Effectiveness of Direct Restorative Materials in Repairing Cast Restorations

T J CARLSON • M A COCHRAN • M R LUND

Summary

Based on SEM analysis, this study presents a criteria for choice of restorative material when the decision is to repair rather than replace a cast restoration. If conditions are not favorable to direct filling gold — amalgam is the best alternative choice for sealing ability — amalgam is an acceptable though less permanent alternative. Restorative resins are unacceptable, since there is no bond between resin and metal.

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INTRODUCTION

The cast restoration is generally considered to be a stable and reliable option in restorative dentistry; however, it may become defective if caries develops at a margin or if the occlusal surface is perforated for an endodontic access. When the defect is not extensive, consideration is frequently given to repair rather than replacement of the casting. This is particularly true if the restoration is an abutment for an existing fixed or removable prosthesis.

Three factors having the greatest influence on the success of a casting repair are: access to the area, ability to attain adequate isolation, and the choice of restorative material. Perhaps the most perplexing and controversial of these has been the repair material itself. Research on the interface leakage of direct restorative materials (Martin, 1981; Hormati & Chan, 1980; Taylor & others, 1959) has generally indicated that direct gold restorations offer superior margin adaptation when properly manipulated. While amalgam and composite resins are widely used for casting repair, their sealing ability and compatibility with gold alloys have been questioned.

The purpose of this study was to utilize scanning electron microscopy to present visual evidence of the integrity of margin interfaces between gold castings and the three commonly used direct repair materials: composite resin, high-copper amalgam, and direct filling gold.

MATERIALS AND METHODS

Fifteen caries-free human canines were selected which had been stored in water immediately following their extraction. All teeth selected were visually free from fractures or craze lines, and were cleaned with a white webbed prophy cup and slurry of pumice.

A one-surface inlay preparation was cut on the facial of each tooth. A #56 bur was used in a high-speed handpiece with an air-water spray coolant. Burs were used for five teeth and then replaced. The preparations were cut 1.5 mm deep and 2 mm x 4 mm in outline. All margins were cut in enamel, and a 45° bevel was placed on the mesial, distal, and incisal margins. The preparations were lubricated, direct wax patterns made, and the teeth replaced in water. All patterns were cast with type III gold.

Just prior to cementation of the inlays, the teeth were dried and two coats of cavity varnish were applied to each preparation. The inlays were cemented with zinc phosphate cement and, following a 30-minute delay, were again placed in water for storage.

At a subsequent time, preparations were cut at the cervical margin of each inlay to simulate a clinical margin repair (Fig 1). The instrumentation was similar to that of the initial preparation. Retentive features were added cervically and incisally to each of the preparations, and all margins except those against the inlays were kept in enamel. Five of the preparations were modified with rounded internal line angles; two layers of cavity varnish applied, and these preparations restored with amalgam (Dispersalloy, Johnson & Johnson Dental Products, East Windsor, NJ 08520, USA) (Fig 2). Five of the preparations had sharpened internal line angles and were restored with direct gold (Goldent, Williams Gold, Buffalo, NY 14214). The remaining five were restored with composite resin (Silar, 3-M Co, St Paul, MN 55144, USA), and the enamel margins were etched with 37% phosphoric acid for 60 seconds and washed with water for 20 seconds. The preparations were then air dried and coated with a thin coat of bonding agent prior to restoration.

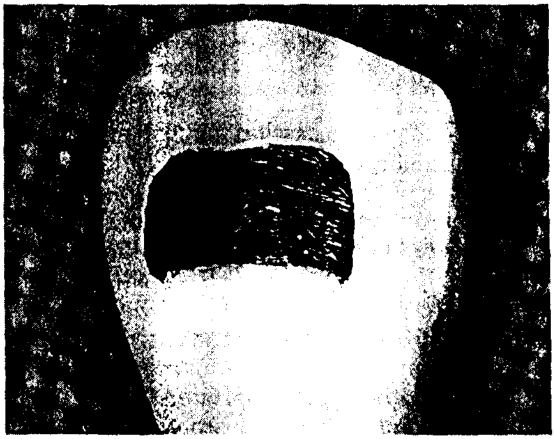

FIG 1. *Typical gold inlay used in this investigation. The cervical margin has been prepared.*

