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Clinical Technique/Case Report

Elevation of an Amalgam-stained Margin With Resin-modified Glass Ionomer to Support an Indirect Ceramic Restoration: A Six-year Case Report

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Clinical Relevance

Using the technique of margin elevation, as described in this article, can often make a restoratively difficult situation more manageable and many times eliminate the need for more aggressive procedures that would ordinarily be required with traditional restorative techniques.

SUMMARY

This case report presents treatment of a mandibular second molar with an extensive proximal margin, which was finished on amalgam-stained dentin. A resin-modified glass ionomer for margin elevation and a lithium disilicate onlay were used to restore the tooth to proper form and function. The patient has been followed for six years and has had no complications during this period.

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INTRODUCTION

Removal of extensive caries that extends onto root surfaces and near the periodontal attachment often results in a preparation margin which is difficult to restore. Initial placement of an adhesive direct restoration in such areas to restore the missing root surface, resulting in a more accessible gingival margin for subsequent restoration of the remaining coronal structure, has been termed "margin elevation."[1-4] Margin elevation has the potential to simplify subsequent restorative procedures and to mitigate the need for surgical crown lengthening, leading to reduced treatment costs and shorter treatment duration.[5]

Because margins on root surfaces are on dentin, bonding is less optimal than if enamel were present,

regardless of the adhesive system chosen.[6,7] Although clinical studies of this type of restoration are difficult to conduct because margins are often obscured by gingival tissue, the extant literature indicates that either resin composite or resin-modified glass ionomer (RMGI) restorative materials are effective in margin elevation.[5,8-11]

When preparing teeth with extensive subgingival caries, it is often difficult to extend margins onto ideally mineralized dentin without impinging on the periodontal attachment and losing access for the subsequent restoration. When further extension would render the tooth nonrestorable without periodontal surgery, the clinician must decide whether or not to use compromised dentin as a restoration margin and proceed with margin elevation. Such dentin, although hard when instrumented, is probably in part demineralized, especially when extrinsic or amalgam stain is present.[12] Laboratory evidence indicates that both resin and RMGI demonstrate adhesion to demineralized dentin that is compromised relative to their adhesion to normal dentin.[13,14] However, there is lower percentage reduction in bond strength with RMGI systems compared with resin bonded systems, and the bond of RMGI to demineralized dentin remains stable over time.[14]

The following case describes the restoration of a left mandibular second molar with a fractured mesio-lingual cusp adjacent to a previous mesial-occlusal-buccal amalgam restoration that extended onto cervical dentin. This restoration had produced dark staining of the dentin, which could not be completely removed without extension into the periodontal attachment. Due to the likely demineralized status of this margin, it was elevated using an RMGI restorative material followed by preparation for a ceramic onlay, given the patient's preference for a tooth-colored restoration. A lithium disilicate (IPS e.max, Ivoclar Vivadent, Inc, Amherst, NY, USA) ceramic restoration was selected because of its combination of strength and effective resin bonding capability. Visual and radiographic evaluation of the restored tooth have been conducted over six years after placement of the restoration.

REPORT OF CASE

A 65-year-old female patient presented with the complaint of a fractured molar on her lower left side. Examination revealed the mesiolingual cusp of tooth No. 18 had fractured, leaving an adjacent mesial-occlusal-buccal amalgam restoration that extended apical to the cementoenamel junction (Figure 1). The patient was asymptomatic and had no periodontal or pulpal pathology, although it was observed that the existing mesial amalgam margin extended nearly to the sulcular depth. The patient wished to retain the tooth, and after the clinician explained the technical difficulties of effectively restoring the proximal margin with a conventional indirect restoration, she agreed to interproximal margin elevation. Because the distal cusps and marginal ridge were intact, a ceramic onlay was chosen for restoring the remainder of the missing coronal tooth structure.

