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The Management of Defective Resin Composite Restorations: Current Trends in Dental School Teaching in Japan

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Clinical Relevance

Repair rather than replacement of defective restorations increases the longevity of existing restorations while avoiding the needless removal of the restoration in total.

SUMMARY

Aim: The aim of this article is to investigate the contemporary teaching of the management of defective direct resin composite restorations in dental schools in Japan.

Methods: A questionnaire relating to the teaching of the management of defective resin composite restorations was developed and e-mailed to 29 dental schools in Japan in 2010.

Results: Completed responses were received from 19 of the 29 invited schools (response rate = 66%). Eighteen schools (95%) report that they included the teaching of repair of direct defective resin composite restorations in their dental school programs. Thirteen schools reported that they included both clinical and didactic instruction on the repair of direct resin composite restorations. Fourteen schools did not teach any mechanical roughening of the exposed resin composite restoration surface before undertaking a repair. The most commonly reported treatment was acid etching with phosphoric acid (12 schools). The most commonly taught material for completing repairs was a flowable resin composite (16 schools).

Conclusion: The teaching of repair of defective resin composite restorations is well established within many Japanese dental schools, to a greater extent than in some other regions of the world. The impact of this teaching on subsequent clinical practices in Japan should

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be investigated. Furthermore, it is concluded that there is a need for much stronger leadership in operative and conservative dentistry, ideally at the global level, to resolve differences in key aspects of operative procedures such as repairs.

INTRODUCTION

Notwithstanding developments in dental materials, one of the most significant advances in dental practice in recent times has been the shift from a "mechanically focused" to a more "biologically focused" approach across the spectrum of dentistry, with an emphasis on minimally invasive treatments.[1] In the fields of prosthodontics and operative dentistry, such developments are evident in, for example, the development of predictable adhesive resin retained bridges in preference to conventional bridges and the increasing use of resin composite for the management of lesions of caries in posterior teeth rather than the "traditional" use of amalgam.[1-4] The main advantages of such techniques include the avoidance of excessive loss of healthy tooth tissue to create mechanical retention and the facilitation of the placement of certain restorations as well as reduction in the need for subsequent advanced restorative maintenance, often involving restoration replacement and financial outlay for the patient and third-party providers of oral health care.

In many countries, there has been a significant increase in the placement of resin composite restorations in posterior teeth in dental schools in recent years. In the late 1990s, dental students in Western Europe and North America graduated with limited, mainly didactic instruction in the placement of resin composites in posterior teeth.[5,6] A similar pattern was noted at that time in dental schools in Japan.[7] However, 10 years later, dental students in the United Kingdom and Ireland gained more experience in the placement of posterior resin composites than amalgam (55%: 45% composite: amalgam), while those in North American schools gained similar amounts of experience at posterior resin composite placement (49%: 51% composite: amalgam).[8,9] This development will drive many changes in the clinical practice of dentistry over the coming years, as a new generation of dentists, skilled in the placement of posterior resin composite restorations, will drive the delivery of more minimally invasive forms of dentistry, let alone pressures from patients and third-party funders to minimize iatrogenic damage and the resultant costs incurred in lifelong oral health maintenance programs.

In Japan, the treatment of lesions of caries in posterior teeth has taken a different direction, effectively following a reduction in the use of amalgam since the 1970s. Treatment choices include the placement of resin composite or indirect metal restorations in the restoration of posterior teeth.[10] A recent survey of Japanese dental school teaching has indicated that resin composite accounts for 45% of posterior restorations placed by Japanese dental schools.[10] This finding, while lower than initially anticipated, was much greater than the proportions (ca. 30%) within UK/Irish, US, Canadian, and Iranian dental schools at this time.[11-16]

Placement of resin composites in posterior teeth, using modern approaches and techniques, offers many advantages, such as the implementation of the principles of minimally invasive dentistry, reinforcement of weakened tooth structure, marginal seal created by adhesion and bonding, and improved esthetics.[17-21] Practice-based research has indicated that resin composite restorations placed in posterior teeth may be found to exhibit greater longevity than less conservative amalgam restorations when well placed in appropriate situations.[22] However, all restorations will, over time, feature signs of degradation. The challenge for clinicians becomes that of deciding when intervention is required and what form this intervention should take.[23]

