Dental Amalgam Update—Part II: Biological Effects

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Dental amalgam restorations have been controversial for over 150 years. In Part I of this Critical Appraisal, the clinical efficacy of dental amalgam was updated. Here in Part II, the biological effects of dental amalgam are addressed.

Dental Composite Restorations and Psychosocial Function in Children

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ABSTRACT

Objective: The objective of this study was to determine whether resin-based composite restorations or dental amalgam restorations are associated with psychosocial problems in children.

Materials and Methods: Of 5116 children aged 6 through 10 screened as part of the New England Children's Amalgam Trial, 596 children with no amalgam restorations and with at least two carious posterior teeth requiring restoration were eligible to participate. Parental consent and children assent was given for 534 children with no parent-reported physician-diagnosed psychological, behavioral, neurologic, psychological, immunosuppressive, or renal disease. Treatment plans were randomized between amalgam and composite restorations for posterior teeth. For teeth requiring composite restorations, primary teeth were restored with compomer (Dyract AP, Dentsply Caulk, Milford, DE, USA) and composite in permanent teeth (Z100, 3 M ESPE, St. Paul, MN, USA). Z100 composite has been shown to release bisphenol A (BPA), bisphenol A-glycidyl methacrylate (bisGMA), bisphenol A-dimethacrylate (bisDMA), and BPA diglycidylether. The urethane dimethacrylate (UDMA)-based compomer Dyract does not release detectable BPA or bis GMA. Children assigned to the amalgam group received Dispersalloy (Dentsply Caulk) amalgam restorations. The children were administered a Child Behavior Checklist (CBCL) parent report and the Behavior Assessment for Children Self-Report (BASC-SR) as a baseline and at follow-up. These assessments are widely used for screening children and adolescents for psychosocial problems, and the examiners were trained and supervised by a psychologist during the study.

Results: Of the original 534 children, 434 were available for follow-up, 217 in the composite group, and 217 in

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the amalgam group. The compomer had no significant or consistent association with BASC-SR or CBCL scores. Greater bis-GMA-based composite exposure, on the other hand, was related to higher BASC-SR scores on Emotional Symptoms and Clinical Maladjustment, and lower scores on Personal Adjustment. There were also significant linear trends for depression, attitude to school, and interpersonal relations. For each additional 10 posterior-occlusal-surface-years (e.g., 2 surfaces in the mouth for 5 years), there was a significant reduction in BASC-SR Personal Adjustment score of 2.2 points versus 0.8 points for total surface-years. There was no relationship between amalgam or compomer group and psychosocial function.

Conclusions: Greater exposure to bis-GMA-based composite restorations was associated with unfavorable psychosocial outcomes in children. Cumulative exposure to posterior occlusal composites was associated with poorer psychosocial outcomes than overall composites. Exposure to dental amalgam or compomer restorations was not associated with detrimental psychosocial problems in children.

COMMENTARY

Resin-based composite restorations may release bisphenol A (BPA) and other chemical components. Amalgam restorations release small amounts of mercury. Chewing can increase degradation of amalgam or composite restorations. Cumulative exposure to amalgam restorations that include the occlusal surface is associated with higher urinary mercury levels long after initial placement. Cumulative exposure to resin-based composite restorations that include the occlusal surface may be associated with higher levels of BPA exposure. In this study, cumulative exposure to resin-based composite restorations was associated with poorer psychosocial outcomes than such exposure to amalgam or compomer restorations. The relationship with poorer psychosocial outcomes was stronger when analyzing composite restorations on the chewing surface. The authors concluded that because resin-based composites are generally associated with decreased longevity compared with amalgam restorations and that in the New England Children's Amalgam Trial, resin-based composites need more repair and replacement, systematic removal of amalgam restorations and replacement with bis-GMA-based composite restorations should not be attempted.

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Neurobehavioral Effects of Dental Amalgam in Children: A Randomized Clinical Trial

T. A. DEROUEN, M. D. MARTIN, B. G. LEROUX *et al.*

Journal of the American Medical Association 2006 (295:1784–92)

ABSTRACT

Objective: The objective of this study was to determine the neurobehavioral effects related to dental amalgam in children.

Materials and Methods: Of 507 children with at least one carious lesion at baseline on a permanent tooth and no previous dental amalgam exposure, a group of 253 received amalgam restorations for posterior lesions and another group of 254 received resin composite restorations. Subsequent restorations needed over a 7-year period were done using the same materials for each group. Psychometrists conducted yearly neurobehavioral assessments including memory, attention/concentration, and motor/visuomotor areas, and nerve conduction technicians assessed nerve conduction velocities yearly.

Results: The amount of treatment needed was initially high, and for the first 4 years, the amalgam and composite groups received the same amount of restorative treatment. Starting at the fifth year, however, the need for additional restorative treatment was 50% higher in the composite group. Over the 7-year study period, there were an average of 18.7 tooth surfaces restored in the amalgam group and 21.3 tooth surfaces in the composite group. Urinary mercury levels were significantly higher in the amalgam group than in the composite group. There were no significant differences at any time over the 7 years between the amalgam and composite group in measurements for memory, attention, visuomotor function, or nerve conduction velocities.

