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The use of glass ionomer in special needs patients

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Abstract

Placement of restorations for patients who are physically or intellectually disabled or mentally ill can pose considerable difficulties for the general practitioner. Access to the oral environment is often limited and patient tolerance and concentration may be reduced to rather brief periods of time. Oral hygiene routines may be less than ideal leading to a high caries rate. Enamel surfaces which do not normally become carious can develop broad but shallow lesions with a poorly defined outline.

Selection of the most suitable restorative material will be important, with longevity of the restoration as the prime consideration. Other factors such as access, isolation of the lesion and patient co-operation must also be taken into account. Also, forces acting on restorative materials may be less than usual due to poor occlusion, teeth opposing dentures or being completely unopposed. Restoration by indirect techniques will often not be possible so the choice will be limited to the three plastic restorative materials normally used in restorative dentistry: amalgam, resin composite and glass ionomer.

As a result of clinical experience it is suggested that glass ionomer will often be the material of choice. This paper describes five years experience with the resin-modified glass ionomers in an institutional practice which is limited to patients with special needs.

Clinical significance

Placement of restorations, with a reasonable expectation of longevity, can pose considerable problems for the patient with special needs. Resin-modified glass ionomer is a useful alternative material and has been placed with a high degree of success over a period of five years.

Key words: Glass ionomer, special needs patients, restorative dentistry.

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Introduction

In every community there is likely to be a small but significant group of people who are either physically or mentally disabled or both and these people will often pose an additional problem for the practising dentist. When presenting for treatment they will generally be anxious to co-operate but both patient and operator may be frustrated by the difficulty of coping with the situation. They may have a limited attention span, be easily distracted, suffer from muscular spasms or have an over-active tongue.Their reduced compliance will often make it impossible to apply rubber dam but at the same time they may have an overly generous salivary flow.They may tire rapidly so that treatment times may be limited.

Oral hygiene routines are often limited to the attention which is available from a patient carer and dietary routines may well be less than ideal from a dental point of view. A limited ability to masticate may lead to a very slow clearance rate so that food debris is added to the usual plaque accumulation and caries is likely to be established on surfaces of teeth not normally identified as caries prone. Many medications prescribed for these patients affect the production and composition of the saliva and these changes may also lead to an increase in the caries rate.

The pattern of caries likely to arise from these situations will often be broadly diffuse. Large areas of enamel, on otherwise smooth surfaces, may become involved and the subsequent dentine involvement will be similarly extensive.Exposed root surfaces are often at greater than normal risk of caries. Penetration into dentine may be relatively slow and definition of the cavity outline may be very difficult.

Recurrent caries for these patients is relatively common in relation to the usual plastic restorative materials. For the purpose of this paper a lesion is regarded as recurrent caries if it is identified at the immediate interface between the tooth structure and the restorative material, arising from penetration of bacteria and/or their nutrients into the margin. On the other hand, continuation of the same caries risk factors which caused the first lesion can initiate a new area of demineralization adjacent to a previously placed restoration, regardless of the material used and, on the assumption that the original restoration is well placed, this should not be identified as recurrent caries.

Prevention of caries through the use of systemic and topical fluoride is particularly important. However, all the limitations mentioned above will combine to reduce the effectiveness of routine topical applications. Patient co-operation may be difficult to obtain and it may be necessary to again rely upon the patient carer to ensure that prescriptions are fulfilled.

Selection of the appropriate restorative material for those lesions which require attention is limited. It should be noted that as some of these patients have limited masticatory ability, they may not be able to exert high stresses upon a restoration so it may not be necessary to develop the ultimate in physical properties on each occasion. The use of indirect restorative techniques is generally out of the question because of the high caries rate and the difficulties posed for both the operator and the patient, so the choice will generally be confined to the direct plastic materials: amalgam, resin composite or glass ionomer.

Placement of amalgam requires reasonable access to the lesion for a sufficient period of time to apply adequate condensation without contamination. As there is no adhesion available it requires reasonable mechanical retentive designs within sound tooth structure and this may pose a problem in a diffuse, poorly defined lesion.The use of amalgam bonding agents is of limited value because the material must still be properly condensed and isolation from contamination is still important. As amalgam lacks aesthetic appeal its use will be confined to posterior teeth and, under these circumstances, access is the greatest problem.

