AMALGAM RESTORATION

BY
Dr. Somaya Ali
Definitions

- **Amalgam**: An alloy of mercury with one or more other metals.

- **Dental amalgam**: An alloy of mercury with silver, tin copper and zinc. The product of this reaction is the dental amalgam.

- **Amalgam restoration**: Plastic mix of mercury with dental amalgam alloy applied to the prepared cavity to restore the tooth structures and function.
a) **Mercury:**

The only metal which is liquid at room temperature with melting point -37.87 °C. Used to liquefy and react with dental amalgam alloy producing a plastic mix, which remains workable at room and body temperature for a reasonable period of time.
b) *Dental amalgam alloy:*

Composed of: → 1. Silver.  
2. Tin.  
3. Copper.  
4. Zinc.
1. **Silver:**

- About 67 - 74 % by weight.
- **Increases:**
  - Strength.
  - Resistance to tarnish and corrosion.
  - Setting expansion.
- **Decreases:**
  - Flow and creep.
  - Setting time.
2. **Tin:**

- About 25 - 28 % by weight.
- Facilitates the reaction (high Hg affinity).
- **Increases:**
  - Flow and creep.
  - Setting time.
  - Corrosion ($\gamma_2$).
- **Decreases:**
  - Setting expansion.
  - Strength properties.
3. Copper:

- About 0 - 6 % by weight.
- **Increases:** Strength (How??) **high Sn affinity.**
  - Hardness.
- **Decreases:** Creep and flow.
4. Zinc:

- About 0 - 2 % by weight.
- Scavenger for oxides.
- Causes delayed expansion when contaminated with moisture or saliva (??).

- Decreases: ➞ Strength.
  ➞ Setting expansion.
CLASSIFICATION OF DENTAL AMALGAM ALLOYS:

1) *According to the particles shape:*

- Conventional lathe cut.
- Spherical: → Smooth surfaced spheres.
- Spheroidal: → Spherical with irregular surface.
Lathe-cut amalgam alloy particles

Spherical amalgam alloy particles

Spheroidal amalgam alloy particles
Advantages of spherical particles:

- Requires less Hg.
- Less condensation force.
- Higher strength.
- Easy amalgamation → i.e. less trituration.
- Smooth surface finishing.
2) **According to copper contents:**

a) Low copper: Copper contents **less than 4 %**. Also called → **Conventional alloy**.

b) High copper: Copper contents **more than 4 %**.
High copper amalgam:

- **Advantages:**
  1. Increased strength and hardness.
  2. Elimination of $\gamma_2$ phase which is the most corrodible phase.
  3. Unicompositional type shows:
     - Higher strength and hardness.
     - More resistance to tarnish and corrosion.
     - Low flow and creep.
3) **According to zinc content:**

A. **Zinc free** ( < 1% ).

B. **Zinc containing:** → Resulting in delayed expansion when it is contaminated with moisture (??).

4) **According to supply:**

A. Powder.

B. Tablets.

C. Capsules.
FIGURE 10.1: Commercially available amalgam alloy and mercury products
ADVANTAGES:

- Good **adaptability** to cavity walls and margins.
- High **compressive strength** → minimum 80 MN/m².
- Low **coefficient of thermal expansion** when compared to other restorative materials: →
  - Amalgam → 25 x 10⁻⁶.
  - Tooth → 11.5 x 10⁻⁶.
- **Indestructible** in oral fluids.
- Convenient **manipulation**.
- Could take and maintain **high surface polish** that increases the strength.
- Low **cost**.
DISADVANTAGES:

- Low **tensile** and **shear** strength.
- Tendency for **tarnish and corrosion** (heterogeneous structure).
- **Flow** and **creep**
- High **thermal conductivity** (so??).
- **Dimensional changes** during setting ± 20µ/cm.
- Poor **esthetic**.
INDICATIONS:

Small and medium sized class I, II and V cavities in posterior teeth.
FACTORS AFFECTING MATERIAL SELECTION:

1. The extent of the lesion.
2. Esthetics.
3. Caries incidence.
4. Economics.
CONTRAINDICATIONS:

1. Large class I and class II cavities (low tensile and shear strengths).

2. In anterior teeth (poor esthetics).

3. When other (opposing or neighboring) dissimilar metallic restoration is present in the oral cavity (galvanic action).
1- Placing a Matrix:

- Straight and contra-angled Universal (Tofflemire) retainers.
- Lingual positioning requires contra-angled Universal retainer.
- Ivory matrix bands
- Ivory matrix holder

Bands are available with varying occlusogingival measurements.
BURNISHING MATRIX BAND:

Band may be trimmed for the shallower gingival margin.

Using mirror from facial or lingual position to evaluate proximal contour of matrix band.
AUTOMATRIX:
WEDGING:

Correct wedge position.

