Lecture notes on **Dental Amalgam**

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Dental amalgam is a powder of silver-tin alloy mixed with mercury.

**Composition of the Conventional amalgam (Traditional).**

Silver (Ag) 65%:

*Advantages:* increasing strength, promoting setting when mixed with mercury (increasing the setting time, reducing the flow and resisting the tarnish and corrosion.

*Disadvantage:* high degree of setting expansion.

b- Tin (Sn) 25-29%:

*Advantages:* aids in amalgamation process because it has great affinity to mercury and decrease expansion within practical limit.

*Disadvantage:* Large amount of tin cause decrease strength, prolong the setting time, decrease corrosion resistance and increase flow of amalgam.

c- Copper (Cu) 6%:

Increase strength and hardness and setting expansion but decrease flow.

d- Zinc (Zn) 0-2%:

Its presence is not essential.

*advantage:* It prevents oxidation during alloy ingot manufacture.

*Disadvantage:* It gives rise to delayed or secondary expansion if zinc containing alloys are contaminated with moisture.

e- Palladium: 0-1%: It improves the corrosion resistance and the mechanical properties.

f- Indium: 0-4%: In high copper alloy it enhances the clinical performance of amalgam restoration as it reduces the evaporation of mercury and the amount of mercury required to wet the alloy particles.

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Classifications of the types of the amalgam according to:

I-Shape of the particles:

1. **Lath-cut** particles alloys (fig a)
2. **Spherical** particles alloys (fig b)
3. **admixed** particles alloys (Disperse alloy): mixture of lathe-cut with spherical alloy (fig-c)

II-Zinc present

1. **Zinc-containing** alloys ------------------------ Alloy which contain more than 0.01%
2. **Zinc free;** non zinc alloys). ------ Alloy which contain less than 0.01% (Require inert atmosphere during manufacturing)

III-Amount of copper

1. **Low copper (conventional amalgam)**
2. **High copper amalgam:**

The copper content is increase from 6% up to 10-30%. It is of different types:

a- Unicom positional system: *either lathe-cut or spherical*

b- Disperse alloy (*admixed*).
**Setting Reaction (amalgamation process):**

It is a surface-reaction and take place when alloy powder and mercury is mixed, mercury wetted the particles then diffused in side the alloy particles. The reaction products crystallize; the subsequent growth of the crystals causes amalgam to be hardened. A considerable amount of initial alloy remains unreacted.

The reaction of conventional amalgam is given by this equation:

\[
\text{Ag}_3\text{Sn} + \text{Hg} \rightarrow \text{Ag}_2\text{Hg}_3 + \text{Sn}_7\text{Hg} + \text{Ag}_3\text{Sn}
\]

For high copper amalgam:

\[
\text{Ag}_3\text{Sn} + \text{Cu} + \text{Hg} \rightarrow \text{Ag}_2\text{Hg}_3 + \text{Cu}_6\text{Sn}_5 + \text{Ag}_3\text{Sn}
\]

**Advantages:**

1. Easy to inset; are not technique sensitive.
2. Maintain anatomical form.
3. Have relatively long service life.
4. It has an adequate compressive strength: around 45-70,000 psi while for the enamel 58000 psi for the dentine 43000 psi for the composite 30-40000 psi. This strength develops slowly it may takes 24hr after mixing and affected by type of alloy, shape and size of particles(faster with high cupper, small size, spherical), amount of mercury and the manipulation.

Gamma: strongest phase of hardened amalgam.
Gamma-1: second strong.
Gamma-2: least strong. Voids-have drastic effect on the strength.

Gammat-2 is considered to increase corrosion and reduced the strength; to resolve this problem:

a- produce amalgam with little matrix by mixing little mercury as possible
b- the mixed amalgam should be compressed into cavity so that the un reacted core of particles are packed closely together and mercury rich material being brought to the surface as layer of excess material which then removed

c- production of high copper alloy
5. In soluble in oral fluids.
6. Adaptable to cavity walls.
7. Compatible with the living tissues (it is not irritant).
8. Easily removed because of it's color.

**Disadvantages:**

1. Weakness in tensile and shear strength: so that why it should be supported by tooth structure, and we must have adequate bulk of amalgam whenever stress may be applied.
2. In harmonious color.
3. Creep: A plastic permanent deformation of amalgam under static load.
Creep causes protrusion of amalgam out of the cavity, the protruded edges are unsupported and weak and may be further weakened by corrosion, this lead to fracture, as a result a ditch will happened around the margin of amalgam restoration which will cause a gap and microleakage (Ditching of amalgam).

The gamma 2 phase is primarily responsible for high value of creep in conventional amalgam but it is not the only factor involved, while high copper amalgam has lower value of creep because it has a little or no gamma 2 phase.

4- High thermal and electrical conductivity: so protective cement is required.

The Coefficient of thermal expansion and contraction is three times greater than that of dentine this cause more expansion and contraction of the restoration than the surrounding tooth when patient takes cold and hot food and drinks. This leads to microleakage around the filling. So replacement of the restoration is a must every 5 years.

5- Susceptible to tarnish and corrosion: -

Tarnish: discoloration at the surface of the amalgam by chemical attack from component in food or saliva.

Corrosion: roughness and pitting of the surface of amalgam as a result of chemical attack from component in food or saliva.

Tarnish and corrosion may by the result of galvanism.

The gamma 2 phase of conventional amalgam is the most electrochemically reactive. For higher copper amalgam the Cu6Sn3 phase forms the anode but less corrosion occurs than conventional amalgam because absence of gamma 2 phase.

The rate of corrosion is accelerated when the amalgam filling is contact with gold or old restorations. Corrosion will cause roughness of the amalgam which may lead to plaque and bacterial accumulation and inflammation of the soft tissue also will cause poor appearance of the filling surface and may affect the mechanical properties of amalgam.

Level of corrosion may be minimized by polishing the surface of restoration.

Corrosion has one advantage that corrosion products thought to be gathered at the restoration -tooth interface (seal the gap) to prevent or decrease microleakage.

6- Delayed expansion: - for zinc containing amalgam when contaminated with moisture during condensation zinc will react with water, hydrogen will produced as products of such reaction, hydrogen will be collected internally (voids), this cause pressure which may cause expansion which cause pain. This occurs after 3-4 days and may be after a month. This confirms the need for adequate moisture control when using this material.

Contamination of amalgam with moisture during manipulation will cause:

a-un controlled expansion of amalgam.

b-marginal discrepancies.

c-pitted surface.

d-compression of surrounded tooth structures.

e-dental pain.

f-recurrent caries.

g-fracture of the restoration.

To solve these problem; we must do complete isolation and/or using of zinc-free alloy.

However, the contamination of any type of amalgam will lead to amalgam with inferior physical properties.

Factors which affect a final expansion or contraction:

a-Type of alloy.

b-Particle size and shape.

c-Pressure used to condensed amalgam.

A standard test permit a slight expansion typically (0.2%) max. or slight contraction of 0.1% max. a large contraction would result in a marginal gap down which fluids could penetrate. A large expansion would result in the protrusion of the filling from the cavity.

7- Adhesion: - amalgam has no adhesion to enamel or dentin; therefore a potential micro spaces between the restoration and tooth result. Micro leakage may be reduced in the early life
of restoration by coating the cavity walls with varnish. Studies suggest that the use of bonding agents with amalgam restoration provide several advantage among these: enhancement of the retention and decrease the micro leakage so the postoperative sensitivity and recurrent caries will decreased. Also