The traditional approach to the management of restorations exhibiting signs of marginal deterioration (defective margins) or secondary caries as diagnosed clinically has been total restoration removal and replacement. This approach is based on the long-held premise that restorations with defective margins suffer damaging leakage and that lesions of caries formed at the margins of restorations adversely affect the tooth restoration interface down to and including the base of the cavity. This premise is increasingly viewed as false and, if accepted as false, leads to the regrettable conclusion that countless patients have been exposed to overtreatment.[24] It has been estimated that as many as 56% of restorations placed by dental practitioners are replacement restorations rather than restorations placed in the management of new lesions of caries.[25] Apart from the needless use of manpower, consumables, and financial resources, procedures cause iatrogenic damage, increasing the risk of the need for endodontic therapy and, in turn, crown work. The realization that caries occurring at the

margins of a restoration are in reality "new" lesions of caries rather than "recurrent" caries means that localized repair of defective restorations rather than total restoration replacement is possible.[24] Such an approach prolongs the longevity of a restoration while avoiding the damaging effects of excessive cavity preparation, leading to avoidable weakening of the remaining tooth tissue and pulpal complications.

Some areas of the world have witnessed advances in the teaching of resin composite restoration repairs,[26-29] particularly in countries where the teaching of posterior resin composites has seen similar advancement in recent years. The aim of this article is to investigate the contemporary teaching of repairs in the management of defective resin composite restorations in dental schools in Japan, where teaching of posterior resin composites is already well advanced in comparison to many other regions of the world.

MATERIALS AND METHODS

A questionnaire based on previous investigations[26-29] regarding the teaching of the management of defective composite restorations was prepared (in English). This questionnaire was e-mailed to the person identified as being responsible for the delivery of operative dentistry teaching programs within the 29 dental schools with undergraduate programs in Japan.

Information sought included the following:

- The teaching of resin composite repair techniques in their dental school program
- The nature of this teaching
- The reasons for including this teaching
- Clinical indications for repair
- Views on the longevity of resin composite repairs
- Techniques taught for resin composite restoration repair

Both "open" (free-text) and "closed" (tick box) styles of questions were included. Nonrespondents were followed up by e-mail on two occasions. Information collected was entered onto an electronic database. Descriptive results are reported.

RESULTS

Completed responses were received from 19 of the 29 invited schools (response rate = 66%). Responses were collected over a nine-month period. No incomplete responses were received.

Extent and Nature of Teaching

Eighteen schools (95%) report that they included the teaching of repair of direct resin composite restorations in their dental school programs. The one respondent school that reported not presently teaching repair of direct resin composite restorations did not indicate its reasons for not doing so. Neither did it indicate if it intended including this teaching in coming years.

When asked, those schools that indicated that they were presently teaching repair of direct resin composite restorations gave the following reasons:

- Clinical experience: 13 schools
- Existing evidence: six schools
- Information from case reports: six schools

Thirteen schools reported that they included both clinical and didactic instruction on repair of direct resin composite restorations. Four schools reported that they provided "ad hoc" clinical experience to their students. Four schools reported that they provided "didactic-only" teaching with no clinical experience.

Indications for Repair

General Indications—A summary of the general indications taught for the repair rather than replacement of direct resin composite restorations is reported in Table 1. The most common indication was "tooth substance preservation" (18 schools).

Restoration-Related Defects—When asked to consider which restoration defects of direct resin composite restorations were appropriate for repair rather than replacement, the most common reasons were marginal defects (18 schools), marginal dis-

Table 1: *Summary of the General Indications Taught for Repair Rather Than Replacement of Direct Resin Composite Restorations (Maximum Possible Number of Responses = 18)*

Indication	Number of Schools
Tooth substance preservation	18
Reduced risk of harmful effects on the pulp	12
Reduction in treatment time	8
Reduced costs to the patient	4

Table 2: *Teaching of Restoration-Related Failures Considered Appropriate for Repair Rather Than Replacement of Direct Resin Composite Restorations (Maximum Possible Number of Responses = 18)*

Restoration Related Failure	Number of Schools
Secondary caries	14
Marginal defects	18
Marginal discoloration	16
Superficial/surface color correction	12
Restoration discoloration labial/ buccal	13
Restoration discoloration occlusal	11
Restoration discoloration cervical	11
Restoration discoloration proximal	8
Discoloration involving more than one surface	8
Partial loss of restoration	15
Abrasion/attrition/erosion	12
Bulk fracture of an anterior restoration (incisal)	11
Bulk fracture of an anterior restoration (proximal)	8
Bulk fracture of an anterior restoration (proximal-incisal)	6
Bulk fracture of a posterior restoration (occlusal)	6
Bulk fracture of a posterior restoration (isthmus fracture)	3
Bulk fracture of a posterior restoration (box fracture)	4
Bulk fracture of a posterior restoration (marginal ridge fracture)	10

