

## Clinical Research

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# Increasing the Longevity of Restorations by Minimal Intervention: A Two-year Clinical Trial

G Moncada • E Fernández • J Martín  
C Arancibia • I Mjör • VV Gordan

### Clinical Relevance

Treating defective restorations with sealants, repair or refurbishing is an effective way to preserve and treat existing restorations.

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Gustavo Moncada, DDS, chairman of Operative Dentistry, Operative Dentistry Department, University of Chile, Santiago, Chile

Eduardo Fernandez, DDS, Operative Dentistry, Department of Restorative Dentistry, University of Chile, Santiago, Chile

Javier Martin, DDS, Operative Dentistry, Department of Restorative Dentistry, Dental School, University of Chile, Santiago, Chile

Carolina Arancibia, DDS, Operative Dentistry, Department of Restorative Dentistry, Dental School, University of Chile, Santiago, Chile

Ivar A Mjör, BDS, MSD, MS, Dr odont, professor eminent scholar, Department of Operative Dentistry, Health Science Center, College of Dentistry, University of Florida, Gainesville, FL, USA

\*Valeria V Gordan, DDS, MS, MSCI, associate professor, Department of Operative Dentistry, Health Science Center, College of Dentistry, University of Florida, Gainesville, FL, USA

\*Reprint request: PO Box 100415, Gainesville, FL 32610-0415, USA; e-mail: vgordan@dental.ufl.edu

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### SUMMARY

**This investigation assessed the effectiveness of alternative treatments for the replacement of amalgam and resin-based composite restorations. Sixty-six patients (age 18 to 80 years, mean=26.6) with 271 (amalgam [n=193] and resin-based composite [n=78]) defective restorations were randomly assigned to one of five different treatment groups: A) Repair (n=27); B) Sealing of margins (n=48); C) Refurbishing (n=73); D) Replacement (n=42) and E) Untreated (n=81). USPHS/Ryge criteria were used to determine the quality of the restorations. Two calibrated examiners (Cohen's Kappa 0.74) assessed the restorations independently at the beginning of the study (baseline) and at two years after treatment using seven parameters from the USPHS/Ryge criteria (Marginal Adaptation, Anatomic Form, Roughness, Marginal Stain, Occlusal Contact, Secondary Caries and Luster). Results: Two-hundred and fifty-six restorations (178 amalgam and**

78 resin-based composite) were examined at the two-year recall exam. The sealing of marginal defects showed significant improvements in marginal adaptation ( $p<0.05$ ). Refurbishing of the defective restorations significantly improved anatomic form ( $p<0.0001$ ), luster ( $p<0.016$ ), marginal adaptation ( $p<0.003$ ) and roughness ( $p<0.0001$ ). The repair significantly improved anatomic form ( $p<0.002$ ) and marginal stain ( $p<0.002$ ). Replacement showed significant improvements for all parameters ( $p<0.05$ ). The Untreated group showed significant deterioration on marginal adaptation ( $p<0.013$ ). **Conclusions:** The two-year recall examination showed that sealant, repair and refurbishing treatments improved the clinical properties of defective amalgam and resin-based composite restorations by increasing the longevity of the restorations with minimal intervention.

## INTRODUCTION

The replacement of defective amalgam (Am) and resin-based composite (RBC) restorations represents the major part of restorative dentistry in today's general dental practice.<sup>1,2</sup> The main reasons for replacement are secondary caries and marginal defects.<sup>1,3</sup> Frequently, restoration replacement criteria are subjective, where small deviations from ideal concepts determine the replacement, especially in cases where the restorations are clinically acceptable with localized defects.<sup>4</sup> When a restoration is replaced, there is a loss of healthy dental tissue, including areas away from the localized defects, thus increasing the preparation and restoration size.<sup>5-7</sup> The cost of replacing an existing restoration is at least the same as that of the original restoration, and it is probably more costly if indirect restorations are deemed necessary.

