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# BASE SOLUBILITY AND MARGINAL SEALING IN AMALGAM RESTORED TEETH

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Marginal leakage between freshly packed dental amalgam restorations and the cavity wall decreases with time due to the development of a marginal seal which fills the space at the tooth-amalgam interface [1]. It is believed that this seal develops in part from dental materials used in cavity preparation such as the base, varnish and amalgam [2]. The role which the base plays in sealing is obscure. It could be that the disintegration which this material undergoes in the mouth physically blocks the marginal gap. This *in vitro* study was undertaken to investigate the effect of base solubility on marginal seal development and composition with time.

Occlusal cavities were cut in 192 caries-free extracted human teeth. Cavities were lined with one of four bases, which were either predominantly of calcium hydroxide or zinc oxide. The zinc oxide base is hard and insoluble when mixed with eugenol (ZOE) or soluble when mixed with distilled water (ZO). Similarly the calcium hydroxide containing base is insoluble as Dycal$^{R}$ (DY) or soluble when calcium hydroxide is mixed with distilled water (CAL). A varnish was applied to half of the cavities followed by restoration with a low copper amalgam (Cu(low)) to produce 8 treatment combinations. The teeth were stored in 1% NaCl and thymol for 7 days, 3 months and 1 year at 20°C where after a standard fluorescent dye marginal leakage test was performed. These results were subjected to a SAS Linear Logistical Statistical Analysis (CATMOD). Two specimens of each 3 month and 1 year group were fractured to expose the restoration and cavity surfaces which were covered with marginal seal material. Quantitative area analysis was performed on both these surfaces using a peak-background routine to determine the elemental composition of the seal material. Viewing of the specimen took place in a JSM 840 scanning electron microscope equipped with a LINK AN10000 energy dispersive x-ray analyser. The analysis conditions were set at an operating voltage of 20kV, a count rate of 2800 counts/sec and a live counting time of 100 sec. In between each two analyses a reference spectrum was recorded from the cobalt standard in order to calibrate the energy scale. Peak to background ratios were obtained for each element and percentage elemental composition was then calculated for each analysis. The data was statistically analysed with one way ANOVA and Tukey's test using the General Linear Models Procedure. The critical level of significance was chosen at $p < = 0.05$ for all statistical procedures. Similar analyses were carried out on all the dental materials used as well as on the cut tooth cavity surface to obtain reference spectra to serve as comparative standards.

The marginal leakage results are listed in Table 1. With time there was a significant increase in marginal sealing in the CAL specimens, whether varnish was used or not. A marked decline in sealing with time was noted in the DY based specimens which was statistically significant. There was a significant difference in sealing between the two calcium hydroxide based specimens at 3 months and 1 year in both the varnished and unvarnished state. At 7 days only the varnished calcium hydroxide based specimens differed significantly between the two treatments. No significant difference was apparent between sealing and base solubility in the zinc oxide based specimens, which showed very little sealing overall. The Ca content of the marginal seal in the calcium hydroxide based experimental group differed significantly in the 3 month specimens only. When the seal was analysed on the amalgam the %Ca was 25.3% in varnish + CAL + Cu(low) and 3.0% in varnish + DY + Cu(low). The seal material as analysed on the tooth in unvarnished CAL + Cu(low) and DY + Cu(low) specimens was 41.2% and 58.0% respectively. No significant difference was found in the Ca content of the seal between the 1 year CAL and DY specimens. Only the specimen varnish + CAL + Cu(low) showed a significant difference in Ca content in the marginal seal over time. Percentage Ca decreased from 25.0% in the 3 month specimen to 9.9% at 1 year. There was no significant difference in the Zn content of the marginal seal material in any of the zinc ι xide based specimens examined.

In the calcium hydroxide specimens it appears that base solubility could promote marginal sealing as this improved in all CAL specimens over time. However, if the more soluble CAL did physically block the marginal gap, one would expect the Ca content of the marginal seal to increase with time rather than decrease or remain the same as was the case. Solubility of the base appears to play no role in the ability of the zinc oxide based specimens to seal the amalgam restored cavity. It is concluded that the role of the base in affecting marginal sealing is not one of physically blocking the gap at the tooth-amalgam interface.

Table 1
Percentage seal obtained in tooth specimens.

| Restoration combination | Percentage seal 7 day | 3 month | 1 year |
|---|---|---|---|
| Varnish +DY + Cu(low) | 91 | 31 | 12 |
| Varnish +CAL + Cu(low) | 33 | 62 | 68 |
| DY + Cu(low) | 58 | 18 | 25 |
| CAL + Cu(low) | 66 | 87 | 100 |
| Varnish +ZOE + Cu(low) | 8 | 6 | 18 |
| Varnish +ZO + Cu(low) | 0 | 6 | 12 |
| ZOE + Cu(low) | 0 | 12 | 37 |
| ZO + Cu(low) | 8 | 43 | 6 |
| n | 6 | 8 | 8 |

References
1. Going, R.E. (1979) JADA 99, 646.
2. Grossman, E.S., Witcomb, M.J. and Jodaikin, A. (1986) J. Dent. Res. 65, 998.