A Resin Alternative for Posterior Teeth: Questions and Answers on Dental Amalgam

MICHAEL J. WAHL

Abstract: **Amalgam has been used to restore cavities in posterior teeth for over 100 years, but formulations used today are different from those used a century ago. Amalgam restorations have been blamed for a number of problems, such as cusp fracture and higher rates of secondary caries. This article discusses these issues, along with possible toxic effects, in the light of current literature.**

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Clinical Relevance: **Patients may express anxieties over the use of dental amalgam: this article provides answers to the critics of this material.**

The development of tooth-coloured materials has led to a dramatic increase in the restorative choices available to dentists and patients. This development has, however, unfortunately been accompanied by attempts to malign dental amalgam, which has been called 'an inferior restoration that I would not place in the mouths of my family or friends, much less into patients' mouths.'[1] Dickerson called it 'a disgusting restoration'[2] and stated that it was 'a crime' that, after 100 years, amalgam is still the most common restoration in dentistry.[3] He also implied that those who place amalgam restorations in children are poisoning them.[4] After calling any dentist still using it 'a fool,' Maroon summed up his opinion by stating that 'amalgam sucks.'[5]

These emotional attacks have no basis in science and echo the vituperative and outrageous attacks against some dentists in the early twentieth century, when the focal infection theory was first being discussed. In 1918, Novitzky assailed dentists who performed root canal therapy, calling them 'almost criminal.'[6] He went on to state that a dentist who performs root canal therapy should extract the tooth immediately. A well-known dentist in 1921 stated that dentists 'who did crown or bridge work nowadays should receive six months' hard labour.'[7]

The vast majority of dentists, dental assistants, and adult patients participate in the placement and/or removal of dental amalgams. Those who assert that dental amalgam is a 'crown seed' or a 'poison' are therefore asserting that dentistry is neither safe nor effective. Fortunately, the scientific literature shows that dentistry is an extremely safe and effective profession. Presented below are 15 questions and answers about dental amalgam. Some of the information in this article has been condensed from other recent articles I have written, where a more complete bibliography can be found.[8-11]

***Michael J. Wahl,** DDS, Private practice, 1601 Concord Pike, Wilmington, DE 19803, USA. e-mail:WahlMichaelJ@aol.com*

Do Teeth with Amalgam have a High Incidence of Cusp Fracture?

NO

Many dentists believe that amalgam causes cusp fractures, even going so far as calling amalgam restorations 'crown seed[s]'[12] or 'time bombs [that] may threaten not only specific teeth, but possibly an entire dentition.'[13] With assertions like this, what is truly remarkable is that people have any teeth at all!

Fortunately, large long-term prospective clinical studies have shown remarkably low rates of cusp fracture in teeth restored with amalgam. For example, a 5-year study of 600 teeth restored with amalgam showed a cusp fracture rate of less than 1.5%.[14] Another study of 1415 teeth with Class II amalgam restorations showed that, after 10 years, only 25 (1.8%) had a fractured cusp.[15] After 15 years, 1213 teeth with Class II amalgam restorations were available for study and only 61 (5.0%) failed because of enamel fracture only or a combination of enamel fracture, isthmus fracture, and/or caries.[16] Based on the years of publication, the amalgam restorations in these studies were probably unbonded. Amalgam bonding increases

fracture resistance[17] at least as much as bonded resin composite,[18] decreases cuspal deflection, and allows for smaller preparations; smaller preparations generally last longer and are less likely to fracture.[19] The bonded amalgams of today would therefore probably have even lower incidences of cusp fracture.

Do Temperature Changes in Amalgam cause Cusp Fractures?

PROBABLY NOT

Di Tolla tells his patients that 'the [amalgam] filling expands and contracts at a rate greater than that of the tooth and that's why the patient's MB cusp broke off…'[12] Amalgam expands and contracts with temperature changes; resin also expands and contracts with temperature changes.[20] In fact, resin composite expands and contracts with temperature changes more than amalgam: the coefficient of thermal expansion of resin is greater than that of amalgam.[21] But neither cold soda nor hot coffee contacts the teeth very long before swallowing so thermal expansion is not a clinically important issue. Far more important to the issue of cusp fracture are tooth preparation, diet and masticatory habits.

