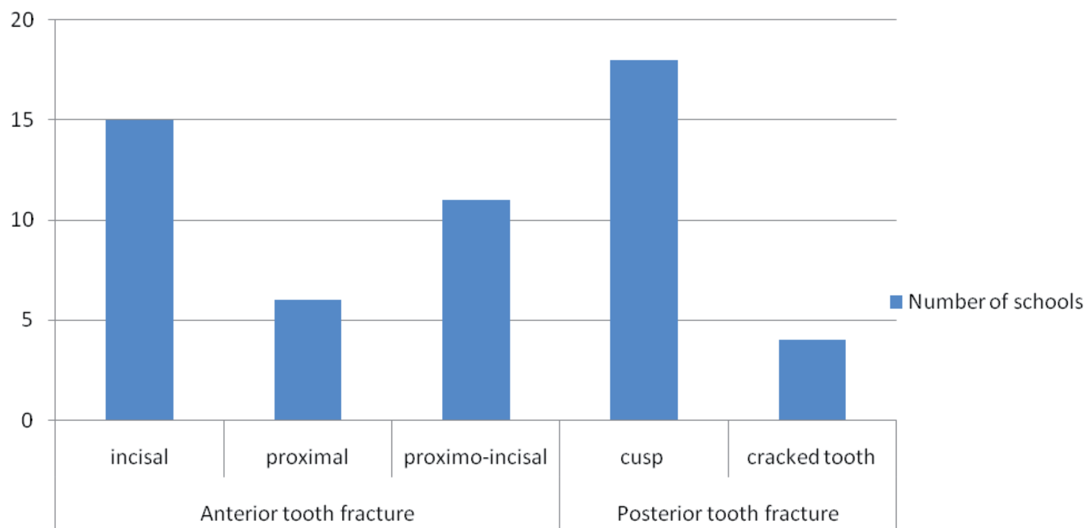

Figure 2. *Summary of the responses in respect of the appropriateness of a repair rather than restoration replacement to manage different types of fractures of tooth tissues adjacent to direct composite restorations (maximum possible number of responses = 22).*

Table 2. *Summary of the findings pertaining to the repair procedures, type of composite and finishing techniques taught for the repair of direct composite restorations (maximum possible number of responses = 22).*

Surface treatments of existing composite restoration	*Number of schools*
Acid etching with phosphoric acid	17
Aluminium oxide air abrasion	13
Acid etching with hydrofluoric acid	3
Cleaning with slurry of pumice	1
No mechanical surface treatment	0
Materials utilised in the repair technique	
Dentine/enamel bonding agent	19
Silane coupling agent	10
Flowable composite	17
Hybrid composite	16
Nanohybrid composite	8
Glazing resin	0
Finishing techniques for the placed repair	
Diamond finishing instruments	19
Finishing discs	4
Composite polishing points	4
Composite polishing paste	2
Tungsten carbide finishing instruments	0

schools interested in composite repairs responding to the survey and thereby resulting in more positive findings than would have otherwise been the case. In addition, there was no attempt at resurveying to check consistency and commonality of views within and between the schools.

The use of repair techniques rather than total restoration replacement is supported by clinical evidence from a number of clinical follow-up studies[10-12]. The result of the present study suggest that teaching of repair techniques in the 22 (88%) schools in Germany which participated in the present study is largely in line with best available evidence.

The increase in the teaching of repair techniques since the time of the previous survey in 2000[24] is considered to be indicative of a shift to minimally interventive techniques in most, if not all dental schools in Germany. It is also noteworthy that in the shift towards a more minimally invasive practice of dentistry that no school indicated that patients would not accept a composite repair, rather than a restoration replacement. This attitude of patients may, however, be driven by features of repair techniques other than minimal intervention, including reduced costs and treatment times, let alone the limited need for local anaesthesia to success-

fully complete repair procedures. Furthermore, it is of note the respondents considered repairs to direct composites to be effective with 17 schools having considered repairs to last more than three years, with seven of these schools having considered repairs to last between five and seven years. Such views of anticipated longevity will in all probability be adjusted upwards in years to come as a result of findings such as those reported by Gordan *et al.*[12], which demonstrate successful outcomes to composite repairs after a seven year follow up.

