

Amalgam to be shelved

Amalgam is an alloy largely consisting of mercury, silver, tin and copper that with certain limitations is permitted for use in dental fillings.

Within a few years, though, it should be possible to replace amalgam with plastic materials. The current "amalgam war" will then be over, and more importantly, mercury pollution of the environment will be reduced. Plastic can already now be used for many of the fillings for which amalgam was formerly used. It is believed that relatively small improvements to the existing plastic materials will yield a material able to fully substitute for amalgam in dental fillings.

Threat to the environment

Background and purpose

In view of the threat posed to the environment by mercury the Danish EPA supported a 1994-98 project aimed at developing a suitable alternative to the mercury-based amalgam used for dental fillings.

The alternatives have limitations

The study

The project aimed to analyse why the existing alternatives to dental amalgam are not suitable for all fillings, and to develop plastic filling materials that are equally as good as amalgam. The project was carried out by the dental company Wolff & Kaaber A/S (contact person engineer Robert Lessèl) under the leadership of E. Christian Munksgaard of the Department of Dental Materials, Odontological Institute, Copenhagen University.

Plastic is an alternative

Main conclusions

Plastic filling materials can be further developed to make them suitable as alternatives to amalgam, with only minor improvements to the existing materials seeming to be necessary. The project results indicate how such improvements might be achieved. In the case of root canal fillings, an alternative to amalgam called Retroplast has been developed. Clinical tests show that this functions approximately 50% better than amalgam.

Increasing experience with the new materials

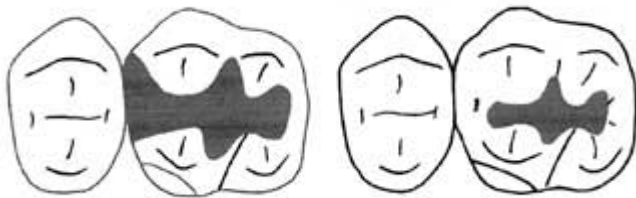
Project results

For many purposes, amalgam can be replaced by cast fillings made of gold alloy, ceramic or metal ceramic. These solutions are expensive, however, due to the fact that such fillings are prepared by a technician based on a model of the tooth: the indirect technique. With the direct technique, the material (e.g. amalgam) is formed in situ by the dentist, whereafter the material sets to a hard mass. Attempts have been made to employ certain gallium alloys instead of amalgam, but these have been unsuccessful due to its tendency to corrode and lower compatibility with the living tissue. A number of other materials have been marketed for the direct technique: plastic filling materials, glass ionomer cements, resin-modified glass ionomer cements, etc. With the exception of the plastic filling materials, these alternatives are too susceptible to wear to be used as chewing surfaces on molars.

Plastic materials as alternatives?

Approximately 75% of amalgam fillings on the chewing surfaces of molars (see Figure 1) last for at least 13 years. Some clinical studies have shown that plastic fillings in molars last for roughly the same length of time. The reasonableness of such comparisons has been challenged on the grounds that the type and size of the fillings are rarely the same in the two groups studied, that the studies often only include patients with good oral hygiene, and that the fillings have been carried out with much greater care than is normal in ordinary dental clinics. In addition, the observation time for the plastic fillings is often relatively short.

The use of plastic materials instead of amalgam for large fillings in molars is generally advised against because experience with the newer materials is too short, the technique is time-consuming and difficult, and because there is a great risk of mistakes during the filling process. Thus it is not that the use of plastic materials for fillings on the chewing surfaces of molars is doubted, but that there is too little information available to be able to determine the long-term effect of the general use of plastics instead of amalgam.



Amalgam fillings in molar teeth. Left: A so-called class 1-2 filling. Right: A class 1 filling.

What deficiencies do the plastic materials have?

