RESTORATIVE MATERIALS

Position Statement / Media Release

Dental restorative materials are specially fabricated materials designed for use as dental restorations (fillings). Dental restorations are used to restore the function, integrity and morphology of missing tooth structure, usually resulting from, but not limited to, dental caries. ADOHTA believes that dental professionals must choose the appropriate material for each restorative situation. This decision should be based on knowledge of the material's physical properties, biocompatibility, aesthetics and application. ADOHTA recommends patients are well informed in regard to restoration selection and patient autonomy and choice needs to be respected. ADOHTA supports ongoing research into the development of new dental materials to compliment and improve those currently available.

Further Information

Once the dental professional has decided to place a restoration in a tooth, an appropriate restorative material needs to be selected. The shift from *'extension for prevention'* to the *'minimal intervention'* philosophy has resulted in the development of technique appropriate restorative materials. Due to the ongoing development of new materials and with advances in adhesive dentistry, a large range of restorative materials are now available. A brief overview of commonly used direct restorative materials and further information follows.

Amalgam

Historically, dental amalgam has been a popular restorative material. It is inexpensive, technique insensitive and highly durable. Amalgam, however, is not adhesive (cavity design needs to include mechanical retention) and not aesthetically pleasant. Concerns have been raised about the use of dental amalgam because it contains mercury. While high levels of mercury are harmful to human health, the metal alloy in modern dental amalgam has low mercury content. Repeated international reviews of the scientific evidence have been unable to link the use of dental amalgam directly with ill health (FDA report Oct 2015 JADA).

Resin Composite, Glass Ionomer Cements, Compomers

These materials have better aesthetic properties and require a more minimal cavity design as they bond to tooth enamel. The varying strength and durability of each restorative material needs to be considered for its appropriate use in a restoration. There has been little or no toxicological testing of composite materials.

Linings and Bases

Liners and bases can be considered as restorative substitutes for dentine that was removed by caries and/or cavity preparation. They act as a barrier against chemical irritation, provide thermal insulation and can resist the condensation forces on a tooth when placing a restoration. Assessing the amount of dentine lost after cavity preparation and the restorative material to be used can guide the choice of an appropriate lining or base.

Evidence Based Information

The objective on any restorative treatment is to:

- Repair or limit the damage of dental caries
- Protect and preserve remaining pulp & tooth structure
- Ensure adequate function
- Restore aesthetics
- Provide ease in maintaining good oral hygiene (no overhangs, clear contacts etc.)

Choice of material should be based on technical considerations, age, caries risk and cooperation.

Amalgam

Dental amalgam is a metal alloy that is generally made up of mercury, silver and tin, with small amounts of copper and zinc. Dental amalgam has been an accepted part of dental treatment for more than 170 years (Ucar & Brantley 2011) and is considered to be the best direct restorative material for posterior restorations in permanent teeth subject to high occlusal load. Benefits of dental amalgam include: easy preparation, relatively inexpensive (compared to other materials used in dental treatment), high longevity and durability, easy to place in the prepared tooth, high compressive strength, high resistance to wear and minimal dimensional change with time (Ucar & Brantley 2011). It is the only dental material known for marginal-sealing capacity due to the formation of corrosion products at the tooth-amalgam interface. It also tolerates a wide range of clinical placement conditions such as wet fields. Disadvantages include poor aesthetics and higher loss of tooth structure during tooth preparation due to the need for mechanical retention. Toxicity of dental amalgam due to mercury has also been a concern.

While high levels of mercury are harmful to human health, the metal alloy in modern dental amalgam has low mercury content. Repeated international reviews of the scientific evidence have been unable to link the use of dental amalgam directly with ill health. The current advice from the National Health and Medical Research Council of Australia is that, for most people, these low levels of mercury exposure will not affect their general health. There is also no clinical evidence to support any connection between amalgam fillings and cancer.

Dental amalgam is not inert and small amounts of mercury vapour are released during the functional life (chewing and brushing) of the restoration. Mercury vapour is released in greater amounts when the restoration is mixed and placed or replaced. Factors such as number of filled teeth, number of surfaces per filling, eating habits (including gum chewing), tooth brushing, oral breathing habits and bruxism can influence the amount of mercury released. The World Health Organization and World Dental Federation state *"No controlled studies have been published demonstrating systemic adverse health effects from amalgam restoration"*. The World Health Organization issued this Consensus Statement in March 1997 dental amalgam is considered to be "safe and effective".

The NHMRC working party report advises caution when using dental amalgam as a restoration on the following client groups:

1. Children (deciduous and permanent dentition)
2. Pregnant women (placement or replacement)
3. Clients with existing kidney disease

When removing existing dental amalgam all possible care should be exercised to minimise mercury vapour exposure to the client and operator through the use of high-volume evacuation and rubber dam where appropriate.

Resin Composite

Resin composite consists of a resin matrix, filler particles**,** interfacial coupling agents and polymerisation initiators, thus having the ability to set with light. Resin composites are classified by filler particle size and an understanding of each composite will aid appropriate selection. Filler loading contributes to the physical and mechanical properties, including strength, stiffness, and dimensional change, setting contraction, radiopacity and improved handling. The size and distribution of filler particles affects the characteristics of the material. The smaller the particle size the better the polish ability of the material.

