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ANALYSES OF MARGINAL SEALS IN AGED AMALGAM RESTORATIONS USING EXTRACTION REPLICAS

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Since dental amalgam does not bond chemically to tooth structure, a microcrevice is present at the amalgam/tooth interface of a freshly placed restoration. This gap is of sufficient width to allow fluids and microorganisms to pass along the cavity walls and thereby facilitating the recurrence of dental caries, which accounts for the majority of amalgam restoration replacements[1]. However, during the first few weeks after placement, a seal derived from amalgam corrosion products[2] and probably oral and dietary substances develops at the amalgam/tooth interface. This seal reduces the leakage of salivary constituents along the restoration margin and thus plays a role in preventing the occurrence of secondary caries. In order to create conditions for speedy seal development, it is paramount to know the composition of the seal. All previous X-ray microanalysis studies on the composition of the marginal seal[3-5] have been performed on bulk specimens where electron beam scattering on and in the sample can cause the generation of X-rays from areas neighbouring the seal. To overcome errors due to this interference, this study employed extraction replicas to remove marginal seal material from aged amalgam/tooth interfaces, this material subsequently being analysed by X-ray analysis.

Ten non-carious teeth with occlusal amalgam restorations which were removed for periodontal reasons were rinsed briefly under running tap water after extraction and dried in an incubator at 37°C. The roots of the teeth were mounted in resin blocks and the crown partially sectioned on three sides with a low speed, watercooled, diamond blade, rotary saw so as to facilitate a fracture perpendicular to the amalgam/tooth interface. The fractured teeth were lightly coated with high purity carbon and examined at 20kV in the SEM. Energy dispersive X-ray analysis was carried out on the tooth, base, amalgam and seal material found at the dentine and/or enamel/amalgam interface. Thereafter a dam of silicon material was built in the fractured area to surround only the amalgam/tooth interface. A 10% solution of nitrocellulose was dripped carefully into the dam and allowed to dry to form a replica. The replica was stripped from the tooth, mounted, coated with high purity carbon and the extracted seal material found along the tooth/amalgam interface analysed. Percentage elemental composition was calculated for all the analyses thus obtained.

The teeth were composed largely of Ca and P with small amounts of Na, Cl and Mg. All teeth contained a base consisting primarily of Zn, Ca and P. All ten amalgams contained Hg, Sn and Ag, nine contained Cu

and eight Fe. The marginal seal appeared as either a continuous layer or as clumps of powdery material along the amalgam/tooth interface. Table I lists the elements found in the seal material in the teeth and replicas. The predominant elements in both the teeth and replica marginal seals were Sn, P, Ca and Zn.

The results obtained in this study are similar to other reports[3-5] on the elemental composition of the marginal seal. It has been established that the Sn-containing phase in the amalgam is more corrosion-prone and the high levels of Sn in the seal confirm this. The Ca, P, S and Cl present at this junction probably originate from the oral environment. However, Ca, P together with Zn were present in the bases found in the tooth specimens. Although the effect of bases on marginal seal formation remains largely unreported[6] the very high levels of Zn found in the seals of this study would suggest that bases could play an active role in seal development. Sarker et al[5] found Hg in varying amounts on all corrosion surfaces examined. The present investigation revealed that although Hg was present in the seal of five tooth specimens, the corresponding seals in the replicas did not exhibit any Hg. This result appears to confirm the opinion of Sarker et al[5] that the Hg peaks detected in their investigation originated from the underlying amalgam. This difference found between marginal seal material on the tooth and the replica suggest that future studies on marginal seal development should be carried out using extraction replicas to ensure accuracy of analysis. The elemental variations found in the marginal seals may have resulted from clinical restorative material differences (Cu), dietary factors (S), oral and operative variables (eg. Fe from blood). This highlights questions such as which materials are optimum and whether the presence of elements such as Fe, Cl and S at the interface are advantageous. This study has moved towards characterising the seals in order to facilitate clinical studies determining which types of seals enhance the retention of amalgam restorations, a perspective which has been largely neglected although dental amalgams have been used extensively for more than a century.

Table I : The number of teeth and replicas showing the presence of different elements in the marginal seal.

Seal	Elements present								
Tooth	10Sn	10P	9Cl	9Ca	8Zn	7S	6Cu	5Fe	5Hg
Replica	10Sn	10P	7Cl	7Ca	7Zn	5S	4Cu	5Fe	

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