

## IN BRIEF

- Composite resin placed at an increased vertical dimension acts in a similar manner to a 'Dahl' type appliance
- Composite resin offers a viable treatment option in the management of localised anterior tooth wear
- There is emerging evidence that composite resin has acceptable clinical performance when used in this way
- This approach is most conservative and does not preclude other options in the future

# The survival and clinical performance of resin-based composite restorations used to treat localised anterior tooth wear

C. D. J. Redman,<sup>1</sup> K. W. Hemmings<sup>2</sup> and J. A. Good<sup>3</sup>

**Objective** To examine the clinical performance of resin-based composite restorations placed at an increased vertical dimension when used to manage localised anterior tooth wear.

**Design** A retrospective analysis of cases treated at a single centre.

**Setting** UK Hospital setting in the year 2000.

**Subjects and Methods** Two hundred and twenty five restorations placed in 31 subjects were included. Assessment was made following examination of study casts and projected slides. Modified United States Public Health Services criteria were used and data analysed using the software *Statistical Programme for Social Sciences (SPSS)*. Survival analysis was carried out at two levels, major failure only and all types of failure. Kaplan-Meier survival plots were produced against different variables and modes of failure were also noted.

**Results** Major failure requiring replacement of the restoration was uncommon within the first five years. Minor failure requiring repair or refinishing presented mainly as wear, marginal discolouration or marginal fracture. Median survival was 4 years 9 months when all types of failure were considered. The restorations have good appearance and are well tolerated.

**Conclusion** Placement of resin-based composite restorations at an increased vertical dimension to treat localised anterior tooth wear, has good short to medium term survival. The technique is conservative and relatively easy to maintain.

Tooth wear appears to be an increasingly significant problem affecting all ages.<sup>1,2</sup> In particular there is an increased incidence of young patients presenting with moderate to severe, erosive wear caused by intrinsic and extrinsic acids.<sup>3-5</sup> Erosion is the most significant cause of tooth wear and has been implicated in 89% of all cases.<sup>6</sup>

<sup>1</sup>Lecturer in Restorative Dentistry, Defence Dental Agency Post Graduate Institute, RAF Halton, Aylesbury, Buckinghamshire HP22 5PG; <sup>2</sup>Consultant in Restorative Dentistry, Eastman Dental Institute and Hospital for Oral Health Care Sciences, 256 Gray's Inn Road, London WC1X 8LD; <sup>3</sup>Honorary Lecturer in Restorative Dentistry, Eastman Dental Institute and Hospital for Oral Health Care Sciences, 256 Gray's Inn Road, London WC1X 8LD

\*Correspondence to: C D J Redman RN  
E-mail: dda-8crclinadvisor@defence.mod.uk

## Refereed paper

Received 17.01.02; Accepted 04.02.03

© British Dental Journal 2003; 194: 566-572

Localised tooth wear of combined erosion/attrition aetiology is often seen affecting the palatal surfaces of the upper anterior teeth. The incisal enamel may become very thin and translucent and often gives a halo effect framing the crown. Chipping of this weakened enamel and a reduction in crown height is common. Sensitivity may also be experienced by younger patients, where the pulps are large, there is little secondary dentine, and where the erosion can be rapid. At the palatal cervical margin the enamel is often preserved and this is significant if adhesive restorations are to be considered (Figs 1 and 2).<sup>7</sup>

Unless wear occurs very rapidly, compensatory eruption usually takes place, maintaining the occlusal vertical dimension despite loss of clinical crown height.<sup>8</sup> The dento-facial complex is not a static entity, but can compensate for the effects of tooth wear by continued eruption, apical cementum deposition and localised alveolar bone growth.<sup>9-11</sup> Anterior occlusal contacts are maintained in intercuspal position and the resultant 'loss' of interoc-