Do Teeth with Amalgam Restorations have a High Rate of Recurrent Decay?

NO

Although many have asserted that teeth with amalgam restorations have high rates of secondary caries, long-term clinical studies have failed to show this. A 1989 study of 600 teeth with amalgam restorations showed no secondary caries after 5 years.[14] A 1993 study of 1415 Class II amalgam restorations showed only 16 (1.1%) had secondary caries after 10 years.[15] In another study, after 14 years, less than 5% of teeth[22] had secondary caries.[23] Another study showed that, after 10 years, none of 35 Class II amalgam restorations had recurrent caries.[24] It is likely that the amalgam in all these studies was unbonded. Amalgam bonding has been shown to inhibit secondary caries[25] so the recurrent caries rate would probably be even lower today.

I Heard there were Studies Showing High Rates of Cusp Fracture and Secondary Caries in Teeth with Amalgam Restorations. What About Those Studies?

These studies have little relevance to most clinical situations.

Dickerson stated 'after 7 years, 50% of the teeth filled with amalgam have fractured.'[2] In a personal communication (February 3, 2000), he cited a small retrospective study in 1988 by Hansen[26] on endodontically treated teeth restored with MOD amalgam or MOD resin. The 181 teeth with MOD amalgam restorations had a much higher incidence of cusp fracture than the 40 teeth with MOD resin. But Hansen stated that the results of this study should be cautiously interpreted, especially because the number of resin-restored teeth was so small. Hansen also asserted that the ideal restoration for endodontically treated posterior teeth was not the MOD restorations in this study, but rather restorations with cuspal coverage, which would have eliminated the possibility of cusp fractures.

Dickerson did not mention that Hansen and his colleagues,[27,28] just 2 years later, published the results of much larger studies which showed that 1584 endodontically treated teeth with MOD amalgam had about the same cuspal fracture rate (34%) after 20 years as 532 with MOD resin after only 10 years (28%).

Dickerson also stated: 'Over 40% of the amalgams deemed in good clinical shape had caries under them.'[2] In a personal communication (February 3, 2000), Dickerson cited two small studies on extracted teeth.[29,30] Of the 17 and 30 extracted teeth in these studies, there were 41% and 54% microscopic caries, respectively. But the caries in these studies was not diagnosable clinically. It was diagnosed only microscopically in histological cross section – a clinical impossibility! The authors of neither of these studies asserted that teeth with amalgam have high rates of secondary caries. In fact, Kidd and O'Hara[29] stated that 'demineralization was slight, no lesion having progressed to cavitation' and hypothesized that the microscopic caries was arrested. Dickerson did not mention a comparative study showing a significantly higher incidence of microscopic caries in resin-restored teeth than in amalgam-restored teeth.[31]

The proper way to determine the rate of secondary caries is in long-term clinical studies, not microscopic studies of extracted teeth. Similarly, the proper way to determine the rate of cusp fracture is in long-term clinical studies on all teeth and not studies limited to endodontically treated teeth with MOD restorations.

Do Resin Composite Restorations Usually Last as Long as Amalgam Restorations?

NO

Dickerson stated, 'We can all find amalgam that has lasted a long time, but statistically, that is the exception not the rule.'[32] Fortunately, this assertion is false. Independent clinical studies in thousands and thousands of teeth have consistently shown the median age of failed amalgam restorations is years longer than the median age of failed resin restorations, for all classes of restorations, including Class 1, 2, 3, 4 and 5 restorations.