Table 3: *Clinical Situations Involving Tooth Fracture Adjacent to Existing Direct Resin Composite Restorations Considered Appropriate for Teaching Repair Rather Than Replacement of Direct Resin Composite Restorations (Maximum Possible Number of Responses = 18)*

Restoration Related Failure	Number of Schools
Anterior tooth (tooth fracture from incisal region)	11
Anterior tooth (tooth fracture from proximal region)	8
Posterior tooth (cusp fracture)	7
Posterior tooth (cracked tooth)	7
Anterior tooth (tooth fracture from proximal-incisal region)	6

colouration (16 schools), and partial loss of a restoration (15 schools).The other responses are summarized in Table 2. Defects of posterior direct resin composites considered least appropriate for repair included an isthmus fracture (three schools) and proximal box fracture (four schools).

Fracture of Adjacent Tooth Tissue—Fracture of tooth tissue adjacent to a restoration can be considered appropriate for restoration repair. When asked which situations they felt were appropriate for this, most respondents reported anterior tooth fracture in the incisal region (11 schools; Table 3).

Clinical Techniques for Performing a Repair

Techniques taught for surface treatments of existing resin composite restorations and the materials selected for use in repair and finishing techniques are summarized in Table 4. Fourteen schools did not teach any mechanical roughening of the exposed resin composite restoration before undertaking the repair. The most commonly agreed treatment was acid etching with phosphoric acid (12 schools). Seventeen schools taught the application of a dentine/enamel bonding agent to the prepared surface. The most commonly taught material for completing repairs was a flowable resin composite (16 schools). Popular finishing devices included diamond finishing instruments (16 schools) and finishing points (12 schools).

Table 4: *Techniques Taught for the Repair of Direct Resin Composite Restorations (Maximum Possible Number of Responses = 18)*

Surface Treatments of Existing Composite Restoration	Number of Schools
Acid etching with phosphoric acid	12
Cleaning with slurry of pumice	4
Aluminum oxide air abrasion	4
Acid etching with hydrofluoric acid	2
No mechanical surface treatment	14
Materials Utilized in the Repair Technique	
Dentine/enamel bonding agent	17
Flowable resin composite	16
Silane coupling agent	15
Hybrid resin composite	13
Nanohybrid resin composite	11
Glazing resin	1
Finishing Techniques for the Placed Repair	
Diamond finishing instruments	16
Polishing points	12
Finishing discs	9
Tungsten carbide finishing instruments	7
Polishing paste	4

Patient Acceptance and Treatment Outcome

All 18 schools teaching repair of direct resin composite restorations reported that they found their patients willing to accept a repair as an alternative to restoration replacement. Respondents were asked to indicate what they considered to be the acceptable longevity of a repair to an existing resin composite restoration. Responses were received from all 18 schools. Their responses were as follows:

- Less than three years: two schools
- Three to five years: 13 schools
- More than five years: three schools

Sixteen schools monitored repaired resin composite restorations as part of a recall system. Of these, three schools estimated that repairs increased the longevity of the direct resin composite restoration by the following:

- 10%: one school
- 30%: three schools
- 50%: eight schools
- 100%: four schools

DISCUSSION

At the time of this survey, there were 29 dental schools with undergraduate teaching programs in Japan. Dental school programs generally last for six years in Japan. While the basic curriculum is prescribed by the government, the content and delivery of programs are the responsibility of individual schools. Graduating students are required to complete the national final qualifying examination before receiving their licences (akin to the US state board examinations).[10]

As with all questionnaire-based surveys, risks exist in relation to the reliability of responses and the potential of nonresponse bias. Within this survey, a 66% response rate was achieved. This would be regarded as an "above-average" response rate for questionnaire-based surveys: previous work by Tan and Burke has reported an average response rate of 62% for questionnaire-based surveys in the dental literature.[30] Notwithstanding this, caution must be exercised in interpreting these results: the potential exists for those who do not practice repair to have not responded (nonresponder bias). However, two follow-up reminders were sent (in keeping with "Dillman's method"),[31] and there were no other possibilities of encouraging nonresponders to complete the survey.