The use of alternative treatments for replacements increases the longevity of the defective restorations, reduces the loss of dental tissue and lessens the cost of treatment.<sup>4-8</sup> Available alternative treatments are:

- Repair, defined as removal of part of the restoration, together with the localized defect, followed by restoration of the prepared defect.
- Sealing, defined as the application of a sealant in the non-carious marginal gap.
- Refurbishing, defined as the removal of excess and reshaping of the anatomic form or removal of a surface stain by polishing.<sup>4,8-10</sup>

This study recorded the effectiveness of alternative treatments versus replacement of Am and RBC restorations over a two-year period. The working hypothesis was that repair, sealing and/or refurbishing defective restorations increases their longevity without the need for replacement.

## METHODS AND MATERIALS

### Study Design

This study included 66 patients, ranging in from age 18 to 80 years (mean=26.6), having 271 defective restorations (193 Am and 78 RBC), who were recruited from the Operative Dentistry Clinic at the Dental School, University of Chile. The restorations were randomly assigned to one of five different treatment groups: A) Repair (n=27); B) Sealing of margins (n=48); C) Refurbishing (n=73); D) Replacement of restorations (n=42) and E) Untreated (n=81).

**Inclusion Criteria:** 1) Patients with marginal deficiencies in Am or RBC restorations, who presented at least one Bravo rating but no Charlie rating in any of the clinical characteristics observed in the study (Table 1), 2) patients who were older than 18 years old and 3) those who could read and sign the consent and registration forms.

**Exclusion Criteria:** 1) Patients with contraindications for normal dental treatment because of their medical history, 2) patients who needed special esthetic requirements that could not be resolved with the proposed treatments and 3) those with xerostomia or patients who were taking medication that significantly decreased salivary flow.

**Methodology:** This study was approved by the Ethics Committee of the Research Office of the Dental School at the University of Chile. All patients signed informed consent forms and completed a registration form.

To determine the quality of the restorations, the USPHS (United State Public Health Service)/Ryge criteria was used (Table 1). Two calibrated examiners (Cohen's Kappa 0.74) assessed the restorations independently at the beginning of the study (baseline). If any differences were found between both examiners, a third calibrated examiner (Cohen's Kappa 0.76) was called to make the final decision.

### Treatment Groups

A. Repair: Carbide burs were used to explore the defective margins of the restorations, beginning with the removal of part of the restorative material adjacent to the defect. Once this material was removed, the exploratory cavity preparation then included any stained or soft tooth tissues. For Am restorations, a dispersed phase amalgam (original D: Wykle Research, Inc, Carson City, NV, USA) was used to repair the preparation. Mechanical retention was created inside the existing restoration.

For RBC restorations, a self-priming bonding system was used (Adper Promp L-Pop, 3M ESPE, St Paul, MN, USA), followed by restora-

Table 1: *Ryge USPHS Clinical Criteria*

| Clinical Characteristic  | Alpha                                                                                          | Bravo                                                                           | Charlie                                                                               |
|--------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Marginal Adaptation (MA) | Explorer does not catch or has one way catch when drawn across the restoration/tooth interface | Explorer falls into crevice when drawn across the restoration/tooth interface   | Dentin or base is exposed                                                             |
| Anatomic Form (A)        | The general contour of the restoration follows the contour of the tooth                        | The general contour of the restoration does not follow the contour of the tooth | The restoration has an overhang                                                       |
| Surface Roughness (R)    | The surface of the restoration has no surface defects                                          | The surface of the restoration has minimal surface defects                      | The surface of the restoration has severe surface defects                             |
| Marginal Staining (MS)   | There is no discoloration between the restorations and tooth                                   | There is discoloration on less than half of the circumferential margin          | There is discoloration on more than half of the circumferential margin                |
| Occlusal Contact (C)     | Normal                                                                                         | Light                                                                           | None                                                                                  |
| Secondary Caries (SC)    | There is no clinical diagnosis of caries                                                       | N/A                                                                             | There is clinical diagnosis of caries                                                 |
| Luster (L)               | The restoration surface is shiny and has an enamel-like, translucent surface                   | The restoration surface is dull and somewhat opaque                             | The restoration surface is distinctly dull and opaque and is esthetically displeasing |

tion with RBC restorative material (Filtek Supreme, 3M ESPE).