A 2001 study showed that the median age of 1827 failed amalgam restorations was nearly 12 years, but the median age of 1548 failed resin composite restorations was slightly less than 5 years.[33] In the previous year, a study of 6761 replaced restorations showed that the median age of replaced amalgam was 10 years, but that of composite only 8 years, with amalgam outlasting composite for Class 1, 2, 3, 4 and 5 restorations.[34] In 1999, a study of 9031 restorations showed that amalgam outlasted resin composite for Class 1, 2 and 5 restorations[35] and one in 1998

showed that the median age of a replaced amalgam restoration was 15 years but only 8 years for resin composite.[36]

Aren't Bonded Restorations Preferable to Amalgam Restorations?

YES

Amalgam restorations can, and should, be bonded to dentine.

Freedman stated, 'Composites are bonded to dentin and enamel, recreating the monobloc of the original undecayed tooth. Amalgam simply fills a cavity, and may act as a wedge during mastication.'[37] The implication in this statement is that amalgam cannot be bonded to tooth structure. Although amalgam has worked well for many years without bonding, an increasing number of dentists are bonding every single amalgam restoration to tooth, allowing for more conservative preparations and restorations that are more resistant to recurrent decay and to cusp fracture.

Teeth can now be prepared *exactly the same* for amalgam restorations as they can for resin composite restorations. In fact, amalgams can even be used for the most conservative of all restorations, the pit and fissure sealant![38] Although bond strength itself may not be clinically important, some studies have shown amalgam-to-dentine bond strengths of 27 and even 33 MPa,[39-41] higher than the 23–25 MPa typically reported for resin-to-dentine bonds.[42] A comparative study showed higher amalgam-to-dentine bond strengths than resin-to-dentine.[43]

Amalgam is Over 100 Years Old – Doesn't That Make it 'Old Fashioned'?

NO

Dickerson has called it ' a crime that the most common restoration today is the same as it was 100 years ago. Where is the progress in our profession? What other industry has not had a significant advancement in materials used in the last 100 years?'[3] Actually, there are many 'state-of-the-art' dentists who place amalgam restorations. Aspirin, the airplane, the automobile, contact lenses, the light bulb, central heating, the telephone, the flush toilet, the *New York Times,* and the *Wall Street Journal* are just a few examples of excellent innovations that are over 100 years old but still in common use today. In dentistry, radiography, nitrous oxide, gold restorations, and rubber dams are more than 100 years old and still used.

Modern amalgam materials and technique bear little resemblance to those used 100 years ago: then there was little or no standardization of amalgam formulations, and powder and liquids were hand mixed with mortar and pestle. There have been truly dramatic improvements, including the use of high-copper formulations, factory-measured components, mechanical trituration, precapsulated amalgam, self-activating capsules, amalgam bonding, caries-indicating dyes, and newer preparation techniques with rounded line angles and no extension for prevention.

Some dentists do not use amalgam so that patients will not think they are 'old-fashioned.' But there are many 'state-of-the-art' physicians who recommend 'old' technologies like aspirin, contact lenses, or radiographs for their patients. The fact that amalgam is over 100 years old does not mean it is outdated; it is a testament to its safety and effectiveness.

Has Amalgam Been Banned in Sweden or Germany?

NO

Many authors have asserted that amalgam is banned in Sweden or Germany,[44-46] but amalgam is not banned in Sweden, Germany, or any other country in the European Union (EU).[47,48] The use of dental amalgam in the EU is governed by the Medical Devices Directive 93/42/EEC.[49] In 1998, an Ad Hoc Working Group of experts from the EU countries issued a report on dental amalgam, which states that there is no scientific evidence of systemic health problems or toxic effects from dental amalgam. There was no recommendation for special restrictions on the use of dental amalgam.[50] Sweden and Germany not only signed on to Medical Devices Directives but also participated in their development.[48] Other countries in the EU, including Austria, Belgium, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the UK have also participated in the Medical Devices Directive.

It would actually be illegal for Sweden, Germany, or any other country in the EU to ban amalgam – or at least it would be against the rules of the Medical Devices Directive 93/42/EEC.

If amalgam is ever banned in one country, that is no reason to ban it in another. The manufacture, sale and import of chewing gum is banned in Singapore;[51] private medical insurance is banned in Canada;[52] most American films are effectively banned on French television to protect the French film industry.[53] Laws such as these are often passed more for political than for scientific reasons.

