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A Scanning Electron Microscope Study of One Year *In Vivo* Amalgam–Enamel Interfaces

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Abstract

The purpose of this study was to compare the margin integrity of burninshed and polished dental amalgams in vivo. *Twenty patients each received one burnished and one unburnished polished amalgam. Each amalgam was placed, burnished, or polished according to conventional, contemporary techniques. After one year, an impression was made using silicone and replicated with araldite. The margins were studied from photomicrographs of the replica using a scanning electron microscope. The results indicated that closed margins were more prevalent in the burnished, compared to the unburnished polished amalgam.*

Introduction

Burnishing of amalgam restorations traditionally has been considered to be a detrimental procedure. It was generally thought that a surface rich in mercury would be created by burnishing and that this surface would exhibit inferior physical properties.

Jorgensen and Saito[1] studied the marginal structure of amalgam restorations. They reported that the optimal structure of the margins was obtained by overfilling and burnishing the margins, and the subsequent removal of the excess alloy by carving. Their findings showed far less porosity in burnished margins than in unburnished specimens.

Fusayama and others[2] studied surface roughness of amalgam using a surface analyzer and found that:

1. Immediate burnishing after carving decreased the surface roughness so that it may not need later finishing.
2. Finishing and polishing greatly reduced the surface roughness produced by carving.
3. Surfaces burnished immediately after insertion were smoother than finished surfaces of carved amalgam.

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Kato and others[3] in a study of the effects of burnishing the marginal seal using a red dye aerosol capable of penetrating a space 2 microns wide found that all unburnished amalgam margins leaked. Specimens burnished once showed less leakage and those alloys burnished twice did not show any marginal dye leakage. Russo et al.[4] used radioisotopes to study the effects of burnishing and polishing on marginal leakage of amalgam. They reported that burnishing improved the marginal seal after 48 hours and the seal was maintained after 78 days.

A mercury emission study by Teixeira et al.[5] using mercury printings showed that burnishing noticeably reduced mercury vapor dissipation, especially at the marginal areas of the sample. Polishing after burnishing resulted in the absence or almost complete absence of mercury vapor printings. Chan and Svare[6] reported in another mercury vapor emission study that mercury vapor emission intensity was greatest at the margin of the specimens tested. They could not show a statistically significant difference between the amount of vapor emitted and burnished amalgam specimens.

Svare and Chan[7] studied amalgam corrodability using anodic polarization data comparisons and found a statistically significant difference between the corrosion rates of burnished amalgam restorations and those that were polished or those that were left unpolished. The burnished amalgams were physically improved over those that were polished or left unpolished.

From the studies cited, burnishing seems to improve the initial seal of the restoration and produces a denser, smoother surface which is not mercury rich. Experiments have shown the marginal areas to be actually denser and relatively mercury poor.[8,10-23]

The purpose of this study is to test the hypothesis that burnished amalgam restorations are superior to non-burnished amalgam restorations after one year of clinical performance.

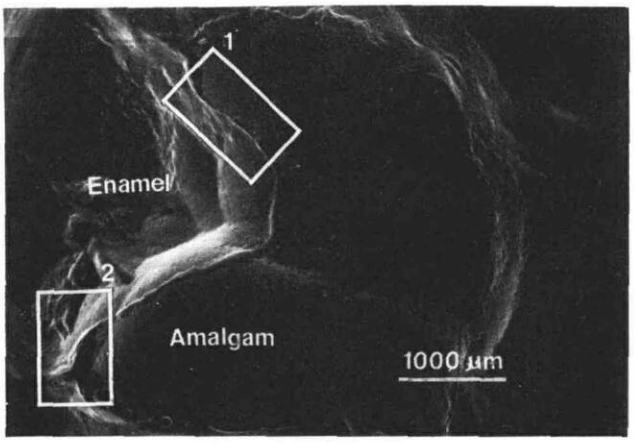

Figure 1. A SEM photomicrograph of a dental amalgam in situ. Area 1 shows a length of closed margin and area 2 a length of open margin.

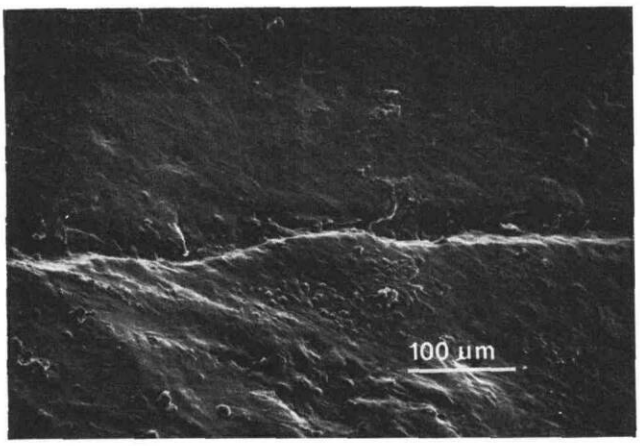

Figure 3. A higher magnification SEM photograph of the open margin indicated by area 2 in Figure 1.

