PROPERTIES OF SET AMALGAM

MICROLEAKAGE
Dental amalgam has an exceptionally fine record of clinical performance because of its tendency to minimize marginal leakage. If the restoration is properly inserted, leakage decreases as the restoration ages in the mouth. This may be due to the formation of corrosion products in the tooth restoration interface. Thus amalgam is a self-sealing restoration. Both low and high copper amalgams, but the accumulation of corrosion products is slower with the high-copper alloys. Initial leakage can be reduced through the application of varnish on the cavity walls.

DIMENSIONAL CHANGE
Ideally, dimensional change should be small. Excessive contraction can lead to microleakage, sensitivity, and secondary caries. Excessive expansion can produce pressure on the pulp and postoperative sensitivity.

Contraction
When the alloy and mercury are mixed, contraction results initially as the particles dissolved and the gamma1 grows. The final volume of gamma1 is less than the initial volumes of silver and mercury that go into making the gamma1. Therefore, contraction will continue as long as growth of gamma1 continues.

Expansion
The gamma1 crystals as they grow, impinge against one another, and produce an outward pressure tending to oppose contraction. The gamma1 crystals will grow into interstices containing mercury, consuming mercury, and producing continued reaction. Therefore, reducing mercury in the mix will favor contraction.

EFFECT OF MOTSATURE CONTAMINATION (DELAYED EXPANSION)
If a zinc-containing-low-copper or high-copper amalgam is contaminated by moisture during triturating or condensation, a large expansion can take place. It usually starts after 3-5 days and may continue for months, reaching value greater than 400 um (4%). The delayed or secondary expansion is caused by the releases of hydrogen gas from the reaction of zinc with water. Amalgam without zinc tends to be less plastic, less workable and indication e.g., patients having excessive salivation, retrograde root canal filling, subgingival lesions, etc.

\[ \text{H}_2\text{O} + \text{Zr} \rightarrow \text{ZnO} + \text{H}_2 \text{ (gas)} \]

TENSILE STRENGTH
Amalgam cannot withstand high tensile or bending stresses and can fracture easily. Therefore, the cavity should be designed so that the restoration will receive minimal tension or shear forces in service.
Factors affecting strength
The strengths of various phases in the decreasing order are gamma, gamma1, eta, gamma2 and voids. Manipulative variables should be controlled to produce maximum amount of stronger phases.

1. Time factors (setting times): gamma1, gamma2 and eta phases formed grow into crystals gradually. Hence strength increases with respect to time. In about 20 minutes the strength reaches about 6% of its maximum strength (i.e. about 25-30 Mpa). When scratched, it gives a metallic sound. Strength increases to about 95% of its maximum value in about 7 days. Thereafter, it increases very slowly even for 5 or 6 months. For the clinician, 8 hours time is considered as setting time and patient can use solid food.

2- Compositions: High copper single composition alloys, form amalgam of very high one hour compressive strengths (250-290 Mpa), and highest maximum strengths (up to 520 Mpa) due to interlocking of gamma1 phases by the eta phase rods growing into the gamma1 phases. Lathe cut, spherical and disperse alloys have nearly same one hour compressive and 24 hours tensile strengths. But high copper alloys have higher maximum strength due to elimination of weaker gamma2 phase.

3- Mercury/alloy ratio: If more mercury enters into the reaction, greater amounts of weaker gamma1 and gamma2 phases are formed, which decreases the strength. Hence minimum mercury is used.

4- Effect of particle size and shapes: Smaller particle size, greater is the strength and adaptability to margins. Lathe cut irregular particles can withstand higher condensation pressure and get higher compressive strength.

5- Effect of triturations: Either undertrituration or overtrituration will decrease the strength for both low-copper, and high-copper amalgams.

6- Condensation pressures: Large condensation force cause better adaptation cohesion and hence higher strength. The condensation pressure applied is about 1.5Kgm-1.7Kgm.

7- Effect of Porosity: voids and porosities reduce strength.

