DENTAL MATERIALS FACT SHEET
June 2001

Received from the Dental Board of California

As required by Chapter 934, Statutes of 1992, the Dental Board of California has prepared this fact sheet to summarize information on the most frequently used restorative dental materials. Information on this fact sheet is intended to encourage discussion between the patient and dentist regarding the selection of dental materials best suited for the patient's dental needs. It is not intended to be a complete guide to dental materials science.

The most frequently used materials in restorative dentistry are amalgam, composite resin, glass ionomer cement, resin-ionomer cement, porcelain (ceramic), porcelain (fused-to-metal), gold alloys (noble) and nickel or cobalt-chrome (base metal) alloys. Each material has its own advantages and disadvantages, benefits and risks. These and other relevant factors are compared in the attached matrix titled "Comparisons of Restorative Dental Materials." A "Glossary of Terms" is also attached to assist the reader in understanding the terms used.

The statements made are supported by relevant, credible dental research published mainly between 1993 - 2001. In some cases, where contemporary research is sparse, we have indicated our best perceptions based upon information that predates 1993.

The reader should be aware that the outcome of dental treatment or durability of a restoration is not solely a function of the material from which the restoration was made. The durability of any restoration is influenced by the dentist's technique when placing the restoration, the ancillary materials used in the procedure, and the patient's cooperation during the procedure. Following restoration of the teeth, the longevity of the restoration will be strongly influenced by the patient's compliance with dental hygiene and home care, their diet and chewing habits.

Both the public and the dental profession are concerned about the safety of dental treatment and any potential health risks that might be associated with the materials used to restore the teeth. All materials commonly used (and listed in this fact sheet) have been shown – through laboratory and clinical research, as well as through extensive clinical use – to be safe and effective for the general population. The presence of these materials in the teeth does not cause adverse health problems for the majority of the population. However, there are individuals who may be susceptible to sensitivity, allergic or adverse reactions to selected materials. As with all dental materials, the risks and benefits should be discussed with the patient, especially with those in susceptible populations.

There are differences between dental materials and the individual elements or components that compose these materials. For example, dental amalgam filling material is composed mainly of mercury[1] (43-64%) and varying percentages of silver, tin, and copper (46-57%). Like all materials in our environment, each of these elements by themselves is toxic at some level of concentration if they are taken into the body. When the are mixed together, they react chemically to form a crystalline metal alloy. Small amounts of free mercury may be released from amalgam fillings over time and can be detected in bodily fluids and expired air. The important question is whether any free mercury is present in sufficient levels to pose a health risk. Toxicity of any substance is related to dose, and doses of mercury or any other element that may be released from dental amalgam fillings falls far below the established safe levels as stated in the 1999 US Health and Human Service Toxicological Profile for Mercury Update.

All dental restorative materials (as well as all materials that we come in contact with in our daily life) have the potential to elicit allergic reactions in hypersensitive individuals.[2] These must be assessed on a case-by-case basis, and susceptible individuals should avoid contact with allergenic materials. Documented reports of allergic reaction to dental amalgam exist (usually manifested by transient skin rashes in individuals who have come into contact with the material), but they are atypical. Documented reports of toxicity to dental amalgam exist, but they are rare. There have been anecdotal reports of toxicity to dental amalgam and as with all dental material risks and benefits of dental amalgam should be discussed with the patient, especially with those in susceptible populations.

Composite resins are the preferred alternative to silver amalgam in many cases. They have a long history of biocompatibility and safety. Composite resins are composed of a variety of complex inorganic and organic compounds, any of which might provoke allergic response in susceptible individuals. Reports of such sensitivity are atypical. However, there are individuals who may be susceptible to sensitivity, allergic or adverse reactions to composite resin restorations. The risks and benefits of all dental materials should be discussed with the patient, especially with those in susceptible populations.

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[1] It should be noted that elemental mercury is listed on the Proposition 65 list of known toxins and carcinogens.