There may be similar problems in the placement of resin composites as well as the polyacid-modified resin composites (compomers). The fact that they are highly aesthetic means that they may be regarded as more universal and the resin composites at least can be placed in any position in the mouth. However, they are not always the material of choice in the presence of a high caries rate. There is a lack of resistance to accumulation of bacterial plaque[1] and the micromechanical adhesion between enamel and both of these groups is dependent upon the presence of sound, well-mineralized enamel which may be hard to find under these circumstances. If the adhesion between enamel and restorative material is lost at any point along the cavo-surface margin, the risk of microleakage and recurrent caries is high.

In many cases the material of choice is a glass ionomer, particularly for those patients with a high caries rate.The need to reduce the risk of recurrent caries may outweigh the need for a restoration with high physical properties. Recent developments in these materials have brought about considerable improvements in clinical placement techniques and physical properties.[2] The original Type II.1 restorative aesthetic glass ionomers showed relatively low physical properties but the modern resin-modified glass ionomers are approximately twice as strong.[3] The older varieties also required care during placement to protect the water balance over the first 24 hours.[4]

The main advantages of glass ionomer in these circumstances include adhesion to both enamel and dentine[5] and a continuing fluoride release which appears to be sufficient to reduce or inhibit plaque build-up.[6] The ion exchange adhesion develops a union with tooth structure which prevents microleakage and the continuing fluoride release appears to assist in remineralization of the affected dentine under a carious lesion. It is simple to handle under difficult circumstances and tolerant to placement in a humid atmosphere over mildly wet dentine because, as a water based cement, it requires a degree of humidity to maintain the water balance during setting.[7]

This paper discusses the results of five years of clinical practice with a group of patients with special needs which falls within the responsibility of the South Australian Dental Services. One operator treated the patients within the Dental Clinic or visited them at their institutions of residence. The clinical situation was not always ideal because of lack of patient mobility but the standard of care was the highest possible under the circumstances. When possible, lesions were photographed prior to restoration and several were photographed again after a two to four year interval.This report should be regarded as clinical observation only and the results shown graphically in Fig. 1-4 are to show the apparent success rate.

Materials and methods

One operator (MEIG) carried out the patient treatment over a four year period. All three plastic restorative materials were used where indicated but one particular resin-modified glass ionomer‡ was utilized throughout the period of this trial. Detailed records were retained for all restorations but some only were photographed before and after insertion, depending largely upon patient co-operation. Prior to this period an auto-cure Type II.1 restorative aesthetic material§ was placed under similar

‡Fuji 11 LC,GC International,Tokyo, Japan.

§Ketac-fil,ESPE GmbH,Seefeld,Oberbay, Germany.