Resin composites are available in a wide range of colours, allowing the restoration to be near invisible and have a high polish ability, giving them a good finish. As resin composite bonds to enamel (and to a degree dentine) via a micromechanical bond, less tooth structure needs to be removed compared to preparation for other materials, such as amalgam. They also have reasonable wear properties and are command set.

Resin composites are technique sensitive and require a dry field during application and setting. They do experience some polymerisation shrinkage on light curing, which can put stress on cavity margins. This makes the tooth more vulnerable to microleakage and recurrent caries, however, good technique can minimise this. Resin composites are hydrophilic, meaning they will take up water over time which can cause staining within the material. Resin composites should be built in increments no more than 2mm to ensure maximum, uniform polymerisation.

Glass Ionomer Cements

Glass Ionomer Cements (GICs) are water-based cements consisting of an aluminosilicate glass with high fluoride content and a polyalkenoic acid. The resulting cement consists of glass particles surrounded by a matrix arising from the dissolution of the surface of the glass particles in the acid. Fluoride is released from the glass particles and lies free within the matrix but plays no role in its physical make-up. The fluoride is able to leach out of the restoration as well as into it, thus acting as a fluoride reservoir. This is important in high caries risk patients or for remineralisation of teeth.

Cavity preparation for the placement of a GIC is conservative, with only minimal tooth structure needing removal. GICs are chemically set via an acid base reaction and are therefore not subject to shrinkage and microleakage. There mechanism of bonding involves an ionic interaction with calcium and/or phosphate ions from the surface of the enamel or dentine.

GICs are relatively tolerant in placement technique, which doesn’t require strict moisture control and have good biocompatibility.

Although GICs are tooth coloured, they vary in translucency and thus are not as aesthetic as resin composites. GICs do not wear as well as resin composites. They can become brittle and won't survive in dry conditions (xerostomia) as they are water based. GICs are water sensitive during the setting phase, thus a protective coating should be placed over them on completion.

Resin-modified Glass ionomers combine the advantages of conventional GICs with light polymerisation technology.

Compomers

Compomers are a combination of resin composite and glass ionomer technology, however, with the emphasis towards the composite resin end of the spectrum. They are composed of aluminosilicate glass particles embedded in a methacrylate resin matrix. Compomers have a dominant resin polymerisation setting and an after setting triggered by water uptake.
This after setting releases some fluoride ions into the oral environment, however, it is at such a low level that it is not considered effective and unlike GICs and RMGICs, compomers cannot act as a fluoride reservoir. Compomers have better mechanical and aesthetic properties than RMGIC but inferior wear and requires a bonding system.

Linings and Bases

Linings and bases protect the pulp from bacterial micro leakage, which is likely to occur with most filling materials. It also protects the pulp from chemical toxicity. Cavity linings are placed thinly usually less than 0.5 mm. There may be additional benefits, such as fluoride release, adhesion to tooth structure, and or antibacterial action that promote the health of the pulp.

Cavity bases replace dentine. There are many clinical options including calcium hydroxide cement, modified zinc oxide eugenol and glass ionomer cement. Cements can be further categorised into zinc phosphate cement, cements containing corticosteroids and urethane dimethacrylate resin. Suitability and pulpal toxicity should be considered when choosing the appropriate lining or base.

Summary of Advantages & Disadvantages of Restorative Materials		
	Advantages	**Disadvantages**
Amalgam	Inexpensive Easy to use – quick Technique insensitive Durable Marginal seal improves with time due to formation of corrosion products at the tooth-amalgam interface	Not adhesive Requires mechanical retention Environmental & occupational hazards Poor aesthetics

Composite resin	Adhesive Aesthetic Reasonable wear properties Command set Micromechanical bond to enamel Minimal tooth preparation	Technique sensitive Expensive Time consuming Post-operative sensitivity Micro leakage Polymerisation shrinkage Relatively poor wear resistance More difficult to achieve satisfactory interproximal contacts, cervical margins and occlusal morphology in posterior teeth
Stainless steel crown	Hall technique allows for no or limited preparation Durable Protects and supports remaining tooth structure	Conventional placement requires extensive tooth preparation Patient cooperation required Poor aesthetics
Glass ionomer cement (GIC)	Adhesive Aesthetic Fluoride leaching Chemically bonds to enamel and dentine Minimal tooth preparation Higher moisture tolerance than resin-based restorative materials Biocompatible: low pulpal toxicity if applied to intact dentine Thermal expansion similar to enamel and dentine Probable anticariogenic properties due to high fluoride release	Brittle Susceptible to erosion and wear Sensitivity to moisture in the early setting process Aesthetics not as good as resin-based restorative materials
Resin-modified glass ionomer cement (RMGIC)	Adhesive Aesthetic Command Set Simple to handle Radiopaque Some fluoride release Minimal tooth preparation Tolerates some moisture Better physical properties than GIC Micromechanical bond to tooth	Technique sensitive Less fluoride release than GICs No true adhesive bond to enamel and dentine Material undergoes polymerisation shrinkage upon setting

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