Fig. 1 Localised anterior tooth wear – frontal view



Fig. 2 Localised anterior tooth wear – occlusal view

**Table 1 Clinical assessment criteria and criteria used to evaluate the restorations**

Anatomic form	A. The restoration is of desirable form. B. The restoration is not of desirable form due to bulk fracture and requires monitoring, refinishing or repair. C. Sufficient material has been lost due to fracture or debonding that replacement is necessary.
Marginal adaptation	A. The restoration appears to adapt closely to the tooth along the periphery of the restoration. An explorer does not catch when drawn across the margins, or, if it does catch it will only catch in one direction and no crevice is visible. B. The explorer catches and there is visible evidence of a crevice into which the explorer will penetrate. C. The explorer penetrates into a crevice that is of such depth that replacement of the restoration is required.
Wear	A. There is no visible evidence of wear. B. There is visible faceting indicative of wear. C. There is gross wear resulting in exposure of tooth substance.
Surface roughness	A. Surface of the restoration is smooth. B. Surface of the restoration is slightly rough or pitted; can be monitored, refinished or repaired. C. Surface of the restoration is deeply pitted or has irregular grooves or defects not related to anatomy; can not be refinished.
Marginal discoloration	A. No visual evidence of marginal discoloration. B. Marginal discoloration of a superficial nature which can be monitored or removed with minimal refinishing. C. More severe marginal discoloration which can not be removed with further refinishing and necessitates replacement.
Colour match	A. The restoration matches in colour and blends well with the adjacent tooth structure. B. The mismatch in colour is within an acceptable range. C. The mismatch in colour is outside an acceptable range.
Gingival health	A. There is no clinical evidence of gingival inflammation adjacent to the restoration. B. There is some evidence of mild gingival erythema adjacent to the restoration but no bleeding on probing. C. There are obvious signs of gingival inflammation adjacent to the restoration including bleeding on probing.
Post-operative pain	A. None. B. Mild; not requiring intervention of any description. C. Moderate to severe requiring operative retreatment or other clinical intervention.
Aesthetic result	A. Subject has no complaint and is pleased with the result. B. Subject has some reservation but accepts the result. C. Subject unhappy about the result and requests intervention.
Re-establishment of posterior occlusion	A. Multiple, firm Shimstock holds between all pairs of opposing posterior teeth. B. Some Shimstock holds between most but not all pairs of opposing posterior teeth. C. No contact between any of the posterior teeth.

clusal space presents a challenge for restoration, especially when the wear is localised and the posterior teeth are unaffected.

This process can effectively be reversed using an anterior bite platform<sup>12,13</sup> and the mandibular rest position is known to adapt to this change, re-establishing a constant freeway space.<sup>14</sup> The original 'Dahl' appliance consisted of a removable cobalt chromium platform worn in the upper arch and retained by clasps in the canine and premolar region. It was designed to disclude the posterior teeth whilst providing even contacts for the lower anterior teeth. Re-establishment of the posterior occlusion was found to occur in a single patient after 8 months and sufficient space was created anteriorly, on removal of the appliance, to allow provision of gold inlays with minimal tooth preparation.<sup>15</sup>

Analysis of a further 20 subjects concluded that space creation anteriorly was achieved by a combination of anterior intrusion and posterior eruption taking place between 6 to 14 months.<sup>16-18</sup> Difficulties with chewing and speaking were reported but treatment was otherwise well tolerated.

Poor patient compliance has been cited as the reason the appliance evolved into a cast metal, fixed bite platform.<sup>19</sup> Subsequently,

individual nickel chromium or gold alloy veneers placed at an increased occlusal vertical dimension were also adopted to achieve the same effect.<sup>20</sup> More recently, so as to avoid greying of thin, translucent teeth, porcelain and direct and indirect resin-based composite (RBC) veneers have also been described.<sup>21</sup>

*In vivo* survival studies of RBCs have invariably analysed routine restorations, with median survival rates of 8-9 years now being quoted.<sup>22</sup> However, owing to the rapid developments of composite materials, longer-term studies are sparse because materials are quickly superseded by the next generation.<sup>23</sup> Additionally, the huge variety of composite types, restoration types, study design, sample size, and statistical analysis makes sensible comparison of the findings almost impossible.<sup>24</sup>

Despite the lack of comparable data, it is generally accepted that RBCs and their mechanical properties have improved over the years.<sup>23,25</sup> Combined with an increased understanding of dentine bonding, these developments now allow more predictable use of composite in situations with significant dentine exposure. RBCs placed at an increased vertical dimension have also been shown to produce similar tooth movements to other

**Table 2 Age distribution of patients**

Age Range	Number of patients
15-20	2
21-25	3
26-30	3
31-35	7
36-40	6
41-45	5
46-50	0
51-55	2
56-60	1
61-65	1
66-70	1
Total	31

**Table 3 Numbers of restorations placed in different incisal relations**

Incisal Relationship	Number of restorations	Number of patients
Class I	132	18
Class II Div. 1	21	3
Class II Div. 2	38	5
Class III	34	5
Total	225	31

**Table 4 Distribution of tooth wear aetiology**

Suspected aetiology	Number of patients
Primarily erosion	16
Primarily attrition	3
Combined erosion/ attrition	12
Total	31

restorations.<sup>26,27</sup> However, although there is some evidence to suggest that composites used in this demanding situation have an acceptable performance, there is little clinical evidence about survival rates and modes of failure.<sup>28</sup> The aim of this study was therefore to analyse the survival and clinical performance of RBC restorations used in this way.

