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The use of adhesive materials in the conservative restoration of selected posterior teeth

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ABSTRACT—The commonly used restorative systems for posterior occlusal restorations by amalgam or cast inlay require removal of sound tooth substance to provide retention, resistance or convenience forms. A better cosmetic result by restricting cavity preparation and using the adhesive properties of glass ionomer cement is described and the results from clinical practice tabulated. This includes a combination system of a surface layer of resin for areas of wear and stress.

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Introduction

Dental amalgam and cast alloys have provided the basis for restoring occlusal surfaces for over one hundred years and despite extensive research and development conducted throughout this time there still remain significant shortcomings in their use. The introduction of new materials provides the dental profession with the opportunity to examine their potential as alternatives.

This paper describes the use of a glass ionomer cement and posterior composite system for use in the restoration of occlusal surfaces, which may prove more beneficial over time than traditional metal-based techniques.

Rationale

The restoration of a tooth depends upon the intra-oral behaviour of the restorative material and the amount of preparation required to contain it.

Restorative materials

Metal-based systems appear to be biologically benign apart from their high thermal conductivity which necessitates lining most restorations. Satisfactory marginal seals can be achieved and they have sufficient wear resistance to contain most occlusal loads. The insertion of a large metal restoration into the body of a tooth interferes with moisture movement and may lead to cusp dehydration and fracture.

Glass ionomer cement[1] has been widely used clinically as an aesthetic Class V and pedodontic restorative material. It is biologically compatible with tooth structure and its low thermal conductivity means that only deep preparations require lining. It adheres to tooth structure which assures a biological seal and reduces the fracture potential of unsupported enamel and dentine. The exudation of fluoride ions protects the margins and adjacent tooth surfaces from caries, and moisture flow through the material reduces cusp dehydration. Glass ionomer cement has a low resistance to direct occlusal loads and will wear rapidly if placed in a region containing a centric stop.

Composite resins have been used for the aesthetic restoration of anterior teeth for almost twenty years. Recent claims on improvements in wear resistance have led to their use as a posterior restorative material but clinical evaluation of those claims is incomplete[2] although indications are that they could be a useful alternative to traditional techniques. Composites will bond to enamel and to some extent to dentine and glass ionomer cements;

[1] American Dental Association Council on Dental Materials and Devices. Status report on glass ionomer cements. J Am Dent Assoc 1979;99:221-6.

[2] American Dental Association Committee on Materials, Instruments and Equipment. Status report on posterior composites. J Am Dent Assoc 1983;107:74-6.

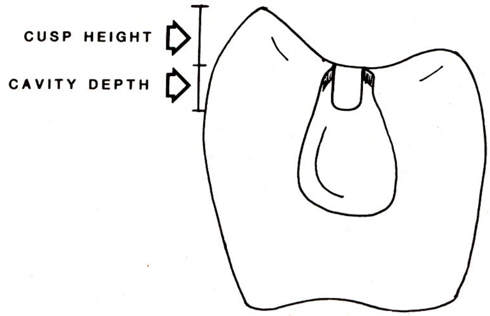

Fig. 1.—A conservative traditional Class II preparation in effect doubles cusp height and increases the propensity to cusp fracture.

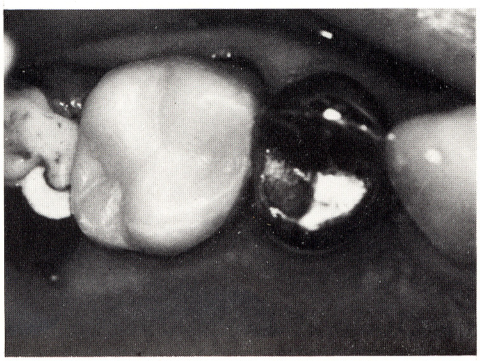

Fig. 2.—The restoration of a tooth that will bear a high occlusal load (16) is achieved by constructing a core of glass ionomer with a posterior composite overlay.