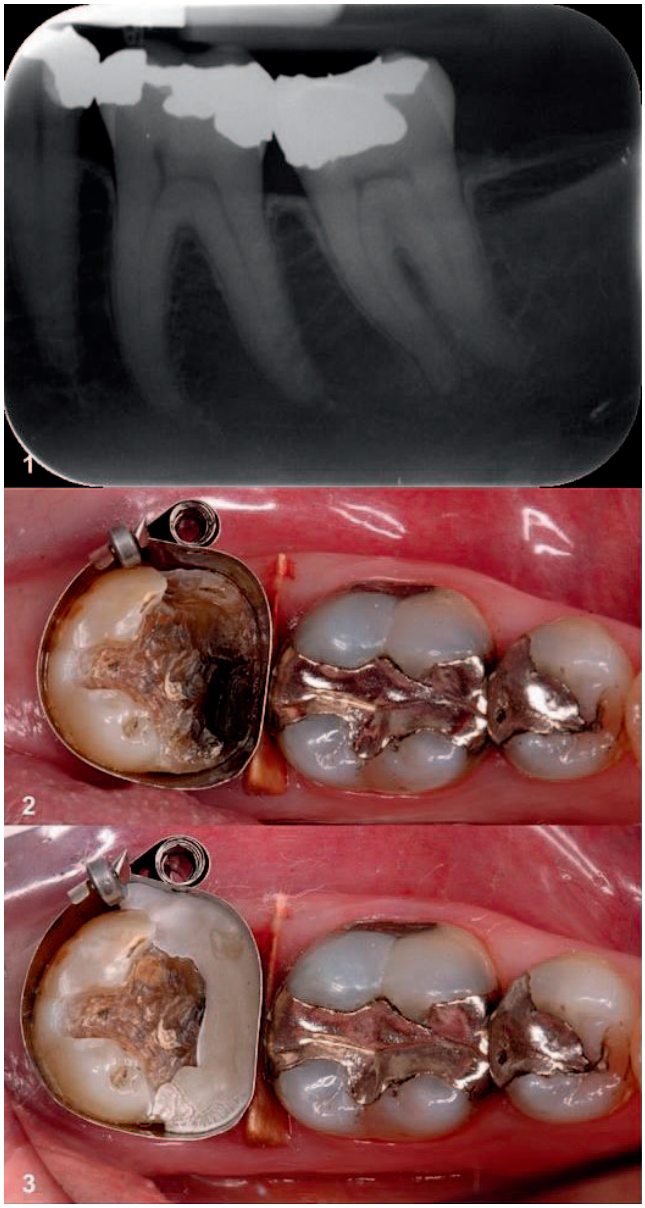

Figure 1. *Preoperative periapical view.*

Figure 2. *Preparation ready for resin-modified glass ionomer.*

Figure 3. *Resin-modified glass ionomer added.*

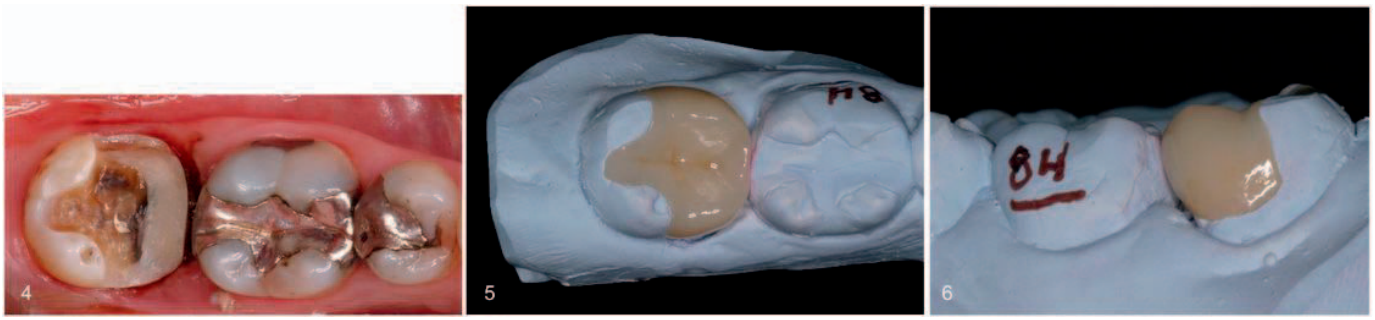

Figure 4. *Final preparation.*

Figure 5. *Onlay on solid cast, occlusal view.*

Figure 6. *Onlay on solid cast, buccal view.*

During tooth preparation, removal of the existing amalgam restoration revealed darkly stained dentin along the gingival margin. This dentin was removed to the extent that what remained was resistant to instrumentation with a slow speed No. 6 round bur but could not be completely removed without violating the periodontal attachment (Figure 2). Given the likelihood that the remaining dark dentin was partly demineralized, it was decided to raise the interproximal margin using an RMGI restorative material (Fuji II LC, GC America, Inc; Alsip, IL, USA).