Rubber dam isolation was used for both Am and RBC restorations.

B. Sealing of Margins: For this group, defective areas were acid etched with 35% phosphoric acid for 15 seconds. A resin-based sealant (Clinpro Sealant, 3M ESPE) was applied over the defective area. The sealant was polymerized with a photocuring unit (Curing Light 2500, 3M ESPE) for 40 seconds. Rubber dam isolation was used for this procedure.

C. Refurbishing: Defective areas of the amalgam restoration were smoothed using carbide burs (#s 12 and 30, Brasseler USA, Savannah, GA, USA). On the occlusal and buccal/lingual surfaces, silicone impregnated points (Brownie/Greenie/Supergreenie, Shofu Dental Corporation, Menlo Park, CA, USA) were used for polishing.

The defective areas, including “flash” of the RBC restorations, were polished with a medium series of aluminum oxide disks or carbide burs, followed by a fine series of aluminum oxide disks and diamond acrylic impregnated points (Diacomp polishing point, Brasseler USA). When the proximal area was affected, the defective areas were smoothed with aluminum oxide finishing strips (Sof-Lex, 3M ESPE).

D. Replacement Group: The defective restoration was totally removed and replaced with a new amalgam (Tytin, Kerr Corporation, Orange,

CA, USA) or RBC restoration (Filtek Supreme, 3M ESPE).

Rubber dam isolation was used for this procedure.

E. Untreated Group: The defective restorations did not receive any treatment.

Digital pictures were taken of all the restorations before and after treatment.

At the two-year recall exam, the examiners performed new calibration exercises (Kappa 0.80) and patients were recalled for evaluation of the restorations. New digital pictures were also taken.

The results for all groups were analyzed with a paired *t*-test to compare the pre- and post-operative conditions using SPSS 11.0.0 (SPSS Inc, Chicago, IL, USA). The significance was set for the 5% level or  $\alpha=0.05$ .

## RESULTS

Of the 66 patients evaluated at baseline, 63 (95%) returned at the two-year recall (256 restorations [94%]). Of the 256 restorations, 178 (70%) were Am and 78 (30%) were RBC (Table 2).

Except for the untreated group, all groups showed greater improvement than deterioration after two

Table 2: *Distribution of the Restorations by Group at the Two-year Recall Exam*

|              | Amalgams   | RBC       | Total (N)  |
|--------------|------------|-----------|------------|
| Repair       | 25         | 17        | 42         |
| Sealant      | 62         | 9         | 71         |
| Refurbishing | 18         | 8         | 26         |
| Replacement  | 21         | 19        | 40         |
| Untreated    | 52         | 25        | 77         |
| <b>TOTAL</b> | <b>178</b> | <b>78</b> | <b>256</b> |

Table 3: Distribution of Restorations That Had a Change in Criteria Between Baseline and Two-year Recall Exam

|              | Improvements | Deteriorations |
|--------------|--------------|----------------|
| Repair       | 13           | 2              |
| Sealant      | 19           | 1              |
| Refurbishing | 24           | 1              |
| Replacement  | 26           | 0              |
| Untreated    | 5            | 24             |
| <b>TOTAL</b> | <b>87</b>    | <b>28</b>      |

years. A total of 115 restorations from all five groups changed between baseline and two-year evaluation: 87 restorations improved and 28 deteriorated (Table 3). Twenty-four of the restorations that deteriorated were from the untreated group.

The repair group showed improvements in all parameters, but they were significant only in anatomy and marginal stain (Figure 1).

In the sealant group, all parameters improved; however, significant improvement occurred for marginal adaptation only (Figure 2).