Fig. 3.—Two proximal restorations (46DO and 47MO) inserted without interference of centric stops, as determined with articulating paper.

some difficulty arises in the placing of large interproximal restorations. This 'pull back' effect may be overcome by using an injection technique. Their biological tolerance is low, they have no direct anticariogenic properties and require protection of dentine.

Tooth preparation

Whilst amalgam restorative techniques have been extensively refined[3] the necessity to remove all unsupported enamel results in the extension of the occlusal surface, often to the extent of overlaying cusps, and the removal of the marginal ridge in Class II preparations. As retention is gained by mechanically keying into the tooth, further undermining of cusps and loss of healthy dentine is required. The overall effect is to increase the height of the associated cusps (Fig. 1), and predispose to the future breakdown of the tooth and the loss of a marginal ridge leads to a whole range of problems.[4]

Cavity preparation for cast restorations requires removal of undercuts in the walls, resulting in the loss of large amounts of healthy tooth structure. Marginal instability of this procedure has led to the premature loss of many teeth through recurrent caries and predisposes to periodontal disease.

As glass ionomer cement bonds to enamel and dentine, cavity preparation on the occlusal surface to gain access to the lesion is minimal. There is also less likelihood of fracture in any unsupported enamel and dentine with a reduction in the disturbance to areas subjected to occlusal stress in the restoration and, in a Class II type lesion, the marginal ridge may in some cases be retained.

Posterior composites similarly bond to enamel and dentine and require minimal cavity preparation. Handling difficulties and reduced biological tolerance make this material more suitable as an overlay on a glass ionomer cement restoration that will be subject to the full load of occlusal forces or whose surface has worn with time

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[3] Sigurjons H. Extension for prevention: historical development and current status of G. V. Black's concept. Oper Dent 1983;8:57-63.

[4] McLean JW. Aesthetics in restorative dentistry. Br Dent J 1980;149:368-73.

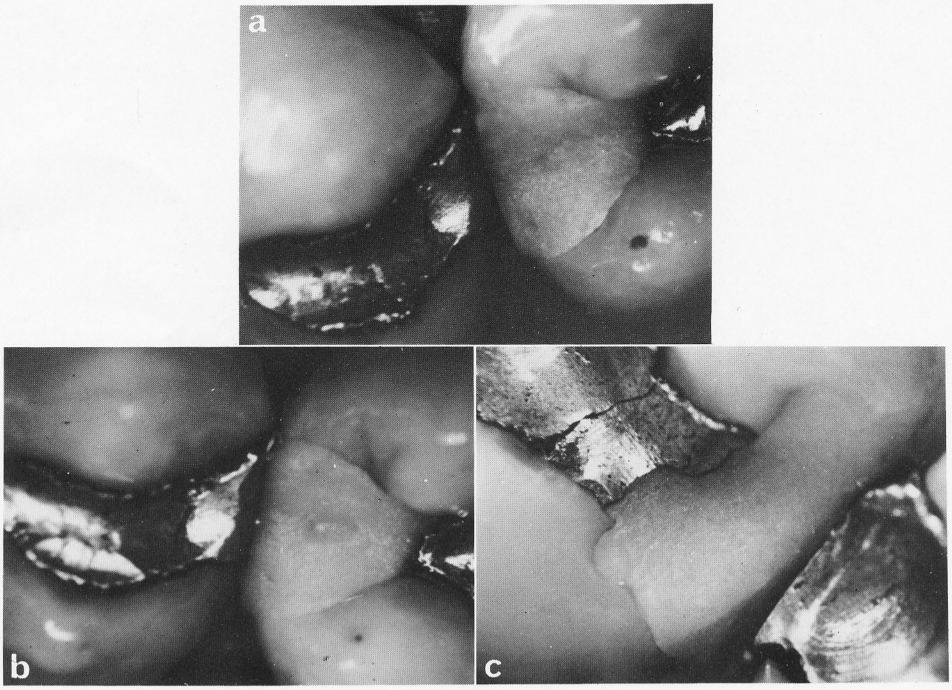

Fig. 4.—When centric stops are not involved, wear on glass ionomer cement restorations is often of no clinical consequence. a, Fuji ionomer (25MO) three years after insertion. b, After four years. c, Ketac restoration (24DO) three years after insertion.

and requires repair (Fig. 2). Etching of a glass ionomer cement surface with 37 per cent phosphoric acid improves the bond between the cement and the composite.