[2] Dental Amalgam: A scientific review and recommended public health service strategy for research, education and regulation. Dept. of Health and Human Services, Public Health Service, January 1993.

Other dental materials that have elicited significant concern among dentists are nickel-chromium-beryllium alloys used predominantly for crowns and bridges. Approximately 10% of the female population are alleged to be allergic to nickel.[3] The incidence of allergic response to dental restorations made from nickel alloys is surprisingly rare. However, when a patient has a positive history of confirmed nickel allergy, or when such hypersensitivity to dental restorations is suspected, alternative metal alloys may be used. Discussion with the patient of the risks and benefits of these materials is indicated.

Glossary of Terms

General Description – Brief statement of the composition and behavior of the dental material

Principle Uses – The types of dental restorations that are made from this material.

Resistance to further decay – The general ability of the material to prevent decay around it.

Longevity/Durability – The probably average length of time before the material will have to be replaced. (This will depend upon many factors unrelated to the material such as biting habits of the patient, their diet, the strength of their bite, oral hygiene, etc.)

Conservation of Tooth Structure – A general measure of how much tooth needs to be removed in order to place and retain the material.

Surface Wear/Fracture Resistance – A general measure of how well the material holds up over time under the forces of biting, grinding, clenching, etc.

Marginal Integrity (Leakage) – An indication of the ability of the material to seal the interface between the restoration and the tooth, thereby helping to prevent sensitivity and new decay.

Resistance to Occlusal Stress – The ability of the material to survive heavy biting forces over time.

Biocompatibility – The effect, if any, of the material on the general overall health of the patient.

Allergic or Adverse Reactions – Possible systemic or localized reactions of the skin, gums and other tissues to the material.

Toxicity – An indication of the ability of the material to interfere with normal physiologic processes beyond the mouth.

Susceptibility to Sensitivity – An indication of the probability that the restored teeth may be sensitive of stimuli (heat, cold, sweat, pressure) after the material is placed in them.

Esthetics – An indication of the degree to which the material resembles natural teeth.

Frequency of Repair or Replacement – An indication of the expected longevity of the restoration made from this material.

Relative Cost – A qualitative indication of what one would pay for a restoration made from this material compared to all the rest.

Number of Visits Required – How many times a patient would usually have to go to the dentist's office in order to get a restoration made from this material.

[3] Merck Index, 1983. Tenth Edition, M Narsha Windhol z, (ed).