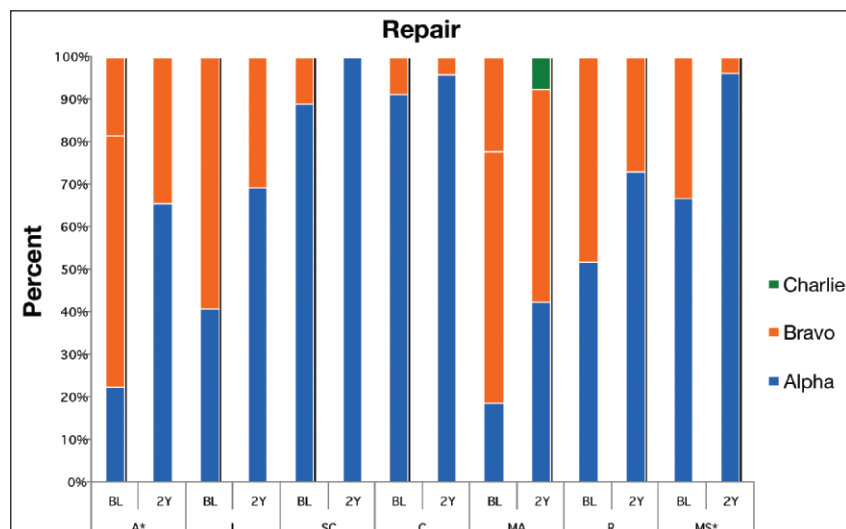


Figure 1: Bar graph illustrating the percentage of restorations in the Repair group, which were either Alpha, Bravo or Charlie at baseline and at two-year recall exam.

\* $p < 0.05$ . (BL: baseline; 2Y: Two-year recall) (A: Anatomic form; L: Luster; SC: Secondary Caries; C: Occlusal Contact; MA: Marginal Adaptation; R: Surface Roughness; MS: Marginal Stain)

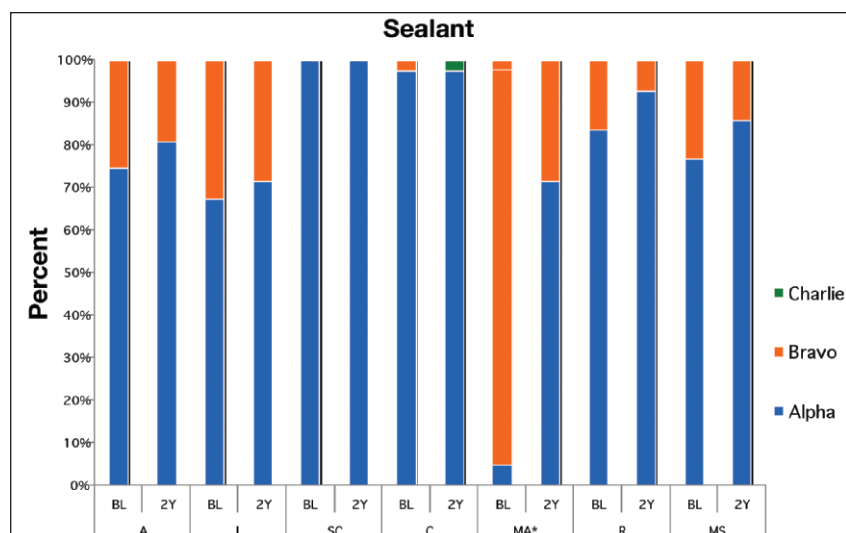


Figure 2: Bar graph illustrating the percentage of restorations in the Sealant group, which were either Alpha, Bravo or Charlie at baseline and at the two-year recall exam.

\* $p < 0.05$ . (BL: baseline; 2Y: Two-year recall) (A: Anatomic form; L: Luster; SC: Secondary Caries; C: Occlusal Contact; MA: Marginal Adaptation; R: Surface Roughness; MS: Marginal Stain)

In the refurbishing group, the parameters for anatomic form, luster, marginal adaptation and roughness improved significantly (Figure 3).

In the replacement group, all parameters, except for marginal stain, improved significantly (Figure 4).

In the untreated group, all parameters, except for secondary caries, showed deterioration and it was significant for marginal adaptation only (Figure 5).

The marginal discrepancies treated by sealing, replacement and repair presented similarly significant improvements ( $p < 0.001$ ).

Figures 6 and 7 illustrate clinical photographs of sealant and repair treatments.

## DISCUSSION

The two-year results of this investigation showed a significant impact on the improvement of the clinical performance of Am and RBC restorations with minimal interventions.

