

1

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MATERIAL FOR FILLING CAVITIES

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ABSTRACT OF THE DISCLOSURE

Filling of dental cavities is accomplished by placing into the prepared cavity a water insoluble, physiologically inactive, pressure mouldable polymeric synthetic resin, e.g., polyethylene, polymonochlorotrifluoroethylene or polytetrafluoroethylene, in finely divided form, or as a coherent pellet of the finely divided resin, and then mechanically working and compacting the resin within the cavity to transform the divided resin within the cavity into a solid mass.

In the treatment of dental caries operative local therapy is still the method of choice. In this form of treatment the final obturation, that is the prosthetic filling of the prepared cavity, is of special importance, since with the closing of the cavity the external form of the tooth and at the same time its function and appearance must be restored. Permanent filling materials are with few exceptions non-biological, and must fulfill as far as possible far-reaching requirements.

The following are the requirements of a tooth filling material:

The tooth filling material should not irritate the tooth nerve (pulp) and it must be able to adapt itself easily to the surfaces of the cavity. It should not be attacked by liquids and other substances found in the mouth and should not be subject to any dimensional changes after its application to the cavity. The tooth filling material must further show a high resistance to abrasion and the chewing process and must be aesthetically pleasing and easy to handle as well as exhibiting a small heat conductivity.

Nevertheless no known tooth filling material fulfills all these requirements.

The known filling materials resembling teeth in appearance consist of silicate cement, oxyphosphate cements or synthetic resins, which polymerise in the warm or in the cold or can be thermoplasticised, and also porcelain. The principally used non-tooth-coloured filling materials are silver and copper amalgams, gold or gold alloys.

In a tooth it is of essential significance that the vitality of the pulp is protected and maintained. Already in the formation of a cavity in a tooth damage of the pulp can occur, since the floor and side walls of the cavity connect with the pulp by way of the incised dentine canals. In these lie the so-called odontoblastic processes or Tome's fibres, which directly transmit externally originating influences to the pulp.

Before one of the known teeth filling materials is applied to the cavity, it is, therefore, necessary first to provide a cavity lining in order to protect the tooth nerve against effects from outside or originating in the filling material. Thus, for example, silver and copper amalgams or gold alloys filled into the cavity can under the fluctuations of temperature in the mouth bring about damage to the pulp. If on the other hand cements are used as filling materials, there is the possibility of damage to the tooth nerve by the acids used in the production and preparation of the cement, which are only neutralized a long time after the introduction of the filling

2

mass into the cavity. Also in cementing in a tooth filling prepared in the indirect way (that is, a tooth filling which is prepared on a model obtained by an impression of the cavity or by direct impression of the cavity and which is set in the cavity after preparation, by means of cement as a binding agent) there is the danger that the tooth nerve may be damaged by the acids used in the preparation of the cement. If, on the other hand, cold polymerising synthetic resins are used as filling or cementing material, it is possible that the methyl methacrylate monomer employed can bring about irreversible changes in the pulp. Also in the use of thermoplasticized synthetic resins, changes of the pulp can occur in deep cavities without cavity lining.

It is thus known in teeth with living pulp, to protect it by first introducing a cavity lining layer into the cavities; on the cavity lining is then superimposed the filling proper. As cavity linings, film-forming lacquers for example solutions of dammar resin in ether or chloroform, or solutions of polyamides in alcohol are used. The film coated on the floor of the cavity exhibits, however, a small thickness so that effective thermal insulation is not possible. The film often permits the penetration of damaging agencies or indeed in some cases may be dissolved, for example by methyl methacrylate monomer. In addition it can also come about that the solvent used for the preparation of the film forming lacquer may itself harm the pulp. The oxyphosphate cements chiefly used for cavity linings afford a sufficient thermal protection even where they are coated in a small thickness. The acids used for their preparation can, however, lead to damage of the pulp. The use of gutta-percha also presents no essential advantages. Rather does gutta-percha itself, since it is thermoplasticized, have harmful thermal effects on the tooth nerve. Moreover, gutta-percha exerts a pump like effect on the dentine, whereby hypersensitivity of the dentine is often brought about.