Wear resistance

The low wear resistance of glass ionomer cement has been a major factor against promoting the material as a posterior restorative agent.[5] The intercuspal relationships of teeth are such that centric stops tend to occur on cusps and in the vicinity of marginal ridges. The prelocation of centric stops prior to cavity preparation enables these significant occlusal areas to be avoided and possibly reduce the problems of increased wear and occlusal instability (Fig. 3).

The replacement of an existing Class I and Class II amalgam restoration with glass ionomer cement, which does not directly involve a centric stop, appear to exhibit little wear of clinical significance, and the routine overlay with posterior composites is not indicated (Fig. 4). It is, however, essential to explain to the patient the possible need for a future composite overlay whenever a load bearing glass ionomer cement restoration is placed.

[5] Mount FJ. Restoration with glass ionomer cement: requirements for clinical success. Oper Dent 1981;6:59-65.

Radiolucency

Glass ionomer cements and posterior composite overlays are generally radiolucent and, whilst the release of fluoride ions protects the margins from recurrent decay and overcomes the major argument for radiopacity, clinical examination must be meticulous otherwise an unaware practitioner may diagnose a carious lesion from a radiographic survey.

Materials of choice for posterior restorations

Clearly, the materials currently available represent a compromise. However, in the light of imminent improvement in the wear resistance of ionomer cements and the conservation of tooth structure, the glass ionomer and composite restorative system would appear to offer in selected cases many advantages over the traditional metal based techniques and meets the current philosophical trends in dentistry.

Restorative technique

Preparation of the cavity

Once carious dentine has been removed, no further preparation is required, but care is needed by the operator during placement of the material to avoid fracturing unsupported tooth structure.

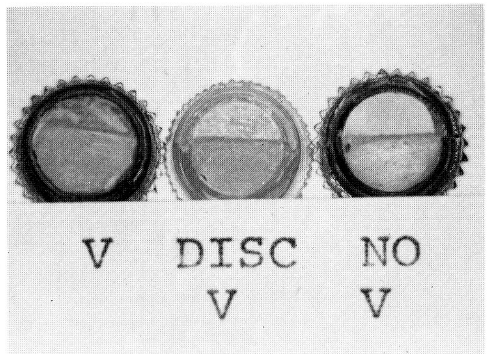

Fig. 5.—Three specimens of glass ionomer cement, initial setting 4 min. Left to right: V was coated with waterproof varnish; DISC V was disced flat and coated with a waterproof varnish, NO V was disced flat and not varnished.

Lining

It has been the usual practice to place a calcium hydroxide lining in most restorations in order to minimize the possibility of an unfavourable pulpal response and provide a line of demarcation between the restoration and tooth structure should removal be required.

Cleaning

The preparation is flushed with 20 per cent stannous fluoride solution, washed with water and dried. This process removes any debris from the preparation and helps to remineralize any small amounts of subclinical caries remaining. Clinically, this process has no effect upon the bond between the ionomer and tooth and *in vitro* studies support this observation (Beech DR. Personal communication, 1981).

Packing

The freshly mixed cement is placed at the base of the preparation with a syringe which is slowly withdrawn during injection until the preparation has been filled and the cement is then worked towards the perimeters of the cavity with a suitable **Teflon** coated plastic instrument. As the viscosity of the setting cement increases, final packing to a slight overfill is carried out with a ball ended burnisher. The restoration is then left undisturbed for four minutes until the initial set stage has been reached.

Finishing

The adjustment of contour of the glass ionomer cement at the initial set phase is generally not recommended[5] however, experience suggests that in posterior teeth there appear to be no adverse clinical consequences and a recent laboratory study supports this.[6] Whilst moisture contamination of glass ionomer cements may cause an opacity in anterior restorations, this is usually only a surface phenomenon which appears to have no effects upon the rest of the material. Figure 5 shows that the surface of the three samples responded differently to procedures undertaken at the initial set phase. The three samples were then immersed in water for one week after which they were dried and about 0.5 mm of cement was removed from the surface of each specimen. While surface opacity is evident on the NO V sample, the subsurface areas in each specimen appear identical.