COMPARISONS OF DIRECT RESTORATIVE DENTAL MATERIALS

TYPES OF DIRECT RESTORATIVE DENTAL MATERIALS				
COMPARATIVE FACTORS	AMALGAM	COMPOSITE RESIN (DIRECT AND INDIRECT RESTORATIONS)	GLASS IONOMER CEMENT	RESIN-IONOMER CEMENT
General Description	Self-hardening mixture in varying percentages of a silver-tin alloy powder and liquid mercury.	Mixture of powdered glass and plastic resin; self-hardening or hardened by exposure to blue light.	Self-hardening mixture of glass an organic acid.	Mixture of glass and resin polymer and organic acid; self-hardening by exposure to blue light.
Principle Uses	Fillings; sometimes for replacing portions of broken teeth.	Fillings, inlays, veneers, partial and complete crowns, sometimes for replacing portions of broken teeth.	Small fillings; cementing metal & porcelain/metal crowns, liners, temporary restorations.	Small fillings; cementing metal & porcelain/metal crowns and liners.
Resistance to Further Decay	High; self-sealing characteristic helps resist recurrent decay; but recurrent decay around amalgam is difficult to detect in its early stages.	Moderate; recurrent decay is easily detected in early stages	Low-Moderate; some resistance to decay may be imparted through fluoride release.	Low-Moderate; some resistance to decay may be imparted through fluoride release.
Estimated Durability (permanent teeth)	Durable	Strong, durable.	Non-stress bearing crown cement.	Non-stress bearing crown cement.
Relative Amount Of Tooth Preserved	Fair; Requires removal of healthy tooth to be mechanically retained; No adhesive bond of amalgam to the tooth.	Excellent; bonds adhesively to healthy enamel and dentin.	Excellent; bonds adhesively to healthy enamel and dentin.	Excellent; bonds adhesively to healthy enamel and dentin.
Resistance to Surface Wear	Low Similar to dental enamel; brittle metal.	May wear slightly faster than dental enamel.	Poor in stress-bearing applications. Fair in non-stress bearing applications.	Poor in stress-bearing applications; Good in non-stress bearing applications.
Resistance to Fracture	Amalgam may fracture under stress; tooth around filling may fracture before the amalgam does.	Good resistance to fracture.	Brittle; low resistance to fracture but not recommended for stress-bearing restorations.	Tougher than glass ionomer: recommended for stress-bearing restorations in adults.
Resistance to Leakage	Good; self-sealing by surface corrosion; margins may chip over time.	Good if bonded to enamel; may show leakage over time when bonded to dentin; does not corrode.	Moderate; tends to crack over time.	Good; adhesively bonds to resin, enamel, dentine/ post-insertion expansion may help seal the margins.
Resistance to Occlusal Stress	High; but lack of adhesion may weaken the remaining tooth.	Good to Excellent depending upon product used.	Poor; not recommended for stress-bearing restorations.	Moderate; not recommended to restore biting surfaces of adults; suitable for short-term primary teeth restorations.
Toxicity	Generally safe; occasional allergic reactions to metal components.	Concerns about trace chemical release are not supported by research studies. Safe, no known toxicity documented.	No known incompatibilities. Safe; no known toxicity documented.	No known incompatibilities. Safe; no known toxicity documented.
Allergic or Adverse Reactions	Rare; recommend that dentist evaluate patient to rule out metal allergies.	No documentation for allergic reactions was found.	No documentation for allergic reactions was found. Progressive roughening of the surface may predispose to plaque accumulation and periodontal disease.	No known documented allergic reactions; Surface may roughen slightly over time predisposing to plaque accumulation and periodontal disease if the material contacts the gingival tissue.
Susceptibility to Post-Operative Sensitivity	Minimal; High thermal conductivity may promote temporary sensitivity to hot and cold; Contact with other metals may cause occasional and transient galvanic response.	Moderate; Material is sensitive to dentist's technique; material shrinks slightly when hardened, and a poor seal may lead to bacterial leakage, recurrent decay and tooth hypersensitivity.	Low; material seals well and does not irritate pulp.	Low; material seals well and does not irritate pulp.
Esthetics (Appearance)	Very poor. Not tooth colored; initially silver-gray, gets darker, becoming black as it corrodes. May stain teeth dark brown or black over time.	Excellent; often indistinguishable from natural tooth.	Good; tooth colored, varies in translucency.	Very good; more translucency than glass ionomer.
Frequency of Repair/ Replacement	Low: replacement is usually due to fracture of the filling or the surrounding tooth.	Low-Moderate, durable material hardens rapidly; some composite materials show more rapid wear than amalgam. Replacement is usually due to marginal leakage.	Moderate; Slowly dissolves in mouth; easily dislodged.	Moderate; more resistant to dissolving than glass ionomer, but less than composite resin.
Relative Costs To Patient	Low, relatively inexpensive; actual cost of fillings depends upon their size.	Moderate, higher than amalgam fillings; actual cost of fillings depends upon their size; veneers & crowns cost more	Moderate, similar to composite resin (not used for veneers and crowns).	Moderate; similar to composite resin (not used for veneers and crowns).
Number of Visits Required	Single visit (polishing may require a second visit)	Single visit for fillings; 2+ visits for indirect inlays, veneers and crowns.	Single visit.	Single visit.