*Sealing of Margins.* Until recently, the marginal failure of amalgam and composite restorations usually resulted in replacement of these restorations. Sealed restorations have been proven to be better than unsealed restorations in preserving tooth tissue and reducing microleakage.<sup>11-12</sup> Additionally, a controversial clinical observation showed that Class I caries can be arrested by adhesive procedures for up to nine years.<sup>13</sup> In this study, only marginal defects were sealed without other treatment, such as preparation with a bur or sandblasting. Similarly, in the current study, sealing of the margins showed significant improvement in the marginal adaptation of Am and RBC restorations during the two-year period. The application of pit and fissure sealant in localized marginal discrepancies represents a conser-



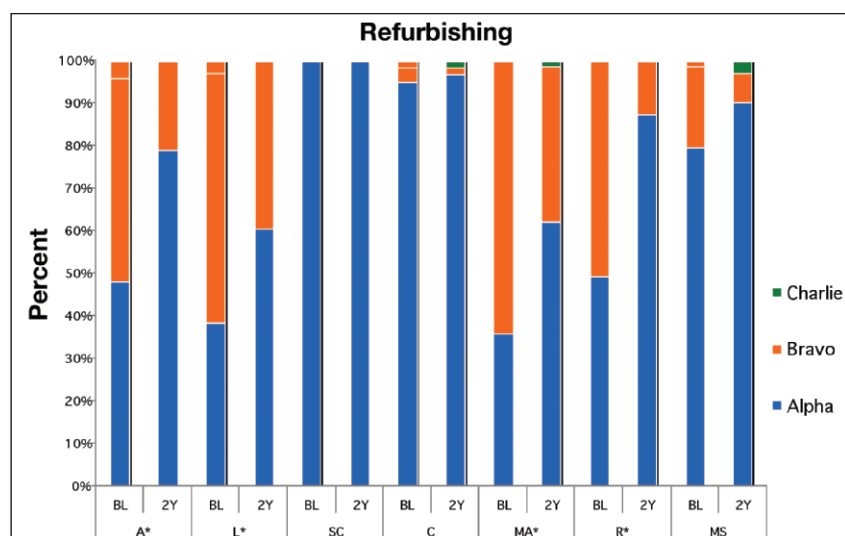


Figure 3: Bar graph illustrating the percentage of restorations in the Refurbishing group, which were either Alpha, Bravo or Charlie at baseline and at the two-year recall exam. \* $p < 0.05$ . Two-year recall) (A: Anatomic form; L: Luster; SC: Secondary Caries; C: Occlusal Contact; MA: Marginal Adaptation; R: Surface Roughness; MS: Marginal Stain)

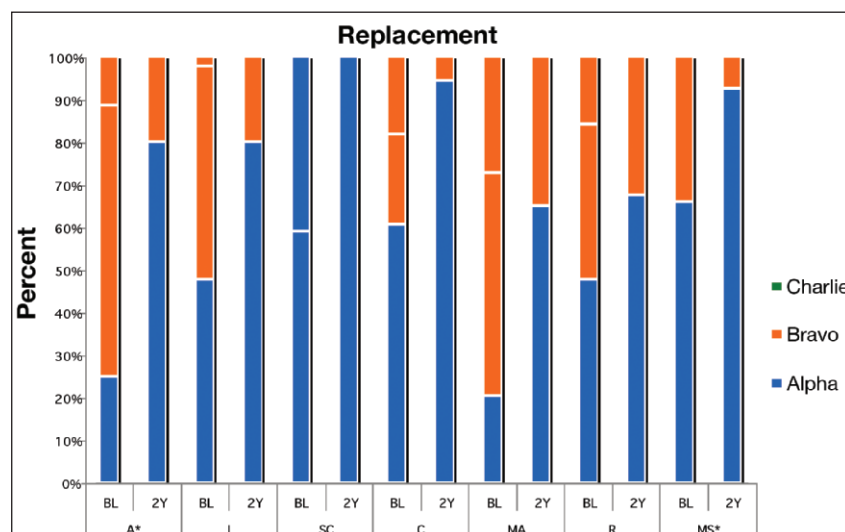


Figure 4: Bar graph illustrating the percentage of restorations in the Replacement group, which were either Alpha, Bravo or Charlie at baseline and at the two-year recall exam. \* $p < 0.05$ . (BL: baseline; 2Y: Two-year recall) (A: Anatomic form; L: Luster; SC: Secondary Caries; C: Occlusal Contact; MA: Marginal Adaptation; R: Surface Roughness; MS: Marginal Stain)