Do Amalgam Restorations Release Large Amounts of Mercury?

NO

The estimated average daily dose of mercury from amalgam restorations has been consistently low in independent scientific studies; levels have been reported at 1.7 microns,[54] 1.7 microns,[55] 1.3 microns,[56] 1.7 microns,[57] and 4.8 microns,[58] well below the daily intake of 40 microns considered acceptable for the general population.[59,60] It is estimated that a patient would have to have 2740 amalgam restorations to reach the threshold limit value of 82.20 microns per day considered dangerous for occupational exposure in the USA.[61]

Does Mercury from Dental Amalgam Restorations Cause Ill-health?

NO, except for rare cases of allergic reactions

Extensive and well-controlled research in humans has consistently failed to show any credible evidence of adverse effects from mercury in dental amalgams, except for rare cases of allergy.[62-70]

Is there Credible Scientific Literature that Shows Health Problems due to Mercury in Dental Amalgam?

NO

Anti-amalgamists assert that there are scientific studies showing that mercury from dental amalgam causes health problems, but these studies have not been credible. For example, Vimy and Lorscheider of the University of Calgary purported to show that large amounts of mercury are released from dental amalgam restorations[71,72] but other scientists, working independently and using Vimy and Lorscheider's own data, showed that these estimations were grossly exaggerated due partly to the misuse of the mercury detector and improper estimations of mouth versus nose breathing.[54,57,73]

A study from the University of Calgary showing disruption of 'the membrane structural integrity of neuritis and the growth cones of identifiable neurons' after exposure to mercury[74] was hailed by anti-amalgamists as a study that 'should remove all doubt regarding the role that dental mercury from amalgam fillings plays in the development of Alzheimer's disease.'[75] But this study was done on the tissue of dead snails, and has little relevance to Alzheimer's disease in humans: there has yet to be a snail, dead or alive, diagnosed with Alzheimer's disease. Another study from the University of Calgary and the University of Kentucky showed that some of the rats exposed to high concentrations of mercury showed brain lesions similar to those found in humans with Alzheimer's disease.[76] Anti-amalgamists claim that this study showed that mercury from dental amalgam causes Alzheimer's disease.[75] But the rats in this study were exposed to more than 100 times greater concentrations of mercury than humans with 25 amalgam surfaces would typically inhale, even under stimulated conditions[77] so the rat study also has little relevance to humans.

Is Mercury from Dental Amalgam Dangerous to Dental Staff?

NO, not if proper mercury hygiene is used

Large studies on dentists and dental staff members have consistently failed to show adverse effects on health from mercury in dental amalgam. For example, a study of 8157 infants in Sweden born to dentists, dental assistants, or dental technicians found no increased risk of spina bifida, perinatal survival, low birthweight, or malformations compared with all births.[78] In fact, the infants of dental workers actually had a lower perinatal death rate than the rest of the infants. In a study of 21 634 male dentists and 21 202 dental assistants there was no difference in the rate of spontaneous abortions or congenital abnormalities of offspring between those with high exposure or low exposure to amalgam, either for dental assistants or the wives of dentists.[79] A study of 859 female dentists and 755 female teachers found no difference in fertility between the two groups.[80]

Of 1706 dentists screened at a 1991 ADA meeting, only 29 (2%) had high urinary mercury levels.[81] These high levels were correlated to poor mercury hygiene (the use of squeeze cloths). Fortunately, most dentists use appropriate methods of mercury hygiene, including water spray, high-speed suction, and precapsulated amalgam (no squeeze cloths).

Are the Ingredients of Resin Composite Non-toxic?