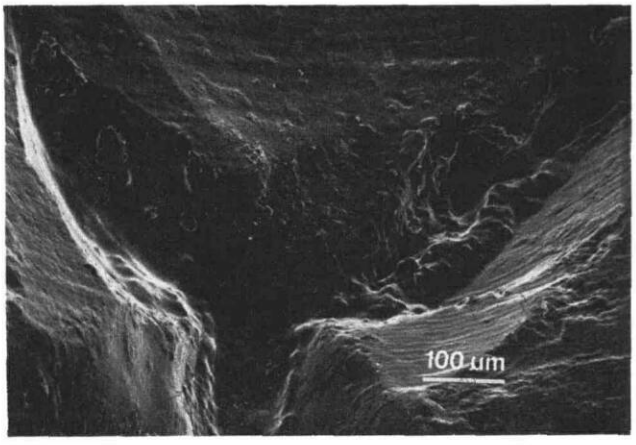

Figure 2. A higher magnification SEM photomicrograph of the closed margin indicated by area 1 in Figure 1.

Methods and Materials

Twenty patients were used in this study. A class I preparation was made in two teeth per patient using a #330 pear-shaped burr extending into all pits and fissures, allowing the cavo-surface margin in a smooth surface. Each preparation was restored with an amalgam.° One tooth was prepared in each of two quadrants, one of the placed amalgams was burnished and the other was not burnished. The burnishing was done after the initial carving was completed. Any flash of alloy which would be noted after burnishing was removed with a carving instrument. The burnishing was done with an egg-shaped burnisher.°° The carving was completed with a Walls carver.°°° The amalgam was polished not before 24 hours or after two weeks. A 12-blade flute polishing burr was used followed with a rubber cup and pumice. All restorations were closely examined for any visible defects.

After one year, a silicone°°°° impression was made of each restoration using the standard putty/neline technique.

The impression was then poured with Araldite,° as described by Barnes.[9] The poured impression containing the Araldite was placed in a dry oven at 68° centigrade for 24 hours to insure a complete set. Once all the specimens had been collected, they were prepared for viewing in the SEM.

Assessments were made of the margins viewed from the Polaroid photomicrograph picture taken on the scanning electron microscope. The margin length was measured with a map tracing instrument noting the total length and the margin length which was open. The clinical judgment of the investigator was used to determine which portion of the amalgam enamel interface was open or closed on the photomicrograph. A representative example of the photomicrographs from which measurements were made appears in Figure 1. The area represented within the square identified as 1 in Figure 1 was recorded as closed margin. Likewise, the area represented within the square iden-

° Dispersalloy, dispersed phase alloy, Johnson & Johnson Dental Products Company.

° CY 212 Resin, 2 ml; HY 964 Hardener, 2 ml; DY 064 Accelerator, 12 drops; Plasticiser, 3 drops.

°° S. S. White in U.S.A., Tarno burnisher, #29.

°°° S. S. White in U.S.A., Tarno Walls carver #3.

°°°° Xantopren Blue, Type III Silicone Base, Class 3 light-bodied, Unitek.

TABLE 1. Open versus closed margins in one year IN VIVO dental amalgams among burnished and non-burnished polished specimens

	Burnished	%	Non-Burnished Polished	%	Combined Groups	%
Total circumference	21.86		22.3		22.12	
		38		59*		50
Open circumference	8.21		13.2		11.15	

*Significantly larger F1.32= 86.28 p .0001 (Using the standard arcsine transformation for ratios).

tified as 2 in Figure 1 was recorded as open margin. Figures 2 and 3 respectively demonstrate more clearly the closed and open area previously identified and enlarged. Percentages were calculated from the measurements.

Results

Thirty-eight percent of the margins appeared to be open in the burnished amalgam, where fifty-nine percent of the margin appeared to be open in the non-burnished polished amalgam. Twenty-one percent more of the burnished amalgam-enamel interface was closed when burnished as opposed to non-burnished. The results can be interpreted from Table 1.

The author determined the reliability of the measurements by measuring the photos a second time. The Pearson product moment correlations of the measurements were for total circumference $r=.92$, $p=<.0001$, and for the open circumference $r=.92$, $p=<.0001$.

Discussion

Investigators conducting research on amalgam *in vitro* have indicated that the physical properties of the restorations can be improved with burnishings. This study was conducted on amalgam *in vivo* and supports the findings of those completed in the recent past *in vitro*.

It was anticipated there would be difficulty in identifying the quality of the enamel alloy interface since the impression was made in silicone rather than Formvar as suggested by Barnes.[9] The silicone impressions were of high quality and reproduced the interface with great detail which was demonstrated by the scanning electron microscope. The difficulties encountered with the use of the model material probably contributed most to obliteration of the specimens. Because of these difficulties, sixteen of the specimens had to be discarded, and could not be viewed as the margin was destroyed or unrecognizable as a result of a poor pour. Although 16 specimens were discarded, 11 of which were burnished and five nonburnished, it was not felt the results were affected. Only the specimens which had been accurately reproduced and easy to view or read were used in the study.

This form of research should be continued in the primary dentition, using a large population in view of attrition. The experimental design should then include a request that parents return the primary tooth to the investigators for direct viewing after it has exfoliated. The results would be more accurate and eliminate the impression and Araldite portion of the research.

The consequence of viewing the actual tooth would not only give more accurate results, but data could be compared to the replica technique from which a more thorough knowledge of reliability could be documented.

Conclusion

This *in vivo* study appears to support previous *in vitro* studies. The amalgam restorations which were placed and burnished appeared to be of better quality and a greater percentage of the margin (amalgam-enamel interface) was closed over those amalgams that were not burnished, but polished after one year, Therefore, it would be recommended to rountinely burnish all amalgam restorations when placed.

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