vative choice of treatment and suggests a predictable result based on a two-year observation period ( $p = 0.0001$ ). Marginal integrity was maintained and did not need to be replaced, showing similar results to other studies.<sup>4,8-9</sup>

**Repair.** Studies related to the repair of Am and RBC restorations have been published during the last 15 years.<sup>14-16</sup> However, this technique is often not considered in daily clinical practice, with the explanation being the lack of long-term studies to support repair as

an alternative to replacement. Another study reporting on restoration repair has recently been published; it documents significant improvement in the margins of restorations after two years.<sup>9</sup> The current study supports that repair has significantly improved and maintained the anatomic form ( $p = 0.0001$ ) of defective restorations during the two-year observation period. The other parameters studied were also improved, but not significantly. Thus, restoration repair is considered a reliable, conservative and effective procedure.

Restoration repair is an acceptable treatment and can be taught in dental schools.<sup>4,9,11-13,17-18</sup> In the current study, the repair group showed similar results to that of the replacement, which is a positive result towards preservation of tooth structure.<sup>14</sup> Repair can also be accomplished faster, and the stress on the pulp is minimal and lower than with restoration replacement. Studies have shown that the strength of RBC repair is about half of the original restoration,<sup>17</sup> indicating the necessity to observe those restorations for long periods of time.

**Refurbishing.** When restorations present poor anatomic form, including excess material beyond the cavosurface margin, overhang, minor marginal ditching and surface stain of composite restorations,<sup>18</sup> it is feasible for the restorations to be polished or refurbished. There is no data or long-term results related to this technique to support such performance. The first publication related to the current material indicated that refurbishing could improve the restorations by removing areas of excess at the margins, as in the case of amalgam, which may have suffered expansion over time.<sup>4</sup> Proper contour of the restorations can then be established by removing and polishing the defective area. Thus, an increase in the permanence of the restoration can be obtained by reducing plaque retention and

providing a healthy relationship between the restorative material and adjacent dental structures.<sup>4</sup> In the current study, refurbishing significantly improved various clinical parameters of the defective restorations over the two-year period.

Finally, longevity and methods used to increase the lifetime of dental restorations should be major goals in restorative dentistry, as they include tooth structure preservation, reduction of dental complications,

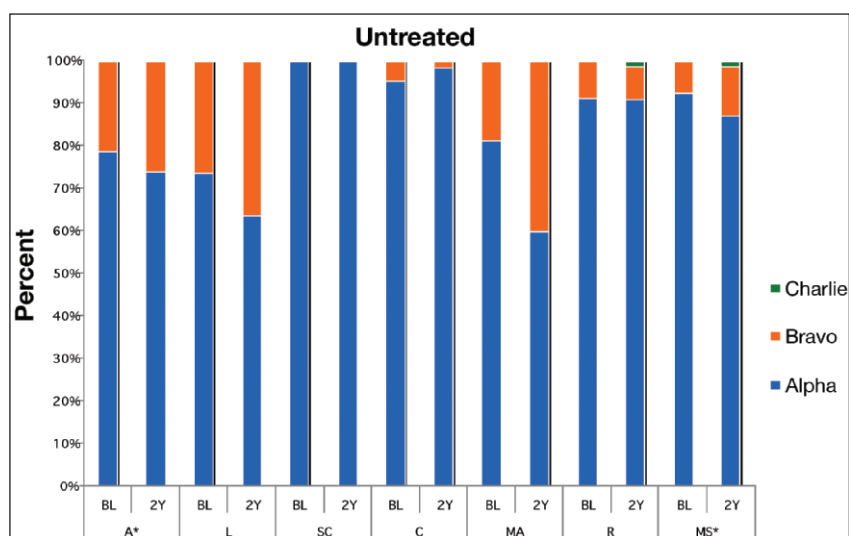


Figure 5: Bar graph illustrating the percentage of restorations in the Untreated group, which were either Alpha, Bravo or Charlie at baseline and at the two-year recall exam.