Within the responses received, it is seen that 95% of respondent schools teach their students to repair rather than replace defective resin composite restorations. This is in keeping with (if not exceeding) the proportions seen in other regions surveyed around the world, such as Scandinavia (92%), the United Kingdom and Ireland (88%), The United States and Canada (88%), and Germany (88%).[26-29] However, despite this, the distribution of teaching within Japanese schools was quite close to that of those in the United States and Canada, with "organized"

didactic and clinical teaching occurring in 68% of Japanese respondents and 69% of US and Canadian schools.[26] This indicates that the teaching of minimally invasive management of defective restorations is well advanced in Japanese dental schools and bodes well for the future use of minimally invasive dental techniques by graduating Japanese dental students.

With little evidence in the form of appropriately controlled randomized clinical trials to demonstrate the effectiveness of repair when compared to replacement techniques,[32,33] most of the evidence for repair of defective restorations comes from a small number of clinical trials[34-37] as well as some laboratory-based research.[38-45] Such studies indicate that some form of mechanical roughening of the exposed restoration surface should be undertaken prior to completing the repair.[38-40] Surprisingly, 78% of Japanese schools (n=14) reported not teaching mechanical surface roughening, with schools, in the main, relying on chemical treatment of the exposed restoration surface with phosphoric acid (12 schools), pumice (four schools), or hydrofluoric acid (two schools). In contrast, 100% of US/Canadian, German, and Scandinavian schools, as well as 93% of UK and Irish schools, reported teaching some form of mechanical roughening of the available restoration surface before completing the repair.[26-29] In the absence of suitable clinical trials, it is unclear if the inclusion of mechanical roughening of the restoration surface affects the clinical performance of the repair. However, based on the available evidence (albeit laboratory based), Japanese dental schools may wish to consider including this technique within their teaching program.

Based on the available clinical studies as well as laboratory-based studies, the application of a bonding agent is considered important for increasing the bond strength between the "fresh" repair and existing restoration.[38,41-43] Within these responses, 94% of schools report teaching such a technique. The use of flowable resin composites for effecting the repair is more popular in Japan (89% of schools) compared to other regions (33% of UK and Irish schools, 55% of Scandinavian schools, 60% of US/Canadian schools, and 77% of German schools).[26-29] Some caution is advised with this practice: while flowable resin composites have a reduced filler load and may offer potential advantages in terms of ease of application and elasticity, their increased porosity and polymerisation shrinkage can cause problems if placed on the external surface of a tooth restoration.[46]

Despite the teaching of repair rather than replacement of defective resin composite restorations being embedded in Japanese dental school programs, it is unclear as to what extent this technique is applied in dental practice in Japan. There is some evidence from the United Kingdom that despite teaching of repair techniques at dental school, these are usually discarded on emergence into independent practice.[47] This is a regrettable development given evidence that as much as 50% of restorations are replaced within 10 years of initial placement.[48] This, in turn, results in many patients being exposed to overtreatment and subjected to the associated economic and financial burdens. Investigation of the application of repair techniques in the management of defective restorations within dental practice in Japan is warranted to assess the influence of the positive developments in dental school teaching.

In the meantime, the results of the present study, when taken together with the findings of the related studies,[26-29] indicate that a strong consensus exists among clinical academics in departments of operative and conservative dentistry around the world that there are merits in repairing rather than replacing defective direct resin composite restorations. With concerted actions through national associations and international and multinational organizations, such as the Academy of Operative Dentistry and the European Federation of Conservative Dentistry, it should be possible to resolve differences in technique, such as the treatment of exposed restoration surfaces, and to disseminate and encourage among general dental practitioners the adoption of the knowledge and skills necessary to effectively apply repair techniques in clinical practice. At the same time, commissioners and funders of third-party oral health care provision should be persuaded of the value of repair techniques as an approach that benefits patients, that offers efficiency savings, and that allows especially younger practitioners to practice the minimal interventive techniques they were taught in their dental school programs. The repair of defective direct composite restorations in this way is a good example of the need for much stronger leadership in operative and conservative dentistry, ideally at the global level.

CONCLUSION

Based on the results of this survey, it appears that the teaching of repair of defective resin composite restorations is established within many Japanese dental schools to a greater extent than other regions of the world. This is to be welcomed, as repair

techniques for defective restorations offer many more advantages to patients than replacement, not the least of which are reduced iatrogenic damage and the associated financial and treatment burdens. The impact of this teaching on subsequent clinical practices in Japan should be investigated. Furthermore, the findings of related studies indicate the need for much stronger leadership in operative and conservative dentistry to at least resolve the differences in key aspects of repair procedures if for no other reason than the benefit of patients.

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Conflict of Interest

The Authors of this manuscript certify that they have no proprietary, financial or other personal interest of any nature or kind in any product, service and/or company that is presented in this article.

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