**METHOD**

Thirty-one patients treated at the Eastman Dental Hospital, London for localised anterior tooth wear were seen on review for assessment. There were 9 female and 22 male subjects whose age range is detailed in Table 2. A total of 225 restorations were included in the sample and, at the time of data collection, they varied from 5 months to 6 years old. The restorations, 37 micro-filled RBC (Durafill), a hybrid RBC (Herculite – 97 direct and 18 indirect), and 73 indirect ‘ceromer’ (Artglass), had been placed under rubber dam by three different, experienced operators. Replacement restorations were placed using a similar technique. A full history and clinical examination was performed and the following data recorded:

1. Patient details.
2. Angles incisal relationship ( from pre-operative study casts ). See Table 3.
3. Aetiology of wear. See Table 4.
4. Type of RBC used.
5. Teeth restored, date of placement, and operator.
6. Assessment of restorations, adjacent gingival health, and patients’ opinion on comfort and appearance.
7. Details of past repairs or replacements.
8. Date of re-establishment of posterior occlusion.

Upper and lower alginate impressions were made, disinfected, and cast in dental stone within one hour. Upper and lower occlusal, and frontal photographs were taken using a Yashica Dental Eye III camera and Kodachrome 64 slide film.

Assessment of the restorations was performed on several days by examination of projected frontal and occlusal colour transparencies and of the casts.<sup>29,30</sup> Calibration of the single assessor was carried out and several cases were scored by a consultant in restorative dentistry to ensure correct application of the criteria. Modified United States Public Health Services (USPHS) criteria<sup>31-33</sup> were used (Table 1) and the data was entered on a spreadsheet run by the software *Statistical Programme for Social Sciences (SPSS)*. Restorations that had been replaced were re-entered as new restorations on the date of replacement.

Restorations that were entirely satisfactory were placed in category Alpha (A). Survival analysis was carried out at two different levels of failure:

1. *Major failure*: Restorations replaced for any reason and those placed in modified USPHS category Charlie (C) for bulk fracture, margin fracture, wear, surface roughness, margin colour and surface colour.

2. *Major and minor failure*. All restorations in the major failure group, all those that had required refinishing or repair for any reason, and those that were placed in USPHS category Bravo (B) for bulk fracture, margin fracture, surface roughness, margin colour and surface colour. Wear scores of B were not included once it became apparent that this was an almost universal finding and would have given an inaccurate impression of overall performance.

Kaplan-Meier survival plots were charted against the following variables:

1. Material used
2. Aetiology of tooth wear
3. Incisal relationship
4. Operator

Log rank values were calculated and data was analysed pairwise over strata for significance of differences with a *P*-value of 0.05.

The incidence of USPHS category B, representing minor failure not requiring replacement, was calculated as a percentage of the total, to give an indication of the modes of minor failure. The time taken for posterior contact to re-establish in each subject was also recorded and a mean value calculated.

**RESULTS**

**Survival analysis**

The survival rate for all restorations was good when only major failure criteria (C) were applied (Fig. 3). No failures had occurred in the first year but nearly half of them occurred in the fifth year. It was only possible to calculate a median survival time for Durafill (*n* = 37) which was 5 years 9 months. The direct Herculite (*n* = 97) had not had enough failures to calculate a median survival time. None of the smaller sample of indirect Herculite (*n* = 18) restorations had failed at this level. Artglass (*n* = 73) had only suffered one major failure and was surviving well up to 3 years at this level (Fig. 4).

At combined major and minor failure levels (B and C) the median survival rate was 4 years and 9 months for all types of material (Fig. 5). Many minor failures occurred in the first year but, as a proportion of those remaining at risk, failures occurring in the fifth

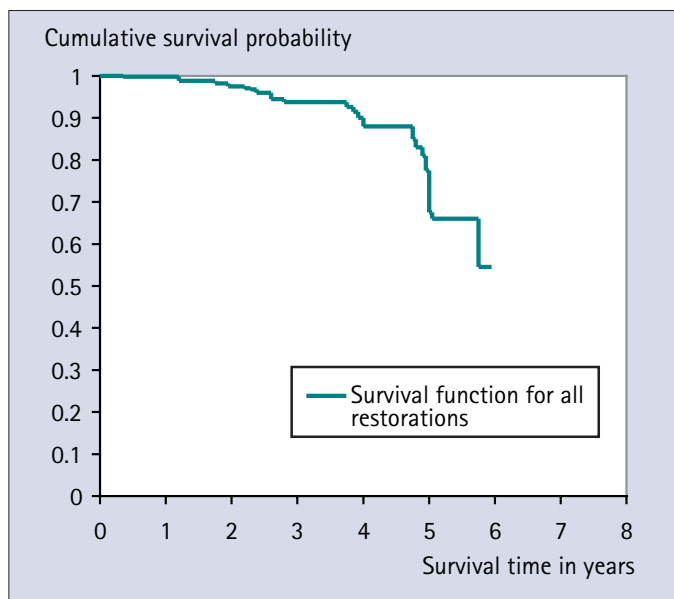


Fig. 3 Kaplan-Meier survival function for all restorations at major failure level (modified USPHS category C)

