Dentin adhesive materials for restoration of cervical erosions. Two and three year clinical observations

Preben Horsted-Bindslev, DDS, Jens Knudsen, DDS & Vibeke Baelum, DDS, PhD

Royal Dental College, Aarhus C, Denmark


Abstract: Different adhesive systems used in cervical erosions without cavity preparation were evaluated. The material comprised three groups of patients who received a total of 146 restorations placed by the same operator (JK). Each patient within a group received the same number of restorations with two different types of materials. Type 1: a capsulated glass-ionomer cement (Fuji-Cap 2). Type 2: no acid etching of the cavosurface enamel, application of a dentin adhesive (Gluma Bonding System) and restoration with a microfilled composite (Pekalux). Type 3: same material and procedure as type 2, but with acid etching of enamel. Type 4: acid etching followed by a dentin adhesive (Johnson & Johnson Dentin Bonding Agent) and restoration with a microfilled composite (Certain). Type 5: same procedure as type 3 but with use of a minifilled composite (Lumifor). Type 6: acid etching followed by a dentin adhesive (Scotchbond) and a minifilled composite (P-30). Direct clinical examination based on the USPHS-system was made immediately after polishing and 6, 12 and 18 months until 24 months (Types 5,6) or 36 months (Types 1,2,3,4). All teeth responded positively to electric pulp testing throughout the observation period and no adverse effects on the gingivae were found. All of the Type 1,3 and 5 restorations evaluated remained in situ throughout the observation period. Minor marginal fractures and discolorations were observed in all types of restorations. The minifilled composites performed significantly better in these respects compared with the microfilled composites.

Key words: Adhesive dental restorative materials; clinical studies.

Reprint requests: Dr. Preben Horsted-Bindslev, The Royal Dental College, Vennelyst Boulevard, DK-8000 Aarhus C, Denmark.

INTRODUCTION

In order to improve adhesion of restorative materials to dentin, a variety of materials and methods have been developed which aim at the formation of a chemical bond between the restoration and the tooth substance.

Glass ionomer cement was the first of such materials to be introduced on the market and the adhesion is mainly based on a chemical reaction between polyacrylic acid from the cement and calcium from the tooth substance (for review see Walls). However, a rather high failure rate was observed in clinical studies of the first generations of restorative glass ionomer cements (for review see Knibbs, Horsted-Bindslev & Asmussen).

The development of dentin adhesives is based on the concept of mediating a chemical bond between resinous restorative materials and dentin (for review see Asmussen & Munksgaard). Most of the commercially available dentin bonding systems react with the calcium ions in the dentin through an interaction of a phosphate group attached to Bis-GMA. When these adhesives were used in non-undercut cavities primarily located in dentin, e.g. in cervical erosions, an unacceptable failure rate was observed especially in cases where acid etching of the cervical enamel was not performed.

Recently, Munksgaard & Asmussen developed a dentin adhesive which mediates a bond between the organic phase of the dentin and the restorative resin through an interaction of glutaraldehyde with collagen. Laboratory studies have shown that high bond strength to dentin can be achieved with this adhesive. However, the clinical performance of restorations placed with this adhesive system, marketed under the name of Gluma Bonding System, has not yet been published.

The aim of the present study was to evaluate this adhesive system in cervical erosions and to compare the clinical performance of these restorations with that of a glass ionomer cement and with the performance of restorations where the phosphate ester types of dentin adhesives were used.

MATERIALS AND METHODS

The material comprised 146 restorations in 26 patients with cervical buccal erosive areas. Restorative treatment was indicated for one or more of the following...
reasons: esthetics, presence of symptoms, and prophylaxis against further loss of tooth substance. The patients were randomly allocated to one of three groups; A, B or C. Each patient within the group received the same number of restorations with two different materials. These two materials were dispersed in each patient as follows: aiming at similar conditions as to occlusion and feasibility of oral hygiene, a pair of teeth with erosions was selected and whenever possible located in the same area of the mouth. The restorative material was randomly allocated. All restorations were made by the same operator (JK). Prior to the operative procedures all teeth were polished by pumice, but no cavity preparations were made. The materials were handled according to the manufacturer’s instructions. The cavities were restored using the syringe injection technique (C-R Mark III) followed by a cervical matrix (Hawe-Neos). The composites were polymerized with Elipar light for 20-40 seconds.

Group A. 44 restorations were made in 10 patients using two materials designated Type 1 and Type 2, respectively. Type 1: A capsulated glass ionomer cement (Fuji-Cap 2) was inserted into the cavities. Gross excess of material around the matrix was removed with a scalpel and the free margins were varnished. The matrix was removed after 6 minutes and the surface of the restoration was covered with varnish. Type 2: In a few cases, the deepest part of the erosions were covered with a calcium hydroxide cement (Dycal). The cavities were moistened with a 0.5 M EDTA solution (Gluma 2 Cleanser, batch #WJK 7012-2) for 60 seconds. The cavities were then rinsed with air-water spray and dried. The dentin was moistened with Gluma 3 Primer (batch #WJK 7012-1) for 60 seconds and the cavities were gently dried. A thin layer of unfilled resin (Gluma 4 Sealer, batch #WKM 6020-5B) was applied to the cavities which were restored with a microfilled composite (Pekalux, batch #s color 12, WKM 6092-5D, color 21, WKM 6092-1C, color 23, WKM 6092-2B, color 31, WKM 6092-3G, color 39, WKM 6092-4F).