The effects of inhalation of set glass ionomer cement dust are at present unknown and the use of a water spray and high volume evacuation to scavenge any free particles is recommended.

Finishing is achieved with coarse disks and slow speed diamond points. It is essential that the glass ionomer does not overheat during reduction as the material is more sensitive to dehydration than moisture contamination.

Once the restoration has been trimmed, the surface is covered with a waterproof varnish, using a small brush or pledget of cotton wool.

The occlusion is checked with articulating paper, and prematurities removed. The patient is advised not to masticate on the restoration for 24 hours until final set has been reached.

Class I restorations

Prior to cavity preparation, the occlusion is marked to determine the position of the centric stops.

Avoiding centric stops, a minimal access cavity is cut to gain access to carious dentine which is removed. Identification of remaining caries is aided by small excavators and trans-illuminating with a white light composite activator. Undermined enamel, contrary to the accepted view, is supported once the restoration has been placed (Fig. 6).

[6] Pearson GJ. Finishing of glass ionomer cements. Br Dent J 1983;155:226-8.

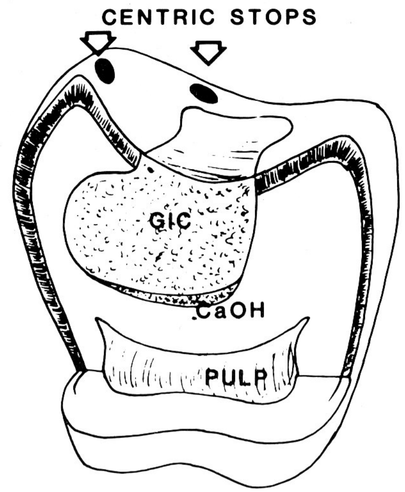

Fig. 6.—The use of glass ionomer cements in large Class I restorations permits the retention of tooth structure that would otherwise have to be removed for an overlay preparation.

Class II restorations (replacing existing restorations)

It is not necessary to extend the preparation beyond the removal of caries. Care needs to be exercised to protect unsupported enamel, particularly during placement of the matrix band. The packing forces generated during the placement of a glass ionomer restoration are less than those with an amalgam, nevertheless, wedging is advised. The matrix is burnished against the opposing tooth wall to achieve maximum adaptation of the restoration at the contact area. In the MOD type restorations, contact areas are achieved by packing one proximal box and after this has set, packing the other.

Class VI tunnel restoration (for unrestored proximal lesions)

The use of glass ionomer cement enables a significantly more conservative restorative technique to be applied to the restoration of the initial interproximal lesion. The technique is applicable to both Class II and Class III lesions where the marginal border remains intact and it is proposed for classification purposes to refer to this as a Class VI type restoration.

After determining the location of centric stops, a small access cavity is made on the occlusal or lingual surface to gain access to the lesion from behind (Fig. 7). Carious dentine is removed, again with the diagnostic aid of a small excavator or light source. Access can be improved by removing an existing Class I restoration so long as this does not involve a centric stop. Care is required during placement of the matrix band to protect the unsupported marginal ridge. (In Class III type restorations, a mylar strip is sufficient interproximally). The matrix is then wedged and the restoration placed as described (Fig. 8).

Overhang removal

In Class II and VI restorations, the interproximal areas are checked for overhangs upon removal of the matrix. At the initial set phase, overhangs are easily removed with a slow speed pointed diamond, abrasive strip, or scaler.