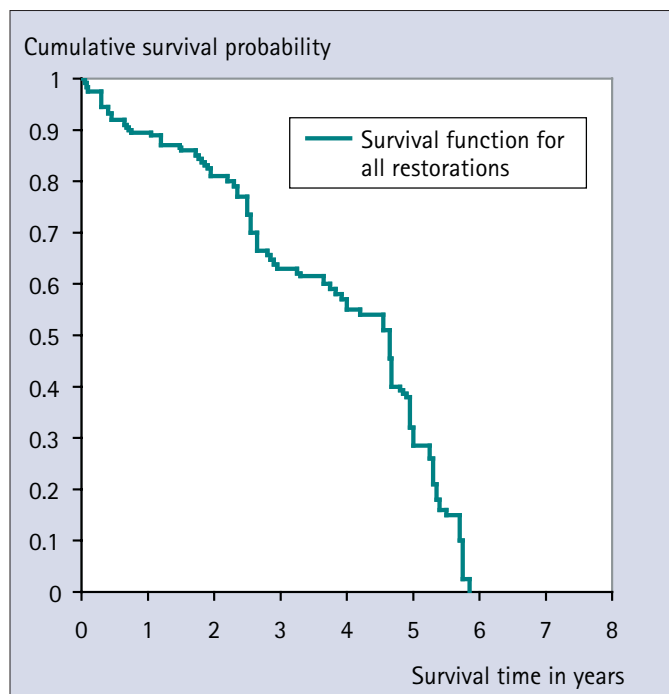


Fig. 5 Kaplan-Meier survival function for all restorations at combined major and minor failure level (modified USPHS category B and C)

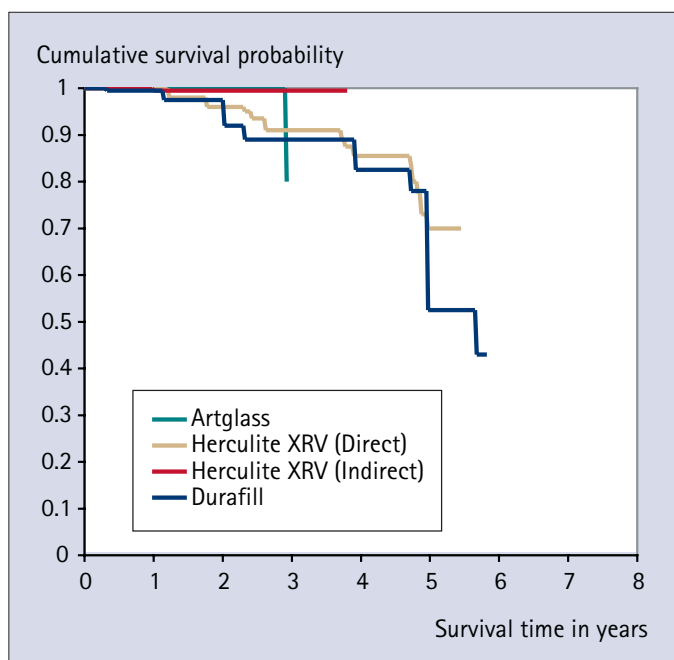


Fig. 4 Kaplan-Meier survival function comparing different materials at major failure level (modified USPHS category C)

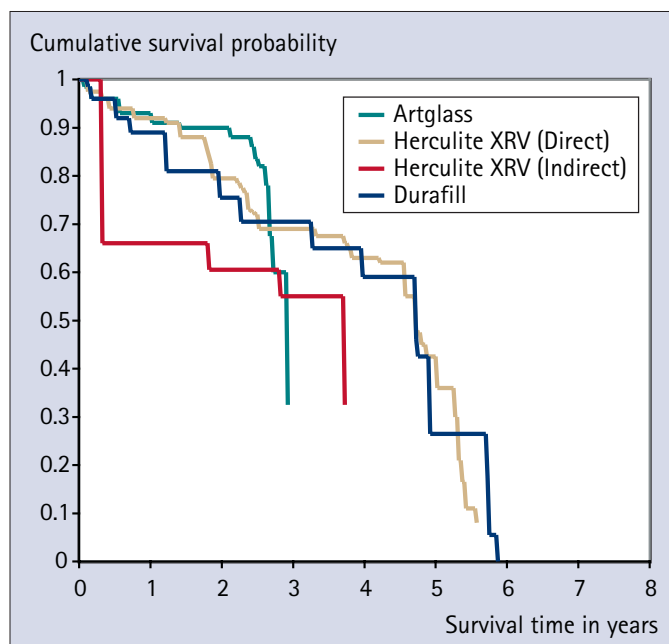


Fig. 6 Kaplan-Meier survival function comparing different materials at combined major and minor failure level (modified USPHS category B and C)

year were again considerable. Durafill and direct Herculite had similar median survival times of 4 years 8 months and 4 years 9 months respectively. Despite the additional minor failures, the total was only just sufficient to calculate median survival times for indirect Herculite and Artglass. These were 3 years 8 months and 2 years 11 months respectively (Fig. 6).