An AutoMatrix band (Dentsply Sirona USA, Milford, DE, USA) was placed (Figure 2), the gingival floor of the preparation conditioned (Fuji Conditioner; GC America), and a capsule of the Fuji II LC restorative material was mixed and syringed into the mesial box up to the level of gingival papilla. Conditioning and mixing were carried out according to the manufacturer's instructions. The RMGI was cured with a light-emitting diode light (Valo, Ultradent Products, Inc. South Jordan, UT, USA) set to 1000 mW/cm^2 for 40 seconds (Figure 3). The matrix band was then removed and the RMGI layer again light cured for 30 seconds each from the buccal and lingual directions.

The preparation was refined (Figure 4) to meet the restoration requirements for a lithium disilicate (IPS e.max) ceramic onlay restoration. A full arch PVS impression (Extrude, Kerr Corporation, Orange, CA, USA) was taken along with an alginate impression of the opposing arch and a facebow record for mounting on a semiadjustable articulator. For the interim period, a self-curing bis-acryl provisional restoration (Protemp Plus, 3M ESPE. St Paul, MN, USA) was directly fabricated and cemented with non-eugenol–based temporary cement (Temp-Bond NE, Kerr Corporation). The lithium disilicate onlay (Figures 5 and 6) was fabricated by pressing using the lost wax technique and returned for delivery.

Approximately two weeks later, the patient was anesthetized and the provisional restoration and residual cement removed. The onlay was tried in for fit and the occlusion lightly verified and adjusted using a fine grit football diamond bur (No. 8379 0014, Komet USA. Rock Hill, SC, USA). The restoration was polished with diamond silicone polishing points (Dialite, Brasseler USA; Savannah, GA, USA) and steam-cleaned to remove any residual oral contaminants. The intaglio was then etched with 5% hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar Vivadent) for 20 seconds followed by thorough rinsing for 20 seconds. Next, in order to remove any residual porcelain precipitates produced by hydrofluoric acid etching, the intaglio of the restoration was lightly scrubbed using a microbrush with 37% phosphoric acid (Etch-37 with BAC, BISCO Dental Products, Schaumburg, IL, USA) for 30 seconds and rinsed. The restoration was thoroughly dried; silane (Silane, Ultradent Products) was applied and left in place for 60 seconds followed by thorough air drying for 30 seconds. The intaglio surface of the restoration was coated with a fifth-generation adhesive (Optibond Solo Plus, Kerr Corporation), which was air-thinned, after which the restoration was placed under a light protective barrier.

A nonlatex rubber dam (DermaDam, Ultradent Products) was placed over the patient's mandibular left quadrant using ligation of tooth No. 18 with unwaxed dental floss. The preparation, including the RMGI layer, was lightly cleaned using air particle abrasion at 30 psi with 50 μm aluminum oxide (Aluminum Oxide 50 Micron White, Danville Materials, San Ramon, CA, USA), rinsed, and lightly dried. The same 37% phosphoric acid was applied to