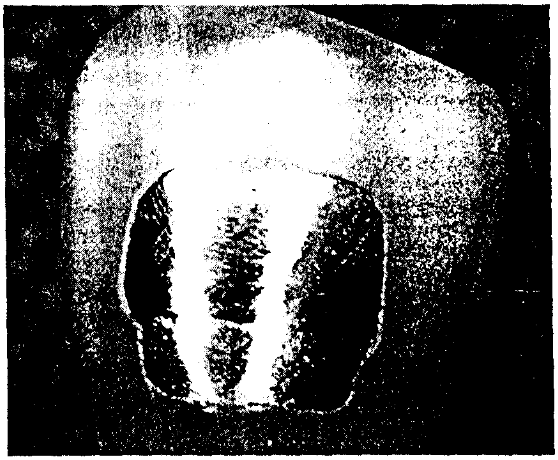

FIG 2. *The same specimen after an amalgam repair has been placed at the cervical margin. The specimen has been polished, but not yet thermocycled.*

All specimens were thermocycled for 3500 cycles at temperatures of 10 and 50 °C. Replicas were made and viewed under a scanning electron microscope at various magnifications to compare their micromorphology and margin adaptation.

RESULTS

Restorations within each category exhibited the same micromorphology and characteristics of adaptation. Figure 3 shows a typical inlay/resin margin; Figure 4, inlay/amalgam; and Figure 5, inlay/direct gold. In all photographs, the cast gold is at the top and the repair material is toward the bottom. The direct gold repairs consistently showed a lack of any visible interface (Fig 5).

FIG 3. *Typical gap formed between the casting (top) and resin.*

FIG 4. *Casting-amalgam interface. A gap is formed, but is filled with corrosion products.*

DISCUSSION

Resin

All of the margins between cast gold and resin demonstrated lack of bonding and all specimens exhibited a gap between the resin and the gold after thermocycling. As expected, the resin bonded with the etched enamel. This pattern would indicate that resin is not an acceptable repair material for cast restorations, since the lack of bonding and resultant open interface between the resin and gold would lead to microleakage and the likelihood of caries.

Amalgam

The amalgam restorations also showed marginal discrepancies after thermocycling, but

FIG 5. *Casting-direct gold interface. This junction was generally not visible even under high magnification. A rough margin is used to highlight the capability of direct gold.*

FIGS 3-5. *Above: Scanning electron micrographs of typical gap, casting-amalgam interface, and casting-direct gold interface. X800 (original magnifications X1000)* these areas were filled with corrosion products which would certainly reduce or eliminate leakage at the repair interface. However, this initially helpful situation actually presents another problem. The dissimilarity between the two metals results in a galvanic reaction that produces excessive corrosion and breakdown in both materials. Although amalgam would provide a better repair than resin, the longevity of the material would be considerably shortened in the corrosive environment of the dissimilar metal interface (Fig 6).

FIG 6. *Although amalgam seals well clinically, this photo illustrates the rapid corrosion from contact with gold.*

Direct Gold

The cast gold/direct gold interface demonstrated the best adaptation of all the repair materials. The compatibility of the materials was obvious under all magnifications, in that the interface was generally undetectable even after thermocycling. Naturally, the use of direct gold requires good isolation, access, and a familiarity with the handling of the material. However, when these conditions are met, direct gold provides the best possible repair material for cast gold restorations.

CONCLUSIONS

Based on SEM analysis of micromorphology and margin adaptation, the recommendations on the selection of a direct repair material for cast gold restorations are:

- Where access and isolation allow, direct gold is the material of choice because of its adaptability and similar composition.

- If conditions exist that are unfavorable to the placement of direct gold, amalgam would be an acceptable alternative since its corrosion products would provide protection against microleakage. However, the patient should be informed that the longevity of such a repair is limited and that the casting will probably require replacement in the future.

- Restorative resins are unacceptable as a repair material for cast restorations since there is no bond between the resin and metal.

(Received 7 April 1986)

References

HORMATI, A A & CHAN, K C (1980) Marginal leakage of compacted gold, composite resin, and high-copper amalgam restorations *Journal of Prosthetic Dentistry* **44** 418–422.

MARTIN, D W (1981) Interface leakage in microfilled composites, amalgam, conventional composites and gold foil: a comparative in vitro study *California Dental Association Journal* 9(8) 33–39.