At both levels of failure, only those cases that were Class II Div 2 had a significantly higher probability of restoration failure. The Class II Div 1 group had the highest median survival time of 5 years 9 months.

Erosion was predominant but, for a number of subjects, it was difficult to know the precise aetiology of their tooth wear. The distribution of the suspected aetiology is detailed in Table 4. As with most materials, it is suspected that RBCs will fare less well where the aetiology of the wear is predominantly parafunctional but the results did not highlight this as a statistically significant finding.

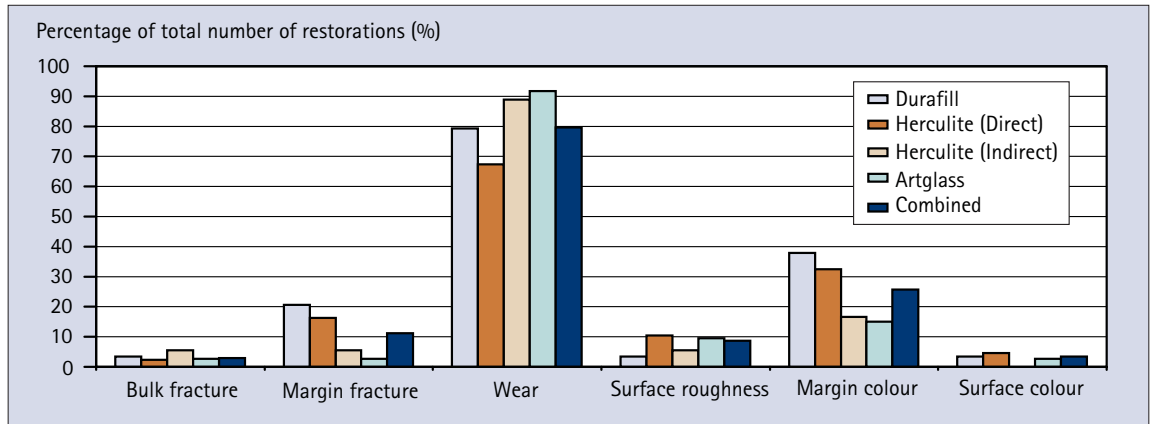
At the major level of failure, replacement restorations appeared to have the highest probability of failure with a median survival time of 4 years. This fell considerably, when minor failures were included, to 1 year 9 months. These figures were statistically significant.

There was no statistical difference between median survival times of the restorations placed by the three different operators.

#### Minor failure – USPHS category B

Surface discolouration, surface roughness and bulk fracture were not common findings (Fig. 7). Restorations were more commonly placed in category B for margin fracture and discolouration. Evidence of category B wear was the most significant finding,

Fig. 7 Summary of minor failure, modified USPHS category B, expressed as a percentage of total number of restorations



affecting 80% of the total sample. Over 90% of the Artglass restorations were affected.

Just over half of the subjects had no adjacent gingival inflammation. Placement of the RBC restorations at an increased vertical dimension had been very well tolerated. Only one subject remembered having some discomfort for about three days subsequently and two other subjects recalled initial problems with phonetics. Nearly all were entirely happy with the appearance. Some had complained about visible margins following placement, but no further intervention had been considered necessary (Fig. 8).

All of the subjects had some posterior contact (Fig. 9). Sixty-one per cent had firm Shimstock holds between all opposing units and 39% of the subjects had Shimstock holds on only some of the posterior teeth. This was invariably between the molar units with space remaining between the opposing premolar pairs. Time taken for re-establishment of the posterior occlusion ranged from 1.5 to 18.5 months and the mean was 7 months.

**DISCUSSION**

**Survival analysis**

The assessment of restorations is often subjective and difficult to quantify for analysis. Arguably the most relevant factor is the clinical action subsequently taken following a certain type of failure. The use of modified USPHS criteria seeks to address this issue but it is a fairly blunt tool with which to assess restorations. Despite this, it remains popular and has been used in recent studies.<sup>22,34</sup>

There was little difference between the microfilled and hybrid RBC survival beyond the 30 month point and the median survival times for both materials were toward the upper end of the age scale for each group. The newer, ceromer material, Artglass, was exhibiting minor wear but had otherwise required virtually no clinical intervention up to 3 years.