On the other hand, cements on the basis of zinc oxide and eugenol have shown themselves as especially good. Tooth cements of this kind are kind to the pulp if also they have little reaction on the pulp. Their handling is nevertheless difficult, since a powder and a liquid must be mixed together with a spatula and through the long setting time of the mixture. The mixing of the cement requires the use of numerous instruments, which take a long time for subsequent cleaning. There are however, also numerous media known under various trade designations, which have a short setting time owing to the presence of catalysts. Nevertheless, these materials also must be mixed before use, a troublesome procedure, for which additional assistance is necessary.

Some commercially available preparations are obtainable ready prepared as pastes. Thus one preparation is known which consists of a slurry of calcium hydroxide in distilled water. The setting or drying of this preparation requires much time and the cavity lining obtained exhibits an exceptionally small resistance to mechanical stress so that it is not possible to introduce, for example, an amalgam filling directly on to this cavity lining.

Furthermore, ready-for-use small sticky plates of various form and size are known which are laid in the cavities. Small plates of this kind are, however, unsatisfactory since, possessing no dimensions which will always correspond to the form and size of the cavities, they are difficult to apply.

The known materials for the formation of a cavity lining in cavities are ineffective, unsatisfactory, and to some extent troublesome to handle.

It has now surprisingly been found that all the above mentioned failings and disadvantages of known teeth filling materials can be avoided by the use of polymeric

synthetic resins as teeth filling materials and especially as cavity linings. According to the invention, polymeric synthetic resins are used, in the form of granules or other small, optionally thread-like or fibrous, particles, which by reason of their small particle size are formable without difficulty into a solid coherent mass, and which attain the necessary resistance to mechanical action through a further densification or condensation by means of suitable instruments. The instruments used in the dental profession for working cement, amalgams and gutta-percha, such as spatulas, stoppers and the like in various shapes and sizes have proved useful for bringing about the condensation. Mechanically driven vibrators and ultrasonic apparatus are also very suitable for the condensation.

In order that the filling material should readily condense on being compacted, it is preferred that the synthetic resin employed should be a pure polymer of very small particle size—for example of sub-micron dimensions. The particles may advantageously be of the order of magnitude of 0.35 micron.

It is also preferred that the particle size of the polymer should not be uniform but that the particle size distribution should approximate to the Fuller curve.

Apart from the mean particle size and particle size distribution of the polymer, the following characteristics are also valuable. The material should readily flow under pressure, so that it can easily be moulded into a thin film. The material should exhibit fibrillation, that is a readiness or tendency to form threads. This can be demonstrated by stretching a thin film of the material, whereupon threads are formed. The surface properties of the individual polymer particles are significant, and polymers best suited to the purposes of the invention appear to have particles with threadlike extensions from their surfaces. These extensions appear to play some part in the behaviour of the polymer under moulding pressure.

While a wide variety of synthetic materials in the preferred finely divided form can be employed for the purposes of the inventions, as described hereinafter, one preferred material which may be mentioned by way of specific example is a plastic of the modified polyethylene group having a mean particle size of the order of 0.3 to 0.35 micron and a particle size distribution which corresponds to the Fuller curve. Such a material and its manner of preparation are well known, although it has never before been employed in dentistry or in an analogous art.

This material has all the preferred properties and especially the property of ready moulding under pressure, and can be taken up by a suitable instrument from the glass and rolled into a small coherent pellet, using a minimum of pressure to avoid premature condensation. The pellet is then introduced into the cavity and pressed firmly against the walls and floor of the cavity, being tamped with a suitable stopper or spatula to compact it in the same way as an amalgam or gold filling. The process of compaction causes the material to condense into a homogeneous, dense, solid and impenetrable layer. Particularly effective condensing (and hence a greater density of the condensed material) can be brought about by the use of a vibrator. For the introduction into the cavity and for the after-condensation, Woodsons' spatula and a small amalgam stopper are especially suitable. One can also employ one of the following methods:

(1) Withdrawal of the granulate with a probe or a small ball instrument and, likewise, application to the cavity floor. Condensation and preparation of the cavity lining on the cavity floor with a small ball instrument.