Creep
This is the time dependent plastic deformation creep of dentar amalgam is a slow progressive permanent deformation of set amalgam which occurs under constant stress (static creep) or intermittent stress (dynamic creep). or strain tacking place in case of viscoelastic materials

Significance of Creep
Creep is related to marginal breakdown of low-copper amalgams. The higher the creep, the greater is the degree of marginal deterioration
Creep Values
In general lathe-cut low-copper alloys show the highest creep values, and the lowest creep values are shown by the high copper amalgams.

<table>
<thead>
<tr>
<th>Type</th>
<th>Creep Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-copper lathe cut amalgam</td>
<td>6%</td>
</tr>
<tr>
<td>Low-copper spherical</td>
<td>1.5%</td>
</tr>
<tr>
<td>High-copper admixed amalgam</td>
<td>0.5%</td>
</tr>
<tr>
<td>High-copper unicompositional amalgam</td>
<td>0.05 to 0.09%</td>
</tr>
</tbody>
</table>

Factors minimising creep
- Composition - Single composition - high copper
- Mercury-alloy ratio - Minimum
- Optimum triturataion
- Large condensation Pressure
- Homogeneous condensation

RETENTION OF AMALGAM
Amalgam does not adhere to tooth structure. Retention of the amalgam filling is obtained through mechanical locking. This is achieved by proper cavity design. Additional retention if needed can be obtained by placing pins within the cavity. Amalgam can also be bonded using special bonding agents.

TARNISH AND CORROSION
Tarnish is the discolouration of metallic restorations in the oral environments. Sulphur and chlorine containing food may react with silver, copper and tin to cause discoulourations.

Corrosion is the continuation of the chemical attack or electrochemical reactions, resulting in the loss of material from the surface. Tin components have least corrosion resistance. Silver amalgam is a multiphase inhomogeneous material and undergoes several types of corrosions. The gamma1 Ag2Hg3 phase has highest, and gamma2 phase has the lowest corrosion resistance. Different phases can be arranged according to increasing order of corrosion resistance as, Sn7.8 Hg, Cu6Sn5, Cu3Sn, Ag3Sn, Ag3Cu2 and Ag2Hg3.

If the surface is not well polished, and margins are not properly adapted, crevice corrosion can take place. Electro chemical corrosion also takes place, if a high copper amalgam (cathodic) comes into contact with the low copper (conventional) amalgam opposing restorations. Similarly amalgam restoration coming into contact with base metal or noble metal alloy restorations (in the opposing teeth), undergo galvanic corrosion.

Amalgam bond
particular dentin bonding agent which can bond composite resins with metals and teeth 4 META (4 Methacryloxy Ethyl Trimellitate Anhydride) has been tried for bonding amalgam to teeth structure successfully. The bonding agent is supplied as powder liquid system with adhesives, acid etching agents etc. Amalgum mix is to be
TECHNICAL CONSIDERATIONS
MANIPULATION OF AMALGAM

If a restoration is defective, it is usually the fault of the operator and not the material.

CAVITY DESIGN
1-creating a cavity with walls that diverge towards the floor of the cavity (or converge towards the mouth of the cavity).
2-retention if needed can be obtained by placing pins within the cavity.
3-Four wall support If one or more of the walls of the cavity is absent, a stainless steel Matrix.
4-sufficient depth and width in order to provide sufficient bulk to the amalgam, especially those in high stress areas.
5-Cavosurface angle The junction of the cavity with the external surface should be as close to a right angles as possible.

TRITURATION
The objective of trituration is to wet all the surfaces of the alloy particles with Mercury Trituration is achieved either by:
1- Manually by hand: A glass mortar and pestle is used
2- Mechanical mixing: Mechanical amalgamators are more commonly used to triturate amalgam alloy and mercury

Under-Triturated Mix
1-It is rough and grainy and may crumble.
2-It gives a rough surface after carving and tarnish and corrosion can occur.
3-Strength is less.
4-Mix hardens too rapidly and excess mercury will remain.

Normal Mix
1-It has a shiny surface and a smooth and soft consistency.
2-It may be warm (not hot) when removed from the capsule.
3-It has the best compressive and tensile strength.
4-The carved surface retains its lustre after polishing, hence increased resistance to tarnish and corrosion.