Incorrect wedge positions.
DOUBLE WEDGING:
FLUTING:

Fluting results in opening between matrix and gingival margin.

Testing with explorer in a press-scape motion for soundness of enamel margin and tightness of matrix to margin.
MANIPULATION:

- It includes:
  1. Selection of the alloy.
  2. Proportioning of alloy to mercury.
  3. Trituration.
  4. Condensation.
  5. Carving.
  6. Finishing and polishing.
Aims of manipulation:

- To mix the alloy with mercury and gain *homogenous plastic* mass of amalgam with *minimal residual* mercury.

The mercury levels:

- 53 wt% of the *final* amalgam restoration → considered as dangerous level leading to ??.

- 50 wt% → the maximum safe level.

- 47 wt% → good level.
1. SELECTION OF THE ALLOY:

A- **Unicompositional** *(high copper silver amalgam)*:
- Superior strength properties.
- The least flow and creep (increased hardness).
- The maximum resistance to tarnish and corrosion ...

B- **Spherical particles** *(of minimal diameter)*:
- Less mercury (40 wt%).
- Less condensation force.
- Higher strength.
- Less trituration.
- Smooth surface.
1. SELECTION OF THE ALLOY:

C- Zinc free:
As zinc containing may lead to delayed expansion when contaminated with moisture or saliva.

Delayed expansion will lead to:
Roughness of the surface (why?) → ditches and blisters leads to accumulation of food debris with:
  → Increased galvanic action.
  → Recurrent caries.
  → Increased tarnish and corrosion.
  → Irritation to gingival tissues.
1. SELECTION OF THE ALLOY:

D- Capsules:
The most convenient (why?):

1. Properly *dispensed* and *proportioned*.
2. More *hygienic* as it is well sealed and the operator will not subjected to Hg vapors.
2- PROPORTIONING OF ALLOY AND MERCURY:

**Aim:**

a) To select the *proper amount of mix* required to fill the cavity.

**Depending on:**

1. The *size of the cavity* (must be slightly overfilled).
2. The amount, which could be *condensed in time* (3-5 minutes).

b) To select the *proper amount of Hg* required to wet every alloy particle without affecting the final properties of amalgam restoration.

**Depending on:**

1. The type of amalgam alloy.
2. Particles shape and size.
Techniques:

- Proportioning by weight % not volume % (??).

**a) Low Hg technique:**

- Also called → *Eame’s technique*.
- With P/L ratio of 5:5 (50 wt%).
- The mix will be too dry: Non-coherent.
  - Weak.
  - Corrodible.
  - Voids.
- So, removal of excess Hg during condensation should not be attempted.
b) **High Hg technique:**

- Also called → *Joregenson’s technique*.
- With P/L ratio of 5:6 (54.6 wt%).
  - This ratio will provide:
    - Easy trituration.
    - Workable mass.
- The excess Hg must be eliminated by *Increased dryness technique* through:
  - Squeezing.
  - Condensation.
  - Carving.
Proportioning will be performed by:

- **Manual** → Using **volume dispenser** (?).
- **Mechanical** using:
  - Amalgamizer.
  - Pre-measured capsules.
3- TRITURATION:

Definition:
The process of mixing together Hg and amalgam alloy and rubbing of particles to remove the thin film of oxides producing a coherent plastic and homogenous mass of condensable amalgam.

Aim:
- Rubbing of particles to remove the thin film of oxides (improved surface energy).
- Facilitate the reaction between Hg and amalgam alloy (improved Hg affinity).
This reaction will result in:

- Decrease in the size of remaining non-reacted $\gamma$ particles (the strongest phase).
- Production of hard, strong and non-corrodible $\gamma_1$ phase.
- Production of soft, weak and corrodbile $\gamma_2$ phase.
- Progressive consumption of Hg with a corresponding decrease of plasticity.
Techniques:

- **Manual:**
  - mortar and pestle with a steady constant force.

- **Mechanical:**
  - Amalgamator (pre-weighted capsules).
  - Amalgamizer (proportioning and trituration).
Trituration is a function of:

- Time (minutes).
- Speed (rpm).
- Pressure (F/A).

Types of resultant mix:

1. Under triturred.
2. Over triturred.
3. Properly triturred.
1- Under triturated:

- Dull.
- Non-homogenous.
- Friable and non-coherent.
- Weak and corrodiible.
- Increased flow and creep.
- Increased setting time.
2- **Over triturated:**

- Adheres to the mortar (manual).
- Higher early strength.
- Faster setting.
- Less expansion or slight contraction.
- Better surface finish.
3- Properly triturated:

- Shiny, smooth and homogenous.
- Starts to climb the walls of the mortar (manual).
- If the mortar is slightly tapped on the bench, the mix will curl at the top.
Squeezing and mulling:

- **Aims:**
  - To reduce the amount of excess Hg (*Squeezing*).
  - To increase the homogenicity and plasticity of the mix (*Mulling*).