**Anatomic form**

Poor anatomic form, as a result of bulk fracture requiring monitoring, refinishing or minor repair, was not a common occurrence. All four materials were involved but the samples were too small to make statistically valid comparisons.

**Margin fracture**

Durafill and direct Herculite appeared to have a higher incidence of marginal fracture requiring monitoring, refinishing or repair than indirect Herculite and Artglass. However, the Durafill and direct Herculite restorations were an older sample group than the other two materials and a higher incidence of marginal defects would be expected with time. These observations are in

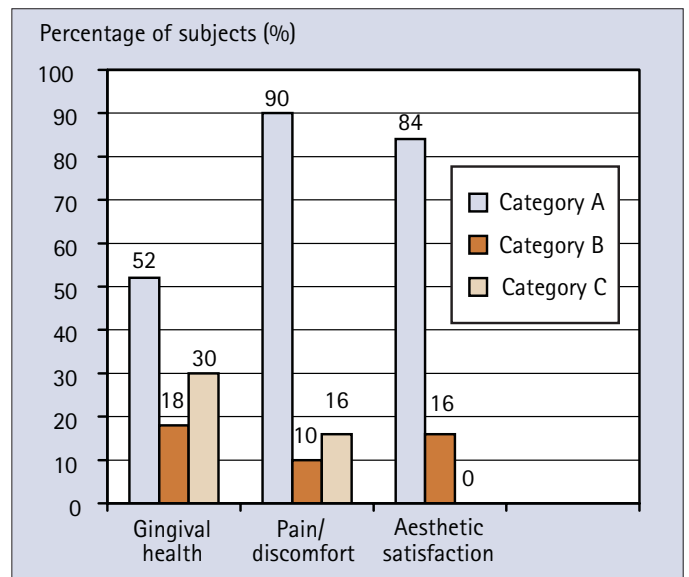


Fig. 8 Summary of additional criteria expressed as a percentage of the sample population

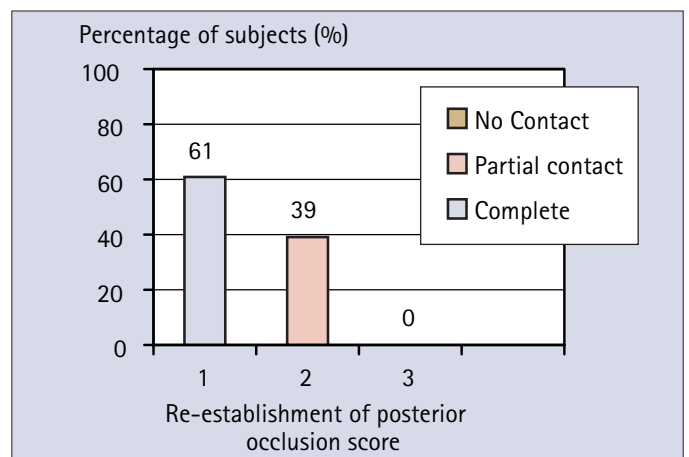


Fig. 9 Re-establishment of the posterior occlusion

line with some *in vitro* studies.<sup>35,36</sup> An overall incidence of 11.2% suggests that marginal fracture is a minor, but significant, mode of failure for these restorations.

**Wear**

The poor wear resistance of RBCs is well-documented<sup>23,37</sup> and is considered to be one of the main limitations of these materials

in load-bearing situations. The proportion of the sample (79.6%) placed in category B reinforces this opinion. Of particular note is the high incidence of wear in the Artglass sample (91.7%), suggesting a material less suited to load-bearing situations.

#### Surface roughness

Surface roughness, although not a common observation, usually took the form of pitting, suspected to be due to exposure of small voids as the composite wore. There was little difference between the materials in this criterion. Surprisingly, the low incidence of roughness seen in the laboratory-made Herculite veneers was not mirrored by the indirect Artglass restorations.

#### Margin colour

At the time of assessment, marginal discoloration scoring B had occurred in about a quarter of the sample. The incidence of marginal staining appeared to correlate with the average age of the different groups of materials, being highest for Durafill and lowest for Artglass. Staining, as a sign of leakage, is a common finding in other types of resin restorations and may be related to the technique used and the age of the patient.<sup>38</sup>

#### Surface colour

Very few of the restorations had poor surface colour. Except when the incisal height had also been restored, and the restoration was visible, minor discoloration was of little significance. Intrinsic colour instability and staining due to food, drink and smoke is a recognised problem with RBCs.