\* $p < 0.05$ . (BL: baseline; 2Y: Two-year recall) (A: Anatomic form; L: Luster; SC: Secondary Caries; C: Occlusal Contact; MA: Marginal Adaptation; R: Surface Roughness; MS: Marginal Stain)

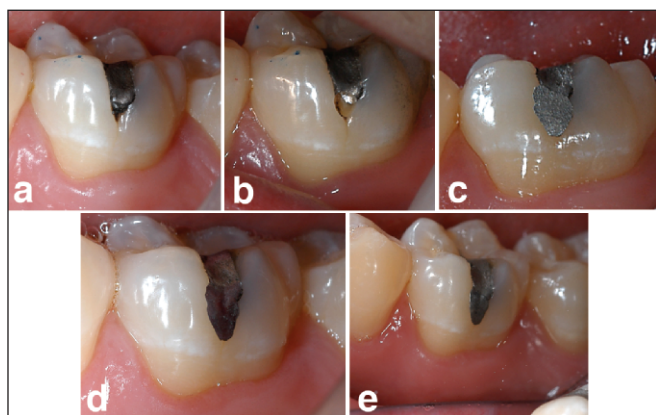


Figure 7: Group of five photographs illustrating a lower first molar with an occlusal buccal amalgam restoration. 7A shows the initial examination, recording bravo on marginal adaptation. 7B shows the removal of part of the restoration, confirming healthy dentin and enamel margins. 7C shows an immediate post-operative amalgam repair. 7D and 7E exhibit the same restoration at one- and two-year recall exams (respectively), recording alpha on both restorations for marginal adaptation.

enhanced positive perception of dentistry by patients and reduced dental treatment cost. Alternative treatments, such as the sealing of localized defects and repairing or refurbishing, are proving to be beneficial in short-term clinical trials. Future research could focus on the long-term outcome of restorative treatments and expand to large communities, including academic institutions, in order to develop the evidence-based criteria needed for each alternative procedure in general practice.

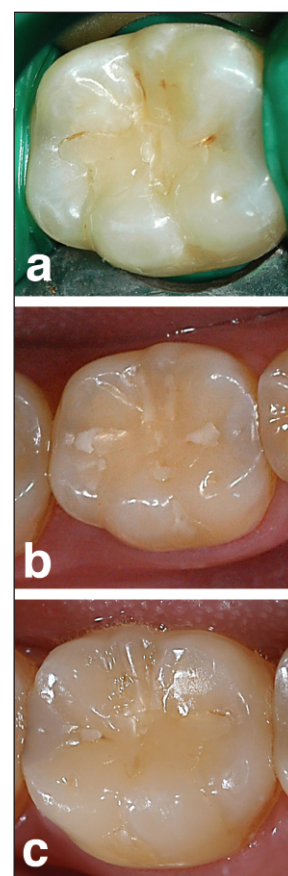


Figure 6: Group of three photographs illustrating three different stages of a lower first molar with an occlusal RBC restoration: 6A exhibits initial examination, recording bravo on marginal adaptation. 6B exhibits the same restoration at one-year recall exam, recording alpha on marginal adaptation. 6C exhibits the same restoration at two-year recall exam, showing partial loss of the sealant on the mesial, while the sealant remained, recording alpha on the buccal, distal and lingual areas.

## CONCLUSIONS

Placing sealants and repairing and refurbishing defective amalgam and resin-based composite restorations increases their longevity with minimal intervention. These procedures represent the most conservative choice of treatment for restorations that are not clinically satisfactory but do not represent complete failure.

Defects related to marginal discrepancy, anatomic form, surface roughness and the marginal staining of restorations can be treated with alternative treatments instead of receiving complete replacement, since these restorations exhibit similar results to that of replacing restorations after two years of observation.

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