Conclusions: Neurobehavioral assessments and nerve conduction velocities were on average no different in children with amalgam restorations as they were in children with resin composite restorations.

COMMENTARY

Because amalgam restorations release small amounts of mercury, there were higher urinary mercury levels in the amalgam group than in the composite group, but these low mercury levels did not lead to any difference in neurobehavioral assessments. Over a 7-year period, there was no difference in assessments for memory, attention, visuomotor function, or nerve conduction velocities in children with amalgam restorations versus resin-based composite restorations. There was a significantly greater replacement rate in the composite group versus the amalgam group. As a result, the authors recommend that amalgam should remain a viable treatment option for children.

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Immune Function Effects of Dental Amalgam in Children: A Randomized Clinical Trial

B. J. SHENKER, N. N. MASEREJIAN, A. ZHANG, S. MCKINLEY

Journal of the American Dental Association 2008 (139:1496–1505)

ABSTRACT

Objective: The objective of this study was to study dental amalgam's effect on the immune system of children.

Material and Methods: Sixty-six children aged 6–10 and requiring restorative treatment were randomized into dental amalgam and resin-based composite groups. To evaluate immune function, total white cell numbers, T-cell, B-cell, and neutrophil and monocyte responsiveness were assessed over a 5-year period.

Results: There was an average of 10.6 amalgam-filled surfaces in the amalgam group and no amalgam-filled surfaces in the composite group. Children in the amalgam group had significantly higher urinary mercury excretion than those in the composite group. There was a slight drop in responsiveness of T-cells and monocytes 5–7 days postoperatively, but this decline was not statistically significant. There were no differences at 6, 12, or 60 months.

Conclusions: Amalgam restorations lead to small increases in urinary mercury levels but no decrease in immune function at 6, 12, and 60 months after treatment. There are small and transient immune effects for 5–7 days after treatment.

COMMENTARY

Although this study was the first to explore immune function effects after dental amalgam placement, the authors caution that it should be considered exploratory because of its small size. Urinary mercury levels were increased but still low in treated children, and dental amalgam restorations did not affect the absolute number or distribution of B- and T-cells, monocytes, and neutrophils in children.

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Biomarkers of Kidney Integrity in Children and Adolescents with Dental Amalgam Mercury Exposure: Findings from the Casa Pia Children's Amalgam Trial

J. S. WOODS, M. D. MARTIN, B. G. LEROUX, *et al.*

Environmental Research 2008 (108:393–9)

ABSTRACT

Objective: This study evaluated the renal effects of dental amalgam in children and adolescents.

Materials and Methods: Five hundred seven children ages 8–12 years at baseline and requiring restorative treatment over a period of 7 years were randomized into two groups, amalgam (treatment) or composite

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(control). Urinary concentrations of glutathione S-transferases (GSTs) α and π, albumin, and creatinine were measured in the children at baseline and annually over the 7-year period.

Results: At baseline, mean urinary mercury concentrations were 1.8 μg/g for the amalgam group and 1.9 μg/g for the composite group. During the follow-up period, the level increased to a peak of about 3.2 μg/g in year 2 for the amalgam group, and tapered off to baseline levels by year 7. The level was constant for the composite group.

GST-α levels were about 5% higher in the amalgam group than in the composite group but the difference was not statistically significant and was similar between groups by gender, race, and age. GST-π levels increased with age for both groups and for each group by gender, race and age. Albumin levels were the same for both amalgam and composite groups and stayed constant throughout the follow-up period. Females had higher GST-α, GST-π, and albumin levels than males. The percentage of children with microalbuminuria (>30 mg/g creatinine) was unaffected by amalgam treatment.

Conclusions: Dental amalgam restorations had no effect on measurements of renal tubular or glomerular functional integrity of children and adolescents over a 7-year period.

COMMENTARY

Studies including the present one have shown little or no effect on renal function in children with amalgam restorations, and no significant effect of dental amalgam treatment on the proportion of children with microabluminuria. An earlier 2008 study by Barregard *et al.* from the New England Children's Amalgam Trial reported no differences in renal biomarkers in children with amalgam restorations versus those with resin-based composite restorations. However, the same study showed a significantly increased prevalence of microalbuminuria in children with amalgam, which was likely temporary, but the authors recommended it to be tested further. The present study showed no effect of amalgam treatment on microalbuminuria incidence.

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THE BOTTOM LINE

- Dental amalgam restorations are not associated with detrimental psychosocial problems in children.
- Amalgam restorations are not associated with unfavorable neurobehavioral assessments in children.
- Amalgam restorations have no apparent effect on immune function in children.
- Amalgam restorations do not appear to affect renal function in children and have no apparent effect on the proportion of children with microalbuminuria.
- Because of its low replacement rate versus resin-based composite and its apparent safety, dental amalgam restoration should remain a viable treatment option.