#### Gingival health

A third of the subjects had one or more sites adjacent to the restorations that bled on probing. It is probable that a bulky composite restoration with poorly finished margins would act as a secondary plaque-retaining factor. However, all the restorations were placed with great care and gingivitis is a common finding. The results do not imply that the restorations cause gingivitis.

#### Pain/discomfort

As with other appliances used to produce relative axial tooth movement, complications were few. Not one subject found the restorations to be intolerable and only two subjects commented on

Fig. 10 Artglass restorations placed at an increased vertical dimension on the upper six anterior teeth – frontal view after cementation



Fig. 11 Artglass restorations placed at an increased vertical dimension on the upper six anterior teeth – occlusal view after cementation



Fig. 12 Artglass restorations placed at an increased vertical dimension on the upper six anterior teeth – frontal view after 3 years



Fig. 13 Artglass restorations placed at an increased vertical dimension on the upper six anterior teeth – occlusal view after 3 years



initial, transient phonetic difficulties. One subject complained of initial tenderness and it was suspected that mild periodontal inflammation due to increased occlusal loading, prior to re-establishment of a new mandibular rest position, might have been responsible.

#### Appearance

In many cases there had been little loss of crown height and the appearance had not changed significantly. Those subjects who had restorations extending onto the incisal edges were generally pleased with the postoperative appearance.

#### Re-establishment of the posterior occlusion

Posterior tooth contact was re-established in all subjects, ranging from just under 2 months to 18 months, with a mean of 7 months. It is likely that mandibular repositioning contributed to the most rapid result. The longest case took 18 months and supports the view that, if given enough time, virtually all appliances will create space.<sup>39</sup> However, many of the restorations showed some degree of wear and it is possible that this contributed to the re-establishment of some posterior occlusal contacts. The mean time of 7 months compares well with other studies<sup>16,39</sup> using cast metal bite planes but differing recall intervals could influence this conclusion. Just over a third of the subjects did not achieve posterior contacts in the premolar region during the study period. Whether there is a limit to the premolar eruptive potential or whether they become impacted behind the canines is unknown.

#### CONCLUSION

The treatment of localised anterior tooth wear with resin-based composite restorations placed at an increased vertical dimension is a viable first-line option in the short to medium term (Figs 10 and 11). Directly placed Herculite and Durafill both perform well up to the fifth year of follow-up, when the probability of failure increases. The 3-year results for Artglass are encouraging although the high incidence of minor wear has been highlighted in this study (Figs 12 and 13).

Limitations in the mechanical properties of composite resins result, to a lesser extent, in marginal staining and marginal fracture. Failures such as bulk fracture, surface roughness and surface discoloration are uncommon. Maintenance of these restorations is straightforward, as localised refinishing or repairs may be all that

is required. Restorations placed in a Class II Div 2 situation and those provided as replacements appear to have a higher probability of failure.

Tooth movements following this approach seem to follow the same pattern and timescale as those produced by other Dahl appliances. There is a high degree of patient satisfaction associated with these restorations. The resin can protect exposed dentine from further wear and the reversible nature of this approach may allow these patients to benefit from future materials development. The technique takes time, but it is conservative of tooth structure and may eliminate the need for conventional preparation.

The authors would like to thank Dr Mark Gilthorpe for his statistical advice.