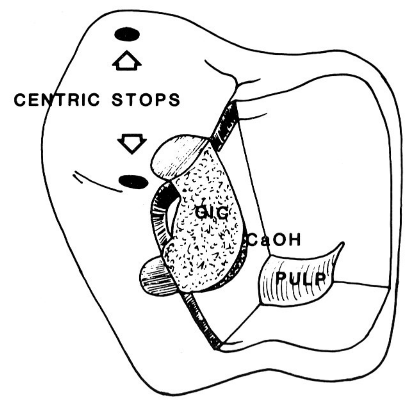

Fig. 7.—Diagram of a Class VI restoration using glass ionomer cement which leaves the marginal ridge intact.

Fig. 8.—Class VI restoration of a proximal lesion leaving the marginal ridge intact. a, Preparation with matrix band in position prior to placement of the cement; b, restoration after three years.

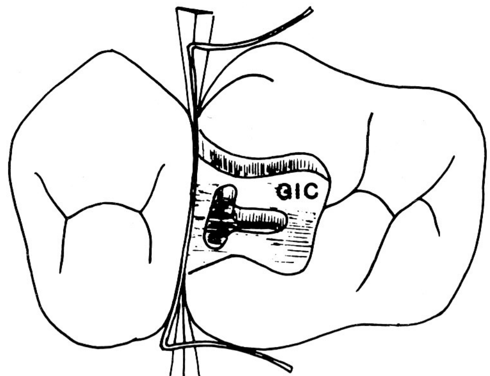

Fig. 9.—Class II cavity preparation with mylar strip and wedges.

Composite overlay of wear affected glass ionomer restorations

When an ionomer restoration wears, it can be repaired by removing the top 3 mm of material, isolating the tooth from moisture and etching the enamel and ionomer with 37 per cent phosphoric acid. For Class II restorations, a mylar strip is folded twice, placed through the contact point and either wedged, or flexed between two fingers (Fig. 9). Care must be taken to ensure that adequate separation is obtained to compensate for the matrix.

A posterior composite placed in this manner will assure an excellent contact area for the restoration, using white light or chemically cured material. Once set, the restoration can be finished by appropriate procedures.

Fractured cusps

One of the most common problems seen in adult dentitions is a fractured cusp on a posterior tooth. This occurs as a result of weakening a tooth due to the conventional methods of cavity preparation. The traditional procedure (removing the remaining enamel and placing a crown) further compromises the tooth eliminating future restorative options. Results obtained indicate that ionomers present a simple and satisfactory means of restoration with a minimum removal of tooth structure.

Technique

If the fracture has secondary caries associated with it, caries must be removed although fractures due to weakened cusps usually need no tooth removal, and consequently no local anaesthetic is required. As glass ionomer cement will bond to clean amalgam, the surface is smoothed with high or slow speed diamond points. A bristle brush, soaked in 20 per cent stannous fluoride, is then applied to the dentine surface to clean the tooth surface of pellicle and plaque, flushed with water and dried. A matrix band is applied and ionomer is placed as described for a conventional Class II restoration. This technique eliminates the need for pins which may adversely affect a tooth. Teeth which have lost load-bearing cusps will need a further overlay of posterior composite in order to bring the restoration into functional occlusion. Composite overlays may be employed as buccal facings of upper premolars where aesthetics are of importance.

Evaluation

The composite and glass ionomer cement system has been used in clinical practice for five years, during which time an estimated four thousand restorations have been placed.

In order to obtain an unbiased sample, each consecutive restoration in place longer than six months was observed over a two week period (except failed restorations which were recorded irrespective of time). For each restoration, a recording of site, type, time of insertion (and failure), occlusal or marginal wear, and colour changes or marginal staining was made. All observable clinical wear was recorded. If marginal or occlusal wear was minimal, and did not affect the function of the restoration, an assessment of satisfactory was recorded. Marginal wear that caused food packing and occlusal wear greater than 1 mm was regarded as unsatisfactory and a composite overlay placed.

Results

A total of 165 restorations were observed within a range of 4-58 months. The results are tabulated in Table 1.

Class I restorations

Of 25 restorations, one was lost and two showed signs of wear.