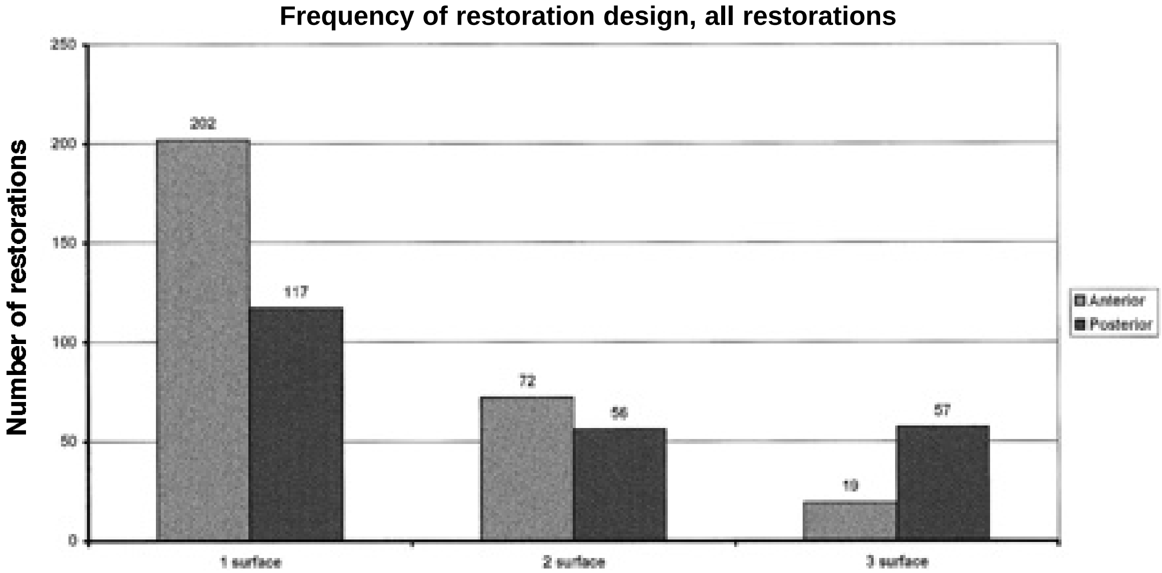

Fig. 1. – The distribution of restorations in both anterior and posterior teeth is shown and the number of surfaces involved in the cavity. The standard GV Black classification cannot always be used to describe such cavities.

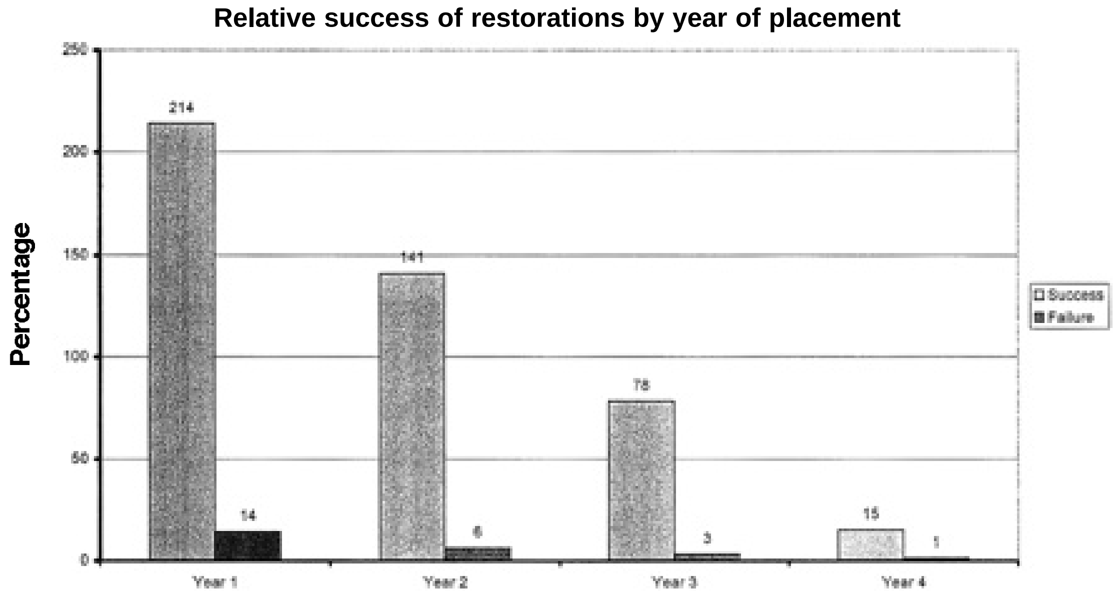

Fig 2. – The number of restorations placed, excluding erosion lesions, in each of the four years with the failures recorded at the end of the fifth year of observation.

circumstances but when the resin-modified glass ionomer became available it was recognized that it showed significant advantages, in particular improved physical properties, as well as immediate stability in the water balance following application of the curing light.[8]

It was not possible to standardize clinical procedures because of patient problems so, on each occasion, the best available techniques were applied. Rubber dam was placed where possible, otherwise cotton rolls were used for moisture control. The basic principles of the atraumatic restorative treatment (ART)[9,10] technique were applied where appropriate, in as much as small areas of affected dentine were left on the floor of some of the cavities on the assumption that they would remineralize under a glass ionomer. Each cavity was conditioned for approximately 10 seconds using the manufacturer's Dentine Conditioner, which is 10 per cent polyacrylic acid. This was thoroughly washed off with air/water spray and, whilst maintaining isolation as best as possible, the tooth was dried out but not dehydrated. If the cavity was contaminated with saliva prior to placement of the restorative material it was conditioned again. Matrices of mylar strips, celluloid crown forms or soft metal, were placed for all except occlusal cavities. At the beginning of the series the material was mixed according to manufacturer's instructions, paying attention to the powder content. Subsequently, the material was used in the capsulated form, thus guaranteeing the correct proportioning.