TAYLOR, J B, STOWELL, E C JR, MURPHY, J F & WAINWRIGHT, W W (1959) Microleakage of gold foil fillings *Journal of Dental Research* Abstract No 218 **38** 749.

Effectiveness of Direct Restorative Materials in Repairing Cast Restorations

By T J Carson, M A Cochran, M R Lund. Oper. Dent.11:143-146. Autumn 1986.

The purpose of this study was to present visual evidence of the integrity of the three materials used commonly to repair cast restorations *(composite resin, high-copper amalgam, and direct filling gold).*

Materials and Methods

15 caries-free' human teeth were selected which had been stored in water immediately after their extraction. An inlay preparation was performed on the facial of each tooth *1.5mm* deep and *2mm* x *4mm* in outline, all margins were in enamel. Direct wax patterns made and were casted with type *III* gold. The inlays were cemented with zinc phosphate cement and , following *30min.* delay, wereagain placed in water for storage. Later on, preparations were cut at the cervical margin of each inlay to simulate a clinical margin repair. Retentive features were added cervically and incisally and all margins were kept in enamel *(except those against the inlay).* Five preparations were restored with amalgam, five of the preparations were restored with direct gold, and the remaining five were restored with composite. All specimen were thermocycled for *3500* cycles at temperatures of *10* and *50·C.* Replicas were made and viewed under scanning electron microscope.

Results and Discussion

After thermocycling, each category exhibited the same micromorphology and characteristics of adaptation.

In case of the resin restorations, all specimen exhibited a gap between the resin and the gold due the lack of bonding between the two restorations. This would lead to microleakage and a possibility of caries.

In case of amalgam restorations, there was a gap between the amalgam and the cast restoration but this gap was filled with corrosion products which reduced or eliminated the leakage. But the galvanic reaction between the gold and the amalgam will accelerate the corrosion process leading to shortened longevity of the amalgam restoration.

The direct gold restoration showed the best adaptation to the cast restoration. The interface between the two restorations was generally undetectable. The use of direct gold requires good isolation , access, and familiarity with the handling of the material.

Conclusions

In direct repair for cast restorations, restorative resin are unacceptable as a repair material. The direct gold is the material of choice provided that we have good isolation and access. If the direct gold can not be used ,for any reason, amalgam is the second choice, however, the patient should be informed that the casting will probably require replacement in the future.

[Effectiveness of Direct Restorative Materials in Repairing Cast Restorations]

Carlson, T.J., Cochran, M.A., Lund, M.R. Oper Dent 11(4):143-7, Autumn 1986

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P:

___ *To utilize scanning electron microscopy to present visual evidence of the integrity of margin interface between gold castings and the three commonly used direct repair materials: composite resin, high-copper amalgam, and direct filling gold.*

M&M:

One surface inlay preparation was cut on the facial of each tooth. All margins were cut in enamel . At a subsequent time preparations were cut at the cervical margin of each inlay to simulate a clinical margin repair .
Five of the preparations were restored with amalgam. Five with direct gold, and the remaining five were restored with composite resin.

R:

* *All margins between cast gold and resin demostrated lack of bonding and all specimens exhibited a gap between the resin and the gold after thermocycling.*
* *The amalgam restorations also showed marginal discrepancies, but these areas were filled with corrosion products which would certainly reduce or eliminate leakage at the repair interface. Also galvanic reaction may occure between the two metals .*
* *The cast gold / direct gold interface demonstrated the best adaptation of all the repair materials.*

> DIRECT GOLD PROVIDES THE BEST POSSIBLE REPAIR MATERIAL FOR CAST GOLD RESTORATIONS.
> AMALGAM WOULD BE AN ACCEPTABLE ALTERNATIVE SINCE ITS CORROSION PRODUCTS WOULD PROVIDE PROTECTION AGAINST MICROLEAKAGE.
> RESTORATIVE RESINS ARE UNACCEPTABLE AS A REPAIRE MATERIAL FOR CAST RESTORATIONS SINCE THERE IS NO BOND BETWEEN THE RESIN AND METAL.

Hakam Mousa

FIG 5. *Casting–direct gold interface. This junction was generally not visible even under high magnification. A rough margin is used to highlight the capability of direct gold.*

FIGS 3-5. *Above: Scanning electron micrographs of typical gap, casting–amalgam interface, and casting–direct gold interface. X800 (original magnifications X1000)*

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