TABLE 1
Assessment of 165 glass ionomer cement restorations during 4-58 months

Type of restoration	N	Age (mths)	Failures	Occlusal wear
Class I	25	30.36	1 (4.0)	2 (8.0)
Class II	89	27.16	19 (21.3)	31 (34.8)*
Class VI	22	29.64	0 (0.0)	3 (13.6)
Composite overlay	29	27.07	3 (10.3)	4 (13.8)

*Marginal wear, 13 (14.6).
Percentage in parenthesis.

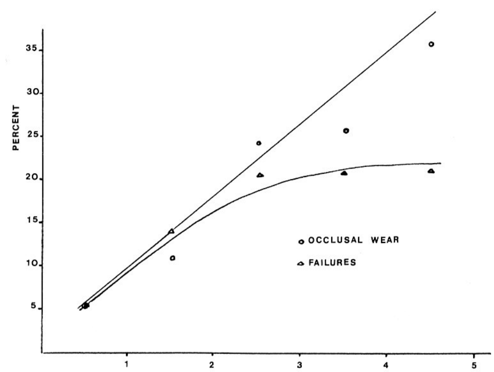

Fig. 10.—Accumulated percentage wear and failure rates of Class II glass ionomer cement restorations measured over 5 years.

Class II restorations

A total of 89 restorations were observed, of these nineteen (21.3 per cent) failed, ten were lost, six had open contact areas, two had worn more than 1 mm, and one required removal for endodontic access.

The accumulated percentage wear and failure rates of Class II restorations were measured as a function of time and expressed graphically in Fig. 10.

Wear appeared to be a linear function from the graph, and a Linear Trend Line Equation was developed to fit the line. At the mid observation time (that is, the third year, $X = 0$) the equation was:

$$Y_t = 22.48 + 7.99X$$

From this it can be calculated that 50 per cent of all Class II type glass ionomer cement restorations will exhibit occlusal or marginal wear after 6.4 years.

Three restorations showed signs of marginal staining.

Class VI restorations

A total of 22 restorations were observed. In line with clinical experience, no failures were recorded, and three showed signs of wear.

Composite overlays

A total of 29 restorations were observed. Of which three had failed, two were lost and one had an open contact area. Clinical wear was present on four restorations, and colour changes were noted on two.

Discussion

The larger number of Class II restorations observed in this survey suggests that the procedure outlined in this paper could be most useful especially as aesthetic needs are readily satisfied and the time factor for insertion is reduced greatly.

Of particular value is the use of the technique for restoration of the initial interproximal lesion, especially in the posterior teeth.

A clinical impression, borne out in the results, indicates that a small proportion of people have teeth that are unsuitable for Class II glass ionomer cement restorations because of wear or staining. In these cases composite overlays can be placed.

It has been noted[7] that such cannot be done until the glass ionomer cement has completely set.

Figure 10 shows that the failure rate of Class II glass ionomer cement restorations is due to other factors than wear, and seems to stabilize before two years. The decreased wear resistance of glass ionomer cement has

[7] Marshall J, Marshall GW Jnr, Harcourt JK. The influence of various cavity bases on the micro-hardness of composites. Aust Dent J 1982;27:291-5.

to be considered in relation to the many positive properties it has a restorative material. In each case, the clinical assessment and the confidence a practitioner has with the material must form the decision for its use.

The performance of glass ionomer cement restorations in Class I and Class VI cases supports clinical impressions that this is a satisfactory restorative procedure, and the conservative nature of these types of preparations suggest that they may offer advantages over the traditional metal-based systems.

The wear resistance of composite resins to occlusal loads is still being evaluated; whilst wear occurred in conventional, non-posterior composites in this survey, the sample is too small to draw significant conclusions. In the light of clinical experience, posterior composites perform well under occlusal loads in small cavities, furthermore, the conservative preparations used assures better future options to achieve the optimal life of a tooth.

Conclusions

There are currently no ideal materials or restorative techniques available for use as load-bearing restorations in posterior teeth. As new materials with appropriate physical properties are made available to the profession, there is a need for them to be examined under clinical conditions in order to determine their full restorative potential. Whilst a composite and glass ionomer cement based system does not currently meet all requirements, experience in dental practice suggests that this is where future improvements could arise.

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