Generally, the more extensive restorations were built incrementally, although this was not always possible because of patient constraints. That is to say, the material was placed in layers no more than 3 mm thick for each increment, light activated for 20 seconds, and a further layer applied immediately from the same or a new mix. Ultimate activation time was never less than 60 seconds prior to removal of the matrix, even for a small restoration. Following matrix removal all restorations were subjected to a further 20 seconds of light activation from as many directions as necessary to ensure complete cure.

Final contouring was undertaken as soon as full light activation was complete. This was carried out using fine polishing diamonds and/or graded polishing discs, then, where possible, a thin application of a low viscosity resin seal was applied to assist in eliminating the scratches and porosities and developing a smooth surface.

Results

Over a period of 49 months a total of 523 restorations was placed for 174 patients using the techniques described above. For the placement of the first 272 restorations the glass ionomer was hand-mixed and the remainder were restored using the material in a capsulated form. One year after the last restoration was placed all the patient case notes were reviewed, with every restoration being checked to confirm its continuing success or date of failure. A restoration was regarded as failed if it was completely missing or a substantial section had fractured and required replacement. Minor chips or loss of contour were not regarded as failures. Although some restorations had not been under observation for a long period, the overall success rate for all restorations was very high. The number and distribution of the lesions restored, showing the surfaces involved in the cavity design, is recorded in Fig. 1.

It was noted early in the investigation that restorations placed to cover exposed dentine in extensive, shallow erosion lesions on the occlusal surfaces of posterior teeth or the palatal surfaces of anteriors were prone to failure, particularly if they were under heavy occlusal load. There were 51 restorations noted in this category with 29 failures recorded within 20 months of placement.This led to the decision that glass ionomer was not the material of choice under these circumstances so it was decided to no longer use it in such cavities.

Figure 2 shows the number of restorations, excluding the above 51 erosion restorations, placed in each of the four years with the failures recorded at the end of the fifth year of observation. In Fig. 3 the percentage success rates are shown both with and without the erosion restorations. As this is an ongoing study and the placement of restorations continued beyond four years the success rate by age of restorations is shown in Fig. 4.

Discussion

Before making a decision in relation to the material to be used in difficult circumstances, the nature of the problem to be solved should be considered. It has been recognized for some time that, for the average patient, the caries process is a simple routine of demineralization of tooth structure followed by remineralization, through the presence of calcium and phosphate ions in the saliva.[11,12] In the healthy mouth there is a continuing balance and it is only in the presence of an imbalance in favour of demineralization that a carious lesion develops. For the patient who has exaggerated difficulties in controlling the oral environment, the profession must utilize every means available to assist in maintaining the balance in favour of remineralization. One important aspect is to ensure retention of as much natural tooth structure as possible through remineralization, because the potential for further caries remains high for problem patients and remineralized tooth structure is more resistant to further carious attack.[13]

The potential for remineralization of enamel and dentine is high, given the right circumstances. Research in recent years into the progress of the carious lesion[14,15] has suggested that there are two layers which can be identified. The surface layer of 'infected' dentine represents tooth structure which has completely disintegrated and is formless. It consists mainly of plaque and other oral debris and must be removed. The second layer is 'affected' dentine which has been demineralized but still retains a reasonably identifiable structure based on the collagen framework of the dentine tubules. It is now recognized that this framework can be remineralized to some degree in the presence of fluoride and it is therefore undesirable to remove it all when preparing a cavity for restoration. The routine suggested by Massler[16] for controlling a carious lesion involved sealing the cavity with zinc oxide and eugenol and leaving it for three weeks before re-opening and redesigning the cavity in preparation for placement of a permanent restoration. The cement provided a reasonably effective seal for the cavity and the eugenol was strongly antibacterial so that the caries process was arrested. The pulpal inflammation subsided and the remaining 'affected' dentine stabilized. The end result was that the conservative operator had the opportunity to retain some of the tooth structure which would otherwise have been removed.

Clinical observation and recent research[9,10] suggest that if glass ionomer is used as the sealant in place of zinc oxide and eugenol, the result will be similar but

, Soflex discs, 3M Dental Products, Minnesota, USA.