(2) A small quantity of the material is spread on a glass slab. This quantity is twice dabbed with a relatively small ball instrument. The first time, a fine powder remains suspended on the surface of the instrument, and the second time, the necessary quantity adheres and can thereafter be directly introduced into the cavity.

In the event that the quantity of filling material introduced is not sufficient, further filling material is intro-

duced for the production of a sufficient cavity lining layer in the cavity. After the introduction of the cavity lining layer the permanent filling can be directly applied. A waiting period such as is necessary for the setting of known cements used as cavity lining materials or for the evaporation of the solvent or dispersion media of the known coating lacquers and slurries is obviated. The cavity lining formed by the use of the filling agent according to the invention is resistant to the acids of cements and to monomeric methyl methacrylate as well as to the monomers of other synthetic resins selected for the same purpose. The tooth filling material protects the pulp against thermal influences on account of its small thermal conductivity, and is absolutely inert to the pulp and the dentine from the chemical and physiological points of view.

Additional materials can be mixed with the tooth filling material, for example medicaments having beneficial effects on the pulp and the dentine. Depending on the circumstances, it can also be advantageous to add calcium hydroxide to the tooth filling material in order to promote the formation of the pulp tissue of secondary dentine.

Fillers, for example in the form of other synthetic resins, can also be added to the tooth filling material in order to improve its mechanical properties, colour, transparency, opacity, and the like. Preferably, however, such synthetic resins are used as tooth filling agents as do not lead to unintended reactions with the additives.

The use of the tooth filling material according to the invention carries the advantage that the working of the filling material need not be preceded by further manipulation; the filling material is available in a condition ready for use. Only a single device or only a few devices are necessary for introducing the filling material into the cavity. The filling material can be stored for an unlimited period. If the filling material is kept for a long time, no phenomena or change occurs. Special precautions are not necessary for storage.

A cavity lining formed by means of the tooth material according to the invention adheres to the floor of the cavity on the clean, dry surface of the dentine, and indeed also when the lining consists of several separately introduced layers. The layers of filling material introduced one after the other into the cavity adhere firmly one to another, or bond with one another, to form a solid integral filling. Clinical experience shows that a cavity lining formed on the floor of a cavity withstands the pressure necessary for condensing an amalgam filling without the lining being moved thereby or pressed out of the cavity.

If a cavity is not to be filled immediately after its preparation but only at a later time, for example in a second stage of treatment, a temporary filling must be introduced into the cavity for the protection of the exposed dentine and the pulp against external harmful influences. The disadvantages arising from the use of known temporary filling materials, especially of gutta-percha, zinc oxide-eugenol mixtures, oxyphosphate and other cements, as well as ready-for-use pastes, are avoided by the use of the polymeric synthetic resins according to the invention as temporary filling material. Moreover, the introduction of a temporary filling occupying the entire cavity is carried out in the same manner as the introduction of a cavity lining. Granulates or particles having a thread-like appearance and consisting of polymeric synthetic resins are formed into a solid coherent pellet which is placed in the cavity. The required resistance of the temporary filling to mechanical action is subsequently brought about by condensation of the synthetic resin used, that is, by compressing the synthetic resin layer by means of suitable apparatus. It has been found surprisingly that such a temporary filling exhibits a very high resistance to abrasion and chewing pressure, even when

used in a molar tooth. The temporary filling is easily removable when necessary.