NO

The ingredients of resin composite and adhesive agents have been shown to be cytotoxic (causing damage or destruction of cells),[82] mutagenic (cause mutations in new generations),[83] to cause immunosuppresion or immunostimulation,[84] and to inhibit DNA[85] and RNA[86] synthesis. Wataha *et al.* stated, 'the components of resin composites are hazardous in that they all cause significant toxicity in direct contact with fibroblasts.'[87] Some components are released after polymerization and in aqueous environments.[88] Composite restorations have been shown to leach between 14 and 22 separate potentially hazardous compounds, including DL-camphorquinone, 4-dimethylaminobenzoic acid ethy ester (DMABEE), drometrizole, 1,7,7-trimethylbicyclo[2,2,1]heptane, 2,2-dimethoxy[1,2] diphenyletanone (DMBZ), ethyleneglycol dimethacrylate (EGDMA), and triethyleneglycol dimethacrylate (TEGDMA).[89]

Does Amalgam in the Waste Water Cause Harmful Environmental Effects?

PROBABLY NOT

During amalgam placement or removal most amalgam particles are captured by dental office traps but some particles can end up in the waste water. There have therefore been environmental concerns about amalgam in the waste water. (There are also environmental concerns about resin composite in the waste water.[90]) But the environmental impact of dental amalgam may be overestimated:[91] only 3–4% of worldwide mercury consumption is for dental purposes.[90]

As shown above, scientific studies have consistently failed to show an adverse effect on health due to mercury in dental amalgam, partly because the amount of mercury released is so small. This is true whether the amalgam is in the mouth or in the waste water. 'Amalgam' and 'mercury' are often words that are used interchangeably, but amalgam is not mercury; it is a fairly stable alloy of mercury and other metals. The mercury in amalgam is practically insoluble in water – it has been estimated that less than 0.3% of amalgam waste is soluble.[92]

Many other potentially harmful substances are released into the waste water by dental offices: high-strength fluoride rinses, disinfectants, radiograph

processing solutions, local anaesthetic solutions, endodontic irrigants, antibiotics, analgesics, ingredients of resin composite restorations, dental cements, impression materials, and many other substances. These are in addition to the substances that dentists prescribe for patients' home use and which can also end up in the waste water (e.g. prescription and non-prescription drugs, toothpastes with fluoride, etc.).

Is the Death of Amalgam Imminent?

NO

It has been stated that the death of amalgam is 'imminent,'[93,94] but a significant number of dentists are likely to continue placing amalgam into the foreseeable future. Over 75% of dentists in the USA place some amalgam.[95] While it is certainly true that the use of posterior tooth-coloured restorations has increased over the years, in 1999 private practitioners in the USA placed more than twice as many amalgam restorations as posterior resin restorations.[96] It is clear that, while some patients prefer tooth-coloured restorative materials for posterior teeth, many do not consider the appearance or alleged safety concerns of amalgam restorations in posterior teeth to be a problem.

CONCLUSION

Dentistry remains an extremely safe and effective profession. As used today, both dental amalgam and resin composite fillings appear safe and effective. Many dentists are successfully using resin composite fillings and other amalgam alternatives, but this is no reason to malign amalgam.

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ABSTRACT

AN EASY SOLUTION TO ENDODONTIC PROBLEMS?
Treatment of Combined Endodontic Periodontic Lesions by Intentional Replantation and Application of Hydroxyapatites. L. Yu, B. Xu and B. Wu. *Dental Traumatology* 2003; **19:** 60–63.

This case report describes a novel approach to treating a severely compromised lower first molar in an 18-year-old female. At examination, the tooth was found to have a draining sinus, grade II mobility with an 8 mm pocket and Class III furcation defect. Radiographs revealed extensive radiolucencies in the distal root, pulp cavity, distal alveolar bone, furcal and peripical regions. A diagnosis of endodontic-periodontic lesion was made, but the patient strongly wished to save the tooth.

The report describes how the tooth was surgically extracted and the root canal treated outwith the mouth. The surgical site was prepared and packed with hydroxyapatite before the tooth was replanted.

Four months after surgery a metal-ceramic crown was fitted and, at 15-month review, the tooth was found to be clinically and radiographically healthy, and in normal function.

Not a case for everyone, perhaps, but certainly worth bearing in mind for that difficult case and a determined patient!

Peter Carrotte
Glasgow Dental School