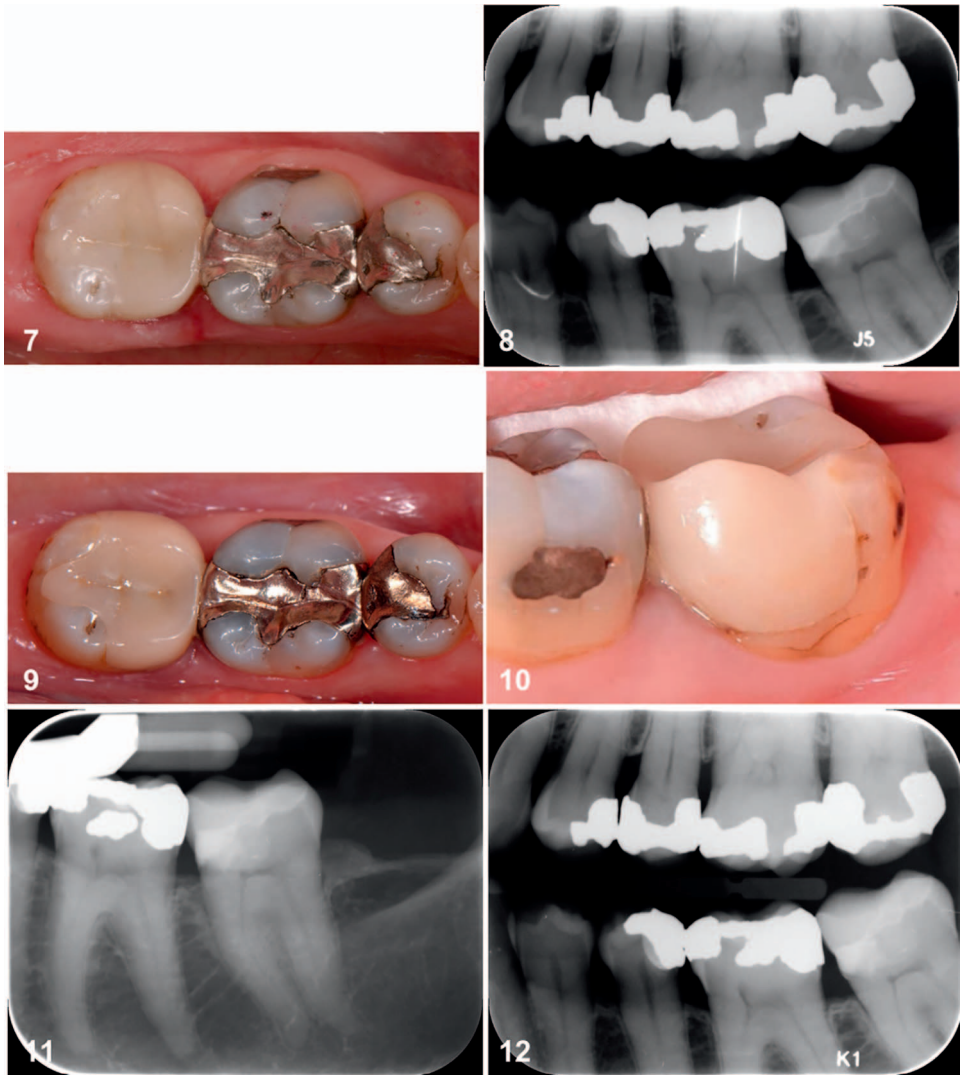

Figure 7. *Onlay after cementation and polishing.*

Figure 8. *Postoperative bitewing radiograph.*

Figure 9. *Six-year follow-up, occlusal view.*

Figure 10. *Six-year follow up, buccal view.*

Figure 11. *Six-year periapical radiograph.*

Figure 12. *Six-year bitewing radiograph.*

the enamel margins for 10 seconds, after which additional etchant was extended onto the dentin and RMGI base for an additional 10 seconds. The preparation was then thoroughly rinsed for 15 seconds and moisture evacuated using a high volume suction, leaving the preparation slightly moist.

Three coats of a fifth-generation adhesive (Optibond Solo Plus, Kerr Corporation) were applied successively followed by excess removal via high volume evacuation. After the third coat was thinned, the adhesive layer was thoroughly air-dried to remove excess solvent and ensure that no adhesive had pooled in the preparation that could have interfered with seating of the restoration. The dentin surfaces were visually inspected to ensure that a shiny surface was produced, indicating adequate resin infiltration. This adhesive layer was light polymerized for 20 seconds at 1000 mW/cm^2.

Clear resin composite cement (Nexus III, Kerr Corporation) was then applied to the intaglio surface of the restoration and syringed into the preparation and the onlay seated and stabilized while excess resin cement was removed using microbrushes (Kerr Applicators, Kerr Corporation) and unwaxed dental floss. The restoration was subsequently light polymerized at 1000 mW/cm^2 for 20 seconds each from the occlusal, buccal, and lingual surfaces. Glycerin gel was next applied to all margins to eliminate any oxygen inhibited layer and the restoration was again light polymerized for 20 seconds per surface.