Over-Triturated Mix
1-The mix is soupy, difficult to remove from capsule and too plastic to manipulate.
2-Working time is decreased.
3-Results in higher contraction of the amalgam.
4-strength increases for lathe-cut alloys, whereas it is reduced in high copper alloys.
5-Creep is increased.
CONVERSATION
The amalgam is placed in the cavity after trituration, and packed (condensed) condensers are instruments with serrated tips of different shapes and sizes. The shapes are oval, crescent, trapezoidal, triangular, circular or square. The condenser type is selected as per the area and shape of the cavity.

Aims
1. To adapt it to the cavity wall.
2. Remove excess mercury.
3. Reduce voids.

SHAPING AND FINISHING
Carving of restoration is required only to simulate anatomy and not to get finer details. Eventhough carving can be done about 15-20 minutes until the material shows certain resistance to the carving instrument, otherwise the restoration may be pulled away from the margins. Carving instruments need not have very sharp blades. These haie different shapes, and named as diamond carver, Wartz carver, Hollanback carver etc.

Burnrshing
This is the procedure for smoothening the carved surface by carefully rubbing with rigid flat surfaces of spheretipped-ball burnishers or T burnishers, usually made up of stainless steel .Final burnishing can be done by moving a wet cotton pellet over the surface. The burnishing removes small pits or scratches on the surface and gives a smooth surface and improves marginal adaptation, (and reduce the concentration cell or crevice corrosion)

Final finishing is delayed for about 24 hours for low copper alloys and at least 1 hour for high copper single composition alloys. The material should set into sufficiently hard surface. If required contouring can be done with slow-speed hand pieces, using fine diamond points, brown or green rubber points. Fine pumice, zirconium silicate tin oxide etc. polishing powders can be finally used. These powders are made into thick slurry in water/alcohol and applied with a rotary felt wheel or brush on the surface. Polishing with the dry powders should not be done as they can easily rise the temperature of restoration above 60° C and cause some irreverssible changes.

MERCURY TOXICITY
Mercury is toxic. Free mercury should not be sprayed or exposed to the atmosphere. This hazard can arise during trituration, condensation and finishing of the restoration,
and also during the removal of old restorations at high speed. Mercury vapors can be inhaled. Skin contact with mercury should be avoided as it can be absorbed. Any excess mercury should not be allowed to get into the sink, as it reacts with some of the alloys used in plumbing. It also reacts with gold ornaments. Mercury has a cumulative toxic effect. Dentists and dental assistants, are at high risk. Though it can be absorbed by the skin or by ingestion, the primary risk is from inhalation.

ADVANTAGES AND DISADVANTAGES OF AMALGAM RESTORATIONS

Advantages
1. Reasonably easy to insert.
2. Not overly technique sensitive.
3. Maintains anatomic form well.
4. Has adequate resistance to fracture.
5. After a period of time prevents marginal leakage.
6. Have reasonably long service life.
7. Cheaper than other alternative posterior restorative material like cast gold alloys.

Disadvantages
1. The color does not match tooth structure.
2. They are more brittle and can fracture if incorrectly placed.
3. They are subject to corrosion and galvanic action.
4. They eventually show marginal breakdown.
5. They do not bond to tooth structure.
6. Risk of mercury toxicity.

Gallium alloys
Gallium is a greyish metal of low density, 5.9 grn/cc and low melting point 29.9°C which can be used as an alternative to mercury. The melting point of gallium is depressed by adding tin and indium and makes it remain as liquid at room temperatures. This can be triturated with the Ag-Sn-Cu alloys like mercury. on triturlation the new phase formed are cuGa₂, PdGa₅, Ag₉Ga₃ bind and beta -tin. These sorround and the unreacted particles.

Advantages
- No mercury health hazards
- Less microleakages as the paste has better marginal adaptations.
- Mechanical properties are adequate

Disadvantages
- The mix is like a paste and difficult to fill.
- Very dry field is required for filling
- Lower corrosion resistance.
- Cause adverse effect on the pulp.
- More cytotoxic than traditional alloys.