Relative success with and without erosion group

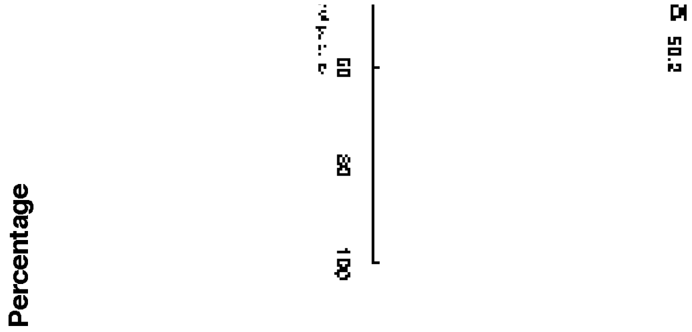

Fig. 3. – The total number of restorations placed showing the success rates, up to the time of assessment, and comparing the figures when the extensive erosion lesions are included or excluded.

Success of restoration by years since placement (excluding erosion lesions)

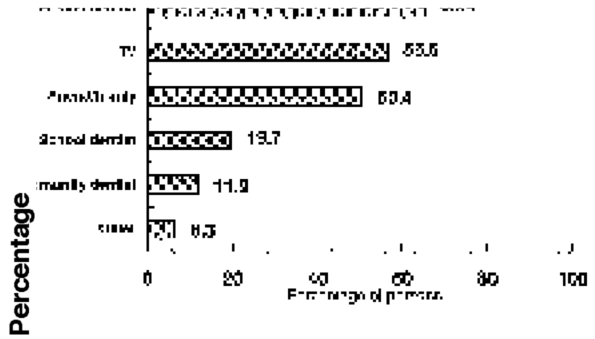

Fig.4. – The success rates of the restorations relative to the age of the restorations at the time of assessment.

with an additional advantage. The ion exchange adhesion available with glass ionomer will ensure complete isolation of the carious lesion thus leading to the same type of stabilization. In addition, the release of fluoride and other ions from the cement appears to lead to a degree of remineralization of the 'affected' dentine enabling even greater retention of remaining tooth structure.

In view of the above observations, the selection of the most appropriate plastic restorative material should be undertaken with care.The primary aim of the dentist is to place restorations with optimum longevity but several factors may limit the result. There are three groups of plastic restorative materials available and none of these is the perfect answer to all problems. It is essential that the operator assesses each situation as it occurs and selects the appropriate material for the task in hand.

The higher failure rate of the restorations placed in the extensive erosion lesions suggested that glass ionomer is not always suitable in these lesions. It has also been shown that, as glass ionomer is a water-based cement, it does not survive well in the presence of xerostomia.[3] Many of this particular series of restorations for erosion lesions were placed in patients receiving head and neck radiotherapy for oncology problems so it is possible that the subsequent development of xerostomia led to desiccation of the glass ionomer, thus contributing to restoration loss.[4] It was decided that, in this survey, these restorations formed a distinct group and justified a separate analysis.

The main limitation for the use of glass ionomers is that they have physical properties lower than the other restorative materials and therefore reduced ability to sustain heavy occlusal load although, it has been noted, the resin-modified glass ionomers have physical properties close to a microfill resin composite.[3] It is necessary then to achieve the optimum physical properties with each mix of the material and this means using the recommended powder to liquid ratio. Further analysis of the records showed that, for the first 272 restorations, the glass ionomer was hand-mixed thus leaving the ratio to the skill of the dental assistant. Subsequently, the material was available in capsules where the ratio was standardized. Careful assessment of the success rate showed that there was no significant difference between these two groups.

In preparation of a cavity for the placement of glass ionomer it is essential to develop a clean margin around the full circumference of the lesion to ensure complete sealing through the ion exchange adhesion. This means it is necessary to remove the 'infected' dentine but retain much or all of the 'affected' dentine on the floor of the cavity. The adhesive mechanism[17] has been shown to be a diffusion-based ion exchange between both enamel and dentine. A separate ion enriched material is developed between the cement and the tooth structure and any subsequent failure will be cohesive in the cement, leaving behind the ion enriched layer firmly adherent to the tooth. There is also a degree of chemical union between collagen and glass ionomer[18] and this appears to develop even though the collagen is demineralized, as in the affected dentine found under an active carious lesion. This means the dentine tubules will remain sealed and somewhat resistant to further caries, even following failure.