The clinical techniques reported were, as indicated above, relatively consistent with best available evidence. Some form of mechanical roughening - considered vital in the production of a satisfactory bond between 'old' and 'new' composite was taught by each school, with acid etching by means of phosphoric acid being the most popular technique taught for treatment of the prepared surfaces (17 schools)[13-17]. It is of some concern that not all schools (n=3) taught the application of a bonding agent prior to the application of the repair composite. The absence of an effective bond between the repair and underlying substrate could lead to leakage, interfacial staining and pulpal irritation, with the subsequent possibility of death of the pulp. In addition, it could be viewed as some cause for concern that the most popular form of composite reported for performing a repair was flowable composite. While flowable materials offer many advantages, including their ease of application in small cavities, as typically occurs in repair procedures, they suffer limitations in respect of relatively high polymerisation shrinkage, increasing the risk of marginal gap formation, and limited resistance to wear in load bearing situations[32]. Further clinical studies of alternative repair procedures, using different types of composite materials are indicated to shed new light on the selection of materials to best effect repairs to direct composite restorations. In addition, it would help inform the planning of continuing education programmes in Germany to know the extent to which existing practitioners are practicing repair techniques taught in the country's dental schools. If teaching in dental schools is the sole means of introducing new procedures into clinical practice, implementation can fail to keep pace with innovations and patients will be disadvantaged.

CONCLUSION

The results of the present survey illustrate that there is increasing acceptance of composite repair techniques as an alternative to restoration replacement in dental schools in Germany. The increase in this teaching is considered to be an indication of a trend towards minimally invasive operative dentistry in dental schools in Germany, as may be observed in dental schools in at least the UK and Ireland. While most of the teaching reported is evidence-based, the widespread use of flowable composites to undertake repairs, and the lack of use of bonding agents in repair procedures in certain schools should be reviewed in the updating of existing teaching.