Group B. 50 restorations were made in six patients using two materials designated Type 3 and Type 4, respectively. Type 3: The cavosurface enamel was acid etched with a 35% acid gel (Gluma 1 Etchant, batch #HWKM 6020-5B) was applied to the etched enamel. The dentin adhesive was cured for 10 seconds. The cavities were restored with a microfilled composite (P-30, batch #070195). All restorations were polished with fine grained diamonds (Intensive) and Sof-Lex discs under water one week after insertion. Direct clinical evaluation was made at regular intervals until 36 months (Types 1, 2, 3, 4) or 24 months (Types 5, 6) after polishing. The evaluation was based on the USPHS-system according to the acceptance program for resin based materials adopted by the ADA and NIOM.13 Pulp vitality was determined at the beginning and at the end of the observation time by an electric pulp tester.1 Restorations lost during the observation period were replaced using the Gluma Bonding System. These "new" restorations were not included in the study.

Data analysis

The cumulative probability of a restoration being either still retained in the cavity, having no marginal fractures, or having no marginal discoloration according to time since insertion was calculated using the life-table calculations for follow-up studies described by Armitage & Berry.14 Statistical differences between types of procedures were evaluated using either the Wilcoxon matched-pairs signed-rank test15 when within-patient comparison was possible or the Mann-Whitney U-test.

RESULTS

All patients except one in Group A were available for evaluation at 24 or 36 months. Three teeth in Group A treated with Type 1 material and one tooth in Group C treated with Type 5 material received full crowns due to tooth fracture. One patient from Group A had all teeth extracted after 18 months of observation.

Retention

The number of restorations still present in the cavities, according to the number of cavities at risk at each date of evaluation is shown in Table 1. In Fig. 1, the proportion of restorations still present in the cavities

Table 1. Each sequence of numbers reflects the number of restorations still present in the cavities (left of inclined lines) in proportion to cavities at risk (right of inclined lines) from date of insertion to the final examination.
RETENTION

% retention

Fuji·Cap 2
Pekalux GBS
Lumifor GBS
Pekalux acid+Gluma
P 30 + Scotchbond
Certain+J J DBA

0 6 12 18 24 30 36

Fig. 1. The proportion of restorations retained in the cavities according to time of insertion.

is plotted as a function of time since insertion for each type of material. All Type 1, 3 and 5 restorations remained in situ throughout the observation period. Five Type 2 restorations were lost after 12 months whereas there was a continuous loss of Type 4 and 6 restorations during the entire observation period. The restorations made with the phosphate ester dentin adhesives (Type 4 and 6) had a significantly higher loss rate than those made with acid etch and Gluma* (Type 3 and 5) from 6 months and onwards ($P < 0.01$).

Eight of the patients did not lose restorations, whereas the remaining 18 patients lost from 1 to 4 restorations each. Lost restorations were replaced using the Gluma Bonding System.* All replaced restorations were still in position at the last date of observation.

Marginal fracture

In Fig. 2, the proportion of restorations receiving an Alpha rating for marginal fracture is related to the time since insertion for the three groups of restorations: Type 1; Type 3 and 4; and Type 5 and 6. As no significant differences were observed between Type 3 and 4; and Type 5 and 6 at any time, these groups were pooled. Restorations with microfilled composites (Type 3 and 4) had significantly more marginal fractures than restorations with minifilled composites (Type 5 and 6) from 12 months and onwards ($P < 0.02$).

Most of the restorations with marginal fractures were rated Bravo. Only six restorations of the 102 restorations evaluated at the final examination were rated Charlie.

All Type 2 restorations showed marginal fractures after 36 months. These fractures were mainly observed at the occlusal cavosurface margins. As to Type 3, 4, 5 and 6, the fractures were primarily located along the gingival or proximal margins, whereas no preferred location was noted for Type 1 restorations.

Marginal discoloration

The proportion of restorations receiving an Alpha rating for marginal discoloration according to time since insertion is presented in Fig. 3. The microfilled composites (Type 3 and 4) showed a significantly lower frequency of Alpha ratings than the minifilled composites (Type 5 and 6) from 18 months and onwards ($P < 0.05$).

Regarding Type 2 restorations, only two were rated Alpha after 36 months. Except for Type 2, where eight restorations were rated Charlie, only seven of the remaining 90 restorations were rated Charlie.

Color match

There were slight changes in the color matching ability of restorations in all groups during the observation period. No significant differences between materials could be recorded. A few restorations rated Oscar and the remaining restorations rated Alpha or Bravo at final examination.