The fluoride release from an old style auto-cure glass ionomer has been shown to continue over a period of at least eight years from the same specimen[6] and the newer materials show a similar pattern. Their antibacterial activity has also been noted[19] and there have been very limited reports of recurrent caries at the interface between tooth structure and properly placed glass ionomer in the clinical environment.[20,21] Even though it is not possible to develop a true glazed surface on glass ionomers, they have proven to be highly resistant to plaque build-up or colour change over many years.

Glass ionomers are simple to handle in the clinical environment and can be placed in bulk more easily than alternative materials. Moisture control is still essential but the shorter placement time, particularly for the light-cured resin-modified materials, means that there is less time for contamination.The results over five years of observation are acceptable in spite of the adverse circumstances for placement. There has been some minor degree of colour change in some patients and there has no doubt been a degree of water uptake and swelling. However, these factors are clinically insignificant under the circumstances.

The alternative plastic restorative materials should also be considered because each will have its place and it is also possible to combine them using a lamination technique. Amalgam has been the simplest, most tolerant, reliable and inexpensive material for over a hundred years but it is far from universal in its application. It is essential to provide mechanical interlocks with remaining tooth structure to ensure retention and this often means removal of either enamel or dentine which could be otherwise retained and remineralized. The alternative use of self-threaded pins to enhance retention is moderately difficult under the best circumstances and cannot be recommended where access and patient co-operation is less than ideal. The use of bonding agents to enhance retention of amalgam may be of value but, to date, the longevity of the bond has not been proven.[22]

It is also necessary to apply considerable manual pressure to condense amalgam properly into a cavity and, for an extensive cavity, this may mean the construction of a complex matrix system. This is time consuming and requires considerable operator skill and patient co-operation. As amalgam has no in-built resistance to plaque build-up it remains subject to recurrent caries, particularly in the patient who has difficulty controlling the caries rate. The lack of aesthetic appeal means it is undesirable for any anterior restoration.

The modern resin composites and polyacid-modified resin composites (compomers) also have limitations. Adhesion between resin and enamel is effective and relatively simple to develop but it relies on sound, fully supported, well-mineralized enamel.[23] In the diffuse type of cavity often seen in these patients it may be difficult to define such a margin and removal of all demineralized enamel may be unduly wasteful of tooth structure because often it can be remineralized. However, neither of these groups of plastic materials has a significant and sustained fluoride release so they cannot be relied upon to encourage remineralization.

If it is decided to bond a resin composite restoration to the dentine it will be necessary to remove all the 'affected' dentine down to a sound, fully mineralized floor. In many cases it would appear to be undesirable to sacrifice this tooth structure which could otherwise be saved. Also, it will take the cavity floor closer to the pulp where there will be a greater density of dentine tubules and commensurately less intertubular dentine available for the development of resin bonding.[24] Should dentine bonding fail and microleakage supervene, the problems will multiply rapidly and it must be recognized that endodontic treatment for these patients is often not an option.

The combination of resin composite and glass ionomer using a lamination technique[25] is a valuable alternative, particularly in situations where the occlusal load is expected to be too heavy to be sustained by glass ionomer alone.The cavity can be prepared in a very conservative manner,as described above, and a base of the strongest glass ionomer available placed in a substantial layer over the dentine. Once the cement has set, the cavity can be prepared again to provide sufficient space for a reasonable thickness of resin composite laminate. The enamel margins must be cleaned and bevelled as required to develop a proper resin to enamel bond. Both the enamel and the glass-ionomer must be etched, washed thoroughly, and the resin composite built incrementally. The result is a restoration which is both strong and aesthetic. However, it does require more steps and greater concentration from both the operator and the patient than the use of glass ionomer alone and therefore is not always a suitable alternative.

Conclusion

The more recent versions of the glass ionomers can be regarded as adequate for the restoration of cavities which are not subject to undue occlusal load. They are relatively simple and uncomplicated to place and are very valuable for patients whose tolerance to dental treatment and ability to co-operate are limited. Recent developments resulting in stronger auto-cure materials suggest that the place of glass ionomer in restorative practice is extending still further. It must be recognized that the final anatomy of these restorations is often less than ideal. However, the prime object is to retain the tooth and avoid the need for extraction because these patients generally have a very low tolerance for oral surgery and are often unable to cope with the problems of prosthetic replacements.

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