The tooth filling material according to the invention can be used in the above described manner not only for the introduction of cavity linings or temporary fillings, but also for permanent fillings of cavities. If a synthetic resin appropriate for the particular purpose is used as the starting material for the filling, the requirements for a tooth filling material are fulfilled to the fullest extent. The tooth filling material does not irritate the pulp, it adapts itself well to the surface of the cavity and it is not attacked by liquids or other substances found in the mouth. Only with temperature variations does the new tooth filling material undergo dimensional changes which differ from those of the tooth substances. These changes are however, very small. By an addition of fillers it is possible to substantially reduce the dimensional changes between the tooth substance and the filling material arising from thermal expansion or contraction. The synthetic resin used according to the invention is only abraded to an extent which is physiologically tolerable. Clinical experience has shown that the new tooth filling material has outstanding resistance to chewing pressure. By the addition of colouring matters to the filling material the filling can be given a colour corresponding to that of the teeth. By means of fillers added to the tooth filling material its transparency or opacity can be additionally improved.

A large number of thermoplastic or thermo-setting resins can be used as tooth filling materials according to the invention. The synthetic resins used are nevertheless physiologically and chemically inactive. Only such synthetic resins are used as are insoluble in water and odourless, exhibit only a small water absorption and no taste, and are not attacked by dilute organic or inorganic acids, bases, fats, essential oils and the like.

Among the synthetic resins used for the purposes of the invention, these requirements are fulfilled, for example, by polyethylene, polystyrene, polyisobutylene, polyvinyl chloride, polytetrafluoroethylene, polymonochlorotrifluoroethylene, polyacrylonitrile, polymethyl methacrylate, polymethyl acrylate, as well as polyamides, polyesters, polycarbonates, cellulose derivatives, phenoplasts, melamine derivatives or condensation products of melamine and the like.

Nevertheless, polyethylene, polymonochlorotrifluoroethylene and polytetrafluoroethylene, appear to be particularly advantageous as tooth filling materials according to the invention.

I claim:

1. A method of filling a dental cavity comprising the steps of: providing a water-insoluble, physiologically inactive polymeric synthetic resin in finely divided form; introducing said resin into said dental cavity; and mechanically working and compacting said resin within said cavity and thereby condensing said resin into a solid coherent mass.

2. A method according to claim 1 in which said resin has a particle size of the order of 0.3 micron.

3. A method according to claim 1 in which said resin comprises polyethylene having a particle size of the order of 0.3 micron.

4. A method according to claim 1 in which said resin has the form of threadlike particles.

5. A method according to claim 1 in which the resin is polyethylene.

6. A method as claimed in claim 1 wherein said synthetic resin is formed into a coherent pellet by gentle pressure and this pellet is introduced into the dental cavity and subjected to said mechanical working and compacting.

7. A method as claimed in claim 1 wherein said synthetic resin is selected from the group consisting of polyethylene, polymonochlorotrifluoroethylene and polytetrafluoroethylene.

8. A method of preparing a filling in a dental cavity comprising the steps of: providing a filling material which comprises a water insoluble, physiologically inactive, pressure mouldable polymeric synthetic resin in finely divided form and at least one physiologically inert material selected from the group consisting of pigments, fillers and other synthetic resins; forming said filling material into a coherent pellet by gentle pressure; introducing said pellet into said cavity; and mechanically working and compacting said pellet within said cavity to form a dense solid coherent filling therein.

9. A method of preparing a filling for a tooth comprising the steps of: providing a water insoluble physiologically inactive, pressure mouldable polymeric synthetic resin in finely divided form, the particles whereof have filamentary extensions on their surfaces; and forming a tooth filling from said resin by mechanically working and compacting it and thereby condensing it into a solid, dense, coherent mass.

10. A filling for a tooth comprising a solid, dense, homogeneous coherent mass of a water insoluble, physiologically inactive polymeric synthetic resin, said mass resulting from the compacting and consequent condensation of fine particles of said resin.

11. A filling according to claim 8 in which said resin is selected from the group consisting of polyethylene and halogen-substituted polyethylenes.

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