- **Technique.**
4. CONDENSATION:

- **Definition:**
  - Forcible packing of fresh amalgam mix (3-5 min) to details of the prepared cavity.

- **Aims:**
  1. Homogenous packing of the freshly triturated amalgam into the cavity.
  2. Improving adaptation.
  3. Elimination of voids.
  4. Elimination of excess Hg (highest at margins).
  5. Improving Density...so... Strength.
Factors controlling proper condensation:

1. Elimination of moisture contamination and debris.
2. The use of properly adapted, wedged, stabilized, smooth, contoured and rigid matrix.
3. Size and shape of the condenser should be of size slightly smaller than the width of the cavity.
4. Addition of mix increment by increment.
5. Forceful condensation.
6. Old Mixes (more than 5 min) discarded and replaced by new freshly mixed one.
7. The cavity should be Over Filled ??.
Instruments:

1. Amalgam carrier.
2. Matrix and wedge (for compound or complex cavities).
3. Condenser:
   - Smooth or serrated.
   - Manual or mechanical.

N.B.

- Smooth Vs serrated condenser (?).
Technique:

1. The cavity is filled increment by increment starting by the **auxiliary cavity**.

2. A **condensation force** is applied on each increment using suitable condenser and should be:
   1. Directed *(vertical and lateral)* against cavity walls, line and point angles.
   2. Continued until the surface of the increment becomes soft (release of **excess Hg**) and a squeezing sound is heard *(Amalgam crying)*.

3. The **Hg-rich layer** of each increment should be removed before packing the next increment.

4. Repeat until the cavity is **over filled**.
5- CARVING:

**Aim:**

1. To reproduce the normal tooth anatomy and contours through:
   - Normal physiologic **contour**.
   - Adequate compatible **marginal ridges**.
   - Properly sized, located and extended **contact area**.
   - Adequate compatible **embrasures**.
   - No interference with the **periodontium**.
Aim:

2. To ensure efficient mastication and tooth function through:
   - Non-interfering occlusion with the opposing tooth (no premature contacts or over carved).
   - Not interfering with the neighboring teeth (proper tilting).

3. To remove the superficial Hg rich layer (why??).
Timing of carving:
- When amalgam starts initial setting (slight resistance of carver movement).

Avoid Early Carving:???:
- Improper tooth anatomy.
- Formation of sub-margins.

Direction of carving:
- From tooth structure towards the bulk of amalgam.
- Parallel with the CSA of the cavity.
- Never from restoration towards the CSA (?).
**Instruments:**

- **Burnisher** → For pre and post carving burnishing.
- **Amalgam carver.**
- **Fine tipped explorer** → for supplemental grooves and removal of overhanged margins of restoration.

Hollenbach carver
Double burnishing technique:

- Amalgam is pre and post carving burnished.

1. Pre-carving burnishing:
   - Using large sized burnisher with pressure.

2. Post-carving burnishing:
   - Small sized burnisher with gentle strokes.
Objectives of burnishing:

- **Pre-carving burnishing:**
  - It continues the process of condensation.
  - Brings the *excess* Hg to the surface to facilitate its removal with carving (highest at margins).
  - More adaptation of amalgam (more cohesive) to cavity walls and margins.
  - It conditions the surface of amalgam to carving.

- **Post-carving burnishing:**
  - To provide smooth surface amalgam.
Carving technique:

Precarving-burnishing
Carving technique:

Marginal Ridge Carving
Carving technique:

Carving direction
Carving technique:

Finally Carved Restoration
6- FINISHING AND POLISHING:

**Aims:**

- Removal of any premature contact, marginal flashes or marginal over hangs.
- Provide a lustrous homogenous amalgam surface.
Advantages:

1. Increases corrosion resistance.
2. Decreases bacterial plaque retention and liability to recurrent caries.
3. Minimizes gingival irritation.
4. Improves strength of amalgam (removes the surface irregularities that act as stress concentration areas).
○ **Timing:**
  - After **24 hours** of carving (avoid disturbing crystallization of amalgam).

○ **Technique:**
  - **Finishing** *(copious coolant is a must)*:
    - Using *finishing bur* in a direction from the tooth to restoration.
    - Using *sandpaper discs* for accessible surfaces.
  - **Polishing**:
    - Using *pumice* with *brush* or *rubber cup*. 
Finishing using sand paper disc

Polishing with rubber cup
Avoid heat generation..?

- Attraction of Hg to the surface
  - Weakening of the surface.
  - Weakening of the bulk due to the formed porosity.
Finished and polished Amalgam Restoration