- Callis P D, Charlton G, Clyde J. A study of patients seen in consultant clinics in conservative dentistry at Edinburgh Dental Hospital. *Br Dent J* 1993; **174**: 106–110.
- Kelleher M, Bishop K. Tooth surface loss: an overview. *Br Dent J* 1999; **186**: 61–66.
- Shaw L, Smith A. Erosion in children: an increasing clinical problem? *Dent Update* 1994; **21**: 103–106.
- Smith B G N, Knight J K. A comparison of patterns of tooth wear with aetiological factors. *Br Dent J* 1984; **157**: 16–19.
- Bartlett D W, Evans D F, Anggiansah A, Smith B G N. A study of the association between gastro-oesophageal reflux and palatal dental erosion. *Br Dent J* 1996; **181**: 125–132.
- Eccles J D. Erosion affecting the palatal surfaces of upper anterior teeth in young people. *Br Dent J* 1982; **152**: 375–378.
- King P A. Adhesive techniques. *Br Dent J* 1999; **186**: 321–326.
- Berry D C, Poole D F G. Attrition: possible mechanisms of compensation. *J Oral Rehabil* 1976; **3**: 201–206.
- Tallgren A. Changes in adult face height. *Acta Odontol Scand* (suppl 24) 1957: 63–75 and 113–116.
- Murphy T. Compensatory mechanisms in facial height adjustment to functional tooth attrition. *Aust Dent J* 1959; **4**: 312–323.
- Crothers A J R. Tooth wear and facial morphology. *J Dent* 1992; **20**: 333–341.
- Bishop K, Briggs P, Kelleher M. The aetiology and management of localized anterior tooth wear in the young adult. *Dent Update* 1994; **21**: 153–160.
- Evans R, Beckett H, Briggs P. The clinical management of localised anterior tooth surface loss. *Eur J Orthod* 1995; **17**: 436 Abst.No: 27.
- Carlsson G E, Ingervall B I, Kocak G. Effect of increasing vertical dimension on the masticatory system in subjects with natural teeth. *J Prosthet Dent* 1979; **41**: 284–289.
- Dahl B L, Krogstad O, Karlsen K. An alternative treatment in cases with advanced localized attrition. *J Oral Rehabil* 1975; **2**: 209–214.
- Dahl B L, Krogstad O. The effect of a partial bite raising splint on the occlusal face height. An X-ray cephalometric study in human adults. *Acta Odontol Scand* 1982; **40**: 17–24.
- Dahl B L, Krogstad O. The effect of a partial bite raising appliance on the inclination of upper and lower front teeth. *Acta Odontol Scand* 1983; **41**: 311–314.
- Dahl B L, Krogstad O. Long term observations of an increased face height obtained by a combined orthodontic/prosthetic approach. *J Oral Rehabil* 1985; **12**: 173–176.
- Ricketts D N J, Smith B G N. Minor axial tooth movement in preparation for fixed prostheses. *Eur J Prosthodont Restor Dent* 1993; **1**: 145–149.
- Ricketts D N J, Smith B G N. Clinical techniques for producing and monitoring minor axial tooth movement. *Eur J Prosthodont Restor Dent* 1993; **2**: 5–9.
- Briggs P, Bishop K, Djemal S. The clinical evolution of the 'Dahl Principle'. *Br Dent J* 1997; **183**: 171–176.
- Millar B J, Robinson P B, Inglis A T. Clinical evaluation of an anterior hybrid composite resin over 8 years. *Br Dent J* 1997; **182**: 26–30.
- Combe E C, Burke F J T. Contemporary resin-based composite materials for direct placement restorations: packables, flowables and others. *Dent Update* 2000; **27**: 326–336.
- Downer M C, Azli N A, Bedi R, Moles D R, Setchell D J. How long do routine restorations last? A systematic review. *Br Dent J* 1999; **187**: 432–439.
- Brown D. The status of restorative dental materials. *Dent Update* 1997; **24**: 402–406.
- Darbar U R, Hemmings K W. Treatment of localised anterior tooth wear with composite restorations at an increased occlusal vertical dimension. *Dent Update* 1997; **24**: 72–75.
- Hemmings K W, Darbar U R, Vaughan S. Tooth wear treated with composite restorations at an increased vertical dimension: results at 30 months. *J Prosthet Dent* 2000; **83**: 287–293.
- Bevenius J, Evans S, L'Estrange P. Conservative management of erosion-abrasion: a system for the general dental practitioner. *Aust Dent J* 1994; **39**: 3–10.
- Elderton R J. Assessment of the quality of restorations: a literature review. *J Oral Rehabil* 1977; **4**: 217–226.
- Smales R J, Creaven P J. Evaluation of three clinical methods for assessing amalgam and resin restorations. *J Prosthet Dent* 1985; **54**: 340–346.
- Cvar J F, Ryge G. *USPHS Publ. No 720 - 244*. San Francisco: US Government Printing Office, 1970.
- Ryge G, Snyder M. Evaluating the clinical quality of restorations. *J Am Dent Assoc* 1973; **87**: 369–377.
- Ryge G. Clinical criteria. *Int Dent J* 1980; **30**: 347–358.
- Welbury R R, Shaw A J, Murray J J, Gordon P H, McCabe J F. Clinical evaluation of paired compomer and glass ionomer restorations in primary molars: final results after 42 months. *Br Dent J* 2000; **189**: 93–97.
- Zhao D, Botsis J, Drummond J L. Fracture studies of selected dental restorative composites. *Dent Mater* 1997; **13**: 198–207.
- Ferracane J L, Condon J R. *In vitro* evaluation of the marginal degradation of dental composites under simulated occlusal loading. *Dent Mater* 1999; **15**: 262–267.
- Willems G, Lambrechts P, Braem M, Vanherle G. Three-year follow-up of five posterior composites: *in vivo* wear. *J Dent* 1993; **21**: 74–78.
- Smales R J. Effect of enamel bonding, type of restoration, patient age and operator on the longevity of an anterior composite resin. *Am J Dent* 1991; **4**: 130–133.
- Gough M B, Setchell D J. A retrospective study of 50 treatments using an appliance to produce localised occlusal space by relative axial tooth movement. *Br Dent J* 1999; **187**: 134–139.