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REFERENCES

1. Lynch CD. *Successful posterior composites*. London: Quintessence Publishing Co., 2008.
2. Lynch CD, Guillem S, Nagrani B, Gilmour ASM, Ericson D. Attitudes of some European dental undergraduate students to the placement of direct restorative materials in posterior teeth. *J Oral Rehabil* 2010; in-press.
3. Gilmour ASM, Latif M, Addy LD, Lynch CD. Placement of posterior composite restorations in United Kingdom dental practices: techniques, problems, and attitudes. *Int Dent J.,* 2009; **59:** 148 -154.
4. Mjör IA, Toffenetti F. Secondary caries: a literature review with case reports. *Quintessence Int.,* 2000; **31:** 165 – 179.
5. Mjör IA. Repair versus replacement of failed restorations. *Int Dent J.,* 1993; **43:** 466 – 472.
6. Mjör IA, Moorhead J. Selection of restorative materials, reasons for replacement and longevity of restorations in Florida. *J Am Coll Dent.,* 1998; **65:** 27 – 33.
7. Deligeorgi V, Mjör IA, Wilson NHF. An overview of reasons for the placement and replacement of restorations. *Prim Dent Care* 2001; **8**: 5-11.
8. Burke FJ, Lucarotti PS. How long do direct restorations placed within the general dental services in England and Wales survive? *Br Dent J.,* 2009; 206: E2.
9. Wilson NHF. *Minimally invasive dentistry – the management of caries*. London: Quintessence Publishing Co., 2007.
10. Gordan VV, Shen C, Riley J 3rd, Mjör IA. Two – year clinical evaluation of repair versus replacement of composite restorations. *J Esthet Restor Dent.,* 2006; **18:** 144 – 154.
11. Moncada G, Martin J, Fernández E, *et al*. Sealing, refurbishment and repair of Class I and Class II defective restorations: a three – year clinical trial. *J Am Dent Assoc.,* 2009; **140:** 425 – 432.
12. Gordan VV, Garvan CW, Blaser PK, *et al*. A long-term evaluation of alternative treatments to replacement of resin – based composite restorations: results of a seven – year study. *J Am Dent Assoc.,* 2009; **140:** 1476 – 1484.
13. Shahdad SA, Kennedy JG. Bond strength of repaired anterior composite resin: an *in vitro* study. *J Dent.,* 1998; **26:** 685 – 694.
14. Chiba K, Hosoda H, Fusayama T. The addition of an adhesive composite resin to the same material: bond strength and clinical techniques. *J Prosthet Dent.,* 1989; **61:** 669 – 675.
15. Puckett AD, Holder R, O'Hara JW. Strength of posterior composite repairs using different composite/ bonding agent combinations. *Oper Dent.,* 1991; **16:** 136 – 140.
16. Denehy G, Bouschlicher M, Vargas M. Intraoral repair of cosmetic restorations. *Dent Clin North Am.,* 1998; **42:** 719 – 737.
17. Padipatvuthikul P, Mair LH. Bonding of composite to water aged composite with surface treatments. *Dent Mater.,* 2007; **23:** 519 – 525.
18. Blum IR, Newton JT, Wilson NH. A cohort investigation of the changes in vocational dental practitioners' views on repairing defective direct composite restorations. *Br Dent J.,* 2005; Suppl: 27 – 30.
19. Blum IR, Schriever A, Heidemann D, *et al*. The repair of defective direct composite restorations in dental practice. *J Dent Res.,* 2003; **82:** (Spec Issue C) C-525, Abstract 372.
20. Blum IR, Jagger DC, Newton JT, Wilson NHF. The opinions of manufacturers of resin-based composite materials towards the repair of failing composite restorations. *Prim Dent Care* 2009; **16**: 149 – 153.
21. Blum IR, Schriever A, Heidemann D, *et al*. Repair versus replacement of defective direct composite restorations in teaching programmes in United Kingdom and Irish dental schools. *Eur J Prosthodont Rest Dent.,* 2002; **10:** 151 – 155.
22. Blum IR, Mjör IA, Schriever A, *et al*. Defective direct composite restorations – replace or repair? *Swed Dent J.,* 2003; **27:** 99 -104.
23. Gordan VV, Mjör IA, Blum IR, *et al*. Teaching students the repair of resin – based composite restorations: A survey of North American dental schools. *J Am Dent Assoc.,* 2003; **134:** 317 – 323.

24. Blum IR, Schriever A, Heidemann D, *et al.* The repair of direct composite restorations: an international survey of the teaching of operative techniques and materials. *Eur J Dent Educ.,* 2003; **7:** 41 – 48.
25. Blaxter L, Hughes C, Tight M. *How to research*. 3rd ed. Berkshire, England: Open University Press, 2006
26. Oppenheim AN. *Questionnaire design, interviewing and attitude measurement*. New edition. London: Continuum, 2003.
27. Tan RT, Burke FJT. Response rates to questionnaires mailed to dentists. A review of 77 publications. *Int Dent J.,* 1997; **47**: 349-354.
28. Lynch CD, O'Byrne MT, McConnell RJ, Neville K. Opinions of Irish dental practitioners on dental nurse training. *J Irish Dent Assoc.,* 2003; **49**: 90-94.
29. Lynch CD, McConnell RJ. Attitudes and use of rubber dam by Irish general dental practitioners. *Int Endod J.,* 2007; **40**: 427 – 432.
30. Brand HS, Kuin D, Baart JA. A survey of local anaesthetia education in European dental schools. *Eur J Dent Educ.,* 2008; **12**: 85-88.
31. Bell, J. *Doing your research project: a guide for first-time researchers in education, health and social science*. 4th ed. Berkshire, England: Open University Press, 2005.
32. Tredwin CJ, Stokes A, Moles DR. Influence of flowable liner and margin location on microleakage of conventional and packable class II resin composites. *Oper Dent.,* 2005; **30:** 32-38.