COMPARISONS OF DIRECT RESTORATIVE DENTAL MATERIALS

TYPES OF DIRECT RESTORATIVE DENTAL MATERIALS				
COMPARATIVE FACTORS	PORCELAIN (CERAMIC)	PORCELAIN (FUSED-TO-METAL)	GOLD ALLOYS (NOBLE)	NICKEL OR COBALT-CHROME (BASE-METAL) ALLOYS
General Description	Glass-like material formed into fillings and crowns using models of the prepared teeth.	Glass-like material that is "enamaled" onto metal shells. Used for crown and fixed-bridges.	Mixtures of gold, copper and other metals used mainly for crowns and fixed bridges.	Mixtures of nickel, chromium.
Principle Uses	Inlays, veneers, crowns and fixed-bridges.	Crowns and fixed-bridges.	Cast crowns and fixed bridges, some partial denture frameworks.	Crowns and fixed bridges; most partial denture frameworks.
Resistance to Further Decay	Good, if the restoration fits well.	Good, if the restoration fits well.	Good if the restoration fits well.	Good if the restoration fits well.
Estimated Durability (permanent teeth)	Moderate; Brittle material that may fracture under high biting forces. Not recommended for posterior (molar) teeth.	Very good. Less susceptible to fracture due to the metal substructure.	Excellent. Does not fracture under stress; does not corrode in the mouth.	Excellent. Does not fracture under stress; does not corrode in the mouth.
Relative Amount Of Tooth Preserved	Good – Moderate. Little removal of natural tooth is necessary for veneers; more for crowns since strength is related to its bulk.	Moderate – High. More tooth must be removed to permit the metal to accompany the porcelain.	Good. A strong material that requires removal of a thin outside layer of the tooth.	Good. A strong material that requires removal of a thin outside layer of the tooth.
Resistance to Surface Wear	Resistant to surface wear; but abrasive to opposing teeth.	Resistant to surface wear; permits either metal or porcelain on the biting surface of crowns and bridges.	Similar hardness to natural enamel; does not abrade opposing teeth.	Harder than natural enamel but minimally abrasive to opposing natural teeth, does not fracture in bulk.
Resistance to Fracture	Poor resistance to fracture.	Porcelain may fracture.	Does not fracture in bulk.	Does not fracture in bulk.
Resistance to Leakage	Very good. Can be fabricated for very accurate fit of the margins of the crowns.	Good – Very good depending upon design of the margins of the crowns.	Very good – Excellent. Can be formed with great precision and can be tightly adapted to the tooth.	Good – Very good – Stiffer than gold; less adaptable, but can be formed with great precision.
Resistance to Occlusal Stress	Moderate; brittle material susceptible to fracture under biting forces.	Very good. Metal substructure gives high resistance to fracture.	Excellent	Excellent
Toxicity	Excellent. No known adverse effects.	Very Good to Excellent. Occasional/rare allergy to metal alloys used.	Excellent; Rare allergy to some alloys.	Good; Nickel allergies are common among women, although rarely manifested in dental restorations.
Allergic or Adverse Reactions	None	Rare. Occasional allergy to metal substructure.	Rare; occasional allergic reactions seen in susceptible individuals.	Occasional; Infrequent reactions to nickel.
Susceptibility to Post-Operative Sensitivity	Not material dependent; does not conduct heat and cold well.	Not material dependent; does not conduct heat and cold well.	Conducts heat and cold; may irritate sensitive teeth.	Conducts heat and cold; may irritate sensitive teeth.
Esthetics (Appearance)	Excellent	Good to Excellent	Poor – yellow metal	Poor – dark silver metal
Frequency of Repair/ Replacement	Varies; depends upon biting forces; fractures of molar teeth are more likely than anterior teeth; porcelain fracture may often be repaired with composite resin.	Infrequent; porcelain fracture can often be repaired with composite resin.	Infrequent; replacement is usually due to recurrent decay around margins	Infrequent; replacement is usually due to recurrent decay around margins.
Relative Costs To Patient	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.
Number of Visits Required	Two – minimum; matching esthetics of teeth may require more visits.	Two – minimum; matching esthetics of teeth may require more visits.	Two – minimum	Two-minimum