Although the chewing surfaces of plastic fillings used to wear easily, the wearing quality of the newer plastics has been shown to be comparable with that of amalgam. The wearing quality can be enhanced by changing the mechanical properties. It has been pointed out several times, however, that the most serious deficiency of plastic materials is their tendency to shrink during and following application. This leads to fissures between tooth and filling. The fissures are the site of bacterial growth and hence pose the threat of continued bacterial degradation of the tooth. A decisive improvement as regards plastic filling materials will therefore be to develop materials/methods that minimize or completely prevent fissure formation. A nuisance associated with the use of plastic materials is the risk that the dental care workers can develop allergic eczema through contact with the materials. One to two percent of dental care workers thus suffer from plastic eczema and it is feared that the percentage will increase in the future. Out of consideration for the dental care workers it would thus be desirable to develop materials having little or no tendency to cause allergy.

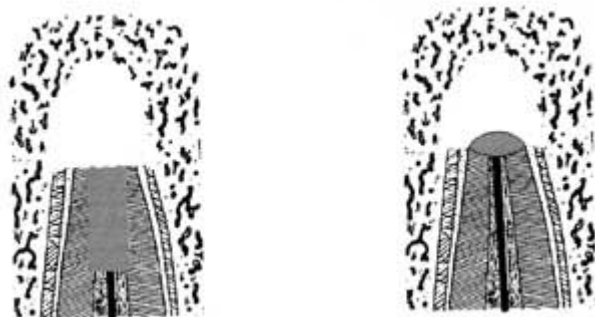
How can plastic filling materials be improved?

In order to enhance the strength of plastic filling materials and reduce their tendency to shrink, the percentage of filler in the plastic material can be increased. Measurements have shown that this can be achieved using rounded, possibly spherical, filler particles of an appropriate size distribution and pretreatment. Enhanced strength and reduced tendency to shrink can also be attained by the correct choice of plastic monomers.

During the project several new types of plastic monomer have been developed. Of these, the results with the so-called dendrimeric (branching) monomers and carbonate-containing monomers seem most promising. Enhanced strength and reduced tendency to shrink can also be attained by appropriate choice of polymerization initiator. The initiator Irgacure 369[®] thus improved the stiffness by 30%. Moreover, with the initiator CIBA 1700[®], the tendency for fissures to form was reduced by up to 25%.

In an attempt to reduce the allergenic properties of the plastic materials, experiments have been conducted with sulphur-containing monomers. Among these a compound was synthesized called thioTEGDMA, from which a plastic material was prepared having greater strength than conventional plastics. Due to thioTEGDMA's extremely low water solubility, its allergenic properties are probably low.

Amalgam is also used for filling root canals inside the jaw in order to prevent infection around the root of the tooth. Prior to and during the project an alternative - Retroplast - was developed that functions better than amalgam (see Figure 2). The clinical result of root canal fillings with Retroplast is approximately 50% better than with amalgam. In addition, the technique enables repair of perforated and fractured roots, which has hitherto not been possible using other techniques. Retroplast has now been made commercially available.



Left: Amalgam root canal filling in a cylindrical drill hole.

Right: Root canal filling of plastic/dental binder in a cup shaped drill hole.

Regulations for the use of amalgam

In 1994, the Ministry of Environment and Energy issued a Statutory Order (No. 520), among other things prohibiting the sale of mercury and mercury-containing products for use in amalgam from 1999. In 1998, the Statutory Order was amended (Statutory Order No. 692 of 22 September 1998) and until further notice now permits the use of mercury-containing products and mercury for molar fillings susceptible to wear. The reason for the amendment was that the Ministry of Health opposed the ban on the use of amalgam in molar fillings from 1999 citing health reasons on the grounds that the Danish Health Agency judged that no suitable alternative to amalgam as a filling material was yet available. In contrast to the former Statutory Order, the new Statutory Order does not permit the use of amalgam for retrograde root fillings, i.e. filling of root canals in order to hinder the spread of an inner tooth infection to the jaw bone.

Project title:

Development of suitable plastic materials for dental fillings

Performing organizations:

Department of Dental Materials, Odontological Institute, Copenhagen University; Wolff & Kaaber A/S

Printed publication:

No printed publication available

Electronic publication:

<http://www.mst.dk/udgiv/publikationer/1999/87-7909-236-5/html/default.htm>

Erstatningsmaterialer for amalgam til tandfyldning (Substitutes for amalgam in dental fillings). Environmental Project 462, Danish EPA 1999. ISBN 87-7909-249-7

Financing:

Danish EPA; Wolff & Kaaber A/S

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