The rubber dam was removed and occlusion checked again, followed by minor adjustment and polishing using the same fine grit diamond bur and polishing points. The final polish was completed with diamond polishing paste (Dialite Intra-Oral Polishing Paste, Brasseler USA) applied with a prophy cup (Figure 7). A post-cementation bitewing radiograph (Figure 8) was taken to verify complete seating and removal of all residual composite resin cement.

The restoration has been followed with annual visual exams and biennial bitewing and periapical radiographs for six years (Figures 9 through 12). The patient has remained asymptomatic with no evidence of caries, fracture of the tooth or restoration, periodontal inflammation, or pulpal pathology.

DISCUSSION

For the restoration described, the principal concern of the authors was the possibility for recurrent caries along the elevated mesial margin. Although evidence is limited to *in vitro* bond strength studies,[14,15] the authors considered an RMGI restorative material for this margin, which was placed on stained and partially demineralized dentin, to have the best prognosis. Although a conventional glass ionomer restorative material could have been used just as effectively in terms of its adhesion to dentin, an RMGI restorative material was selected for margin elevation over conventional glass ionomer due to the ability to develop a covalent bond between the RMGI and the resin cement used for adhesively bonding the ceramic onlay. Over the course of six years, there have been no recurrent caries, so this choice appears to be justified.

A second concern of the authors was that extension of the restoration into the gingival sulcus to this extent would provoke periodontal inflammation. The wish to minimize adverse periodontal effects led to the choice not to extend the proximal margin completely beyond the dark-stained root dentin, which likely would have placed the restoration margin into the periodontal attachment, and to the choice of margin elevation, which lessens the need for tissue retraction near the attachment associated with impression taking for an indirect restoration margin. The lack of bleeding on probing of periodontal tissue in the area of the restoration margin in this patient over six years tends to support these choices. The authors concur with other recent articles that recommend margin elevation more highly than periodontal crown extension surgery[5] for clinical situations like that of the patient reported here and believe that this strategy has been successful thus far in this patient.

The authors do not regret leaving the distal cusps, which appeared sufficiently strong and intact, and the performance of this relatively conservative restoration tends to support this choice. The selection of a lithium disilicate ceramic, rather than a stronger zirconia restoration, was based on the author's belief that optimal resin bonding to the ceramic was necessary to stabilize this restoration and was therefore a higher priority in this case than strength of the ceramic. Lithium disilicate, when of sufficient thickness and bonded with a resin cement, should withstand normal occlusal forces and provide good longevity. A gold onlay restoration would also have been an appropriate choice, but the patient declined a metal restoration.

Finally, the authors acknowledge that a direct cusp-replacement resin composite restoration could have been placed in this tooth after margin elevation. Although of higher initial cost, the ceramic restoration selected is more wear resistant and allowed the design of a more favorable restoration in terms of the proximal contact than was probably feasible with a direct restoration. Both alternatives were explained to the patient, who concurred with the choice of a ceramic restoration.

One consideration for future similar cases would be the placement of the RMGI in a thinner layer at the cervical margin. This modification would allow the emergence profile of the indirect restoration to begin at a slightly more cervical level, thereby providing a more convex contour of the restoration up to the contact zone. Providing this continuous convex surface would reduce the risk of an open gingival embrasure that could result in food entrapment possibly leading to recurrent caries if proper hygiene was not maintained. However, in this case, the restoration was successful, and the patient has not experienced food impaction or secondary decay.

SUMMARY

The elevation of an extensive interproximal amalgam-stained dentin margin with RMGI, done without periodontal surgery, followed by restoration with a lithium disilicate onlay as described in this clinical report, has been an effective treatment over six years. Providing conservative treatment whenever possible when restoring compromised teeth conforms to the main goals of restorative dentistry: conservation of tooth structure and supporting tissues and maintenance of pulpal vitality, all of which have been accomplished in this case.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Dental College of Georgia at Augusta University.

Conflict of Interest

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

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