Morphology

No visible changes were recorded during the observation period except in one case where there was a
firm contact between a composite filling and a partial denture retained by clamps.

Surface texture

No deterioration of the surfaces of the restorations was observed. The well-known material dependent differences in surface texture between glass ionomer cement (Type 1) and microfilled composites (Types 2, 3 and 4) were observed. Furthermore, from six months after treatment and throughout the entire observation period, the surface of one of the microfilled composites (Type 6) was rougher compared with the other microfilled composite (Type 5).

Gingivitis

No changes in gingivitis or plaque indices which could be related to the filling materials were recorded.

Caries

No secondary caries was found.

Pulp response

All non-root canal treated teeth responded positively to the electric pulp tester at the beginning and at the end of the observation period.

DISCUSSION

All the glass ionomer restorations (Type 1) and the composite restorations, where the Gluma Bonding System was used in combination with acid-etching of the occlusal cavosurface enamel (Type 3 and 5), remained in situ throughout the observation periods, whereas there was a continuous loss of restorations retained by the phosphate ester-based dentin adhesives (Type 4 and 6) (Fig. 1). Due to differences in methodology, in length of observation periods, in types, in brands, and curing systems of composite restorative materials and dentin adhesives, a direct comparison of results from the present study with previous findings is rather difficult. Nevertheless, the high retentive success rate in the present study of the two Gluma/acid-etch types of restorations (Type 3 and 5) is superior to most published studies where other dentin adhesive systems have been used for restoration of cervical erosions. To our knowledge, only Schmid et al using Super-Bond, where the active group is a carboxylic acid anhydride, found a retentive success rate almost similar to that found in the present study after 24 months of observation. When the retention of phosphate ester dentin adhesive restorations used with acid-etching of the cavosurface enamel has been studied, a failure rate of 10-12% has been reported after 12-24 months of observation. The cumulative failure rate in the present study was about 35% concerning Scotchbond and 60% for Johnson & Johnson DBA after 24 and 36 months, respectively. Apart from the methodological differences previously mentioned, the reason for the higher failure rates in the present study are obscure. The retentive failure rate in previous investigations was 15-35% after 6-24 months when no acid-etching was performed in combination with use of the phosphate ester dentin adhesive Scotchbond. The cumulative failure rate of the Gluma/non acid-etched restorations in the present study was about 20% after 36 months of observation. Based on laboratory studies on bond strength to dentin of the different types of dentin adhesives, this loss of Type 2 restorations was unexpected. All failures in this group were observed after 6 and 12 months and no restorations were lost during the last period of observation. The reason for the failures of Type 2 restorations may be related to the shape of erosive areas. In superficial and flat cavities, the cavity area may comprise relatively more enamel. The retention may be solely dependent on the bond obtained between the composite restoration and a rather small area of Gluma-treated dentin.

The high retentive success rate of the glass ionomer restorations is in agreement with most of the recent observations on proprietary formulations. The bond strength obtained in laboratory studies between dental hard tissues and glass ionomer cement is much lower than the bond strength found between a restorative resin and acid-etched enamel or between a restorative resin and Gluma treated dentin. The lack of agreement often reported between results from laboratory and clinical studies may therefore be accounted for by the inherent differences in experimental designs, as well as differences in material characteristics under clinical and laboratory conditions, respectively, the importance of which only clinical studies may be able to disclose. Minor differences in e.g. modulus of elasticity and coefficient of thermal expansion between dental hard tissues, resin materials and glass ionomer cements may effect the longevity of the restoration in the complex oral environment.

In contrast to the retention of the composite restorations which was dentin adhesive dependent, our study showed that the performance of the restorations with respect to marginal fractures and marginal discolorations was material-dependent (Figs 2 and 3). The mini-filled composites (Type 5 and 6) performed significantly better than the microfilled composites (Type 3 and 4). The performance of the glass ionomer cement (Type 1) was in between these materials and better than the microfilled composite used without acid-etching (Type 2). The decline in Alpha ratings observed for all materials is in agreement with previous observations. Some of the fractures, often preceded by marginal discoloration, may have occurred in areas with a surplus of restorative material. Because of the shape of the erosive areas, surplus may be difficult to verify clinically. This situation is similar to the feather-edge margins which have shown poor clinical performance compared with bevelled or butt joint margins. Although restorations receiving Charlie ratings are usually considered as requiring replacement for preventive reasons, we have
nevertheless considered that the quality of all restorations was within clinically acceptable limits after 24-36 months of observation. The reason for this is found in the very high oral hygiene standard in the present study population combined with the shape of the erosive lesions.

CONCLUSIONS

Based on our findings in this rather limited material, the following conclusions may be drawn:

1. Acceptable bond to the tooth substance of erosive areas can be obtained by use of a glass ionomer cement or by use of composite resins in combination with the Gluma Bonding System.
2. The restorative materials investigated deteriorated in the oral environment, but no restorations required immediate replacement after 24 or 36 months.
3. The marginal deterioration was more pronounced around the microfilled composites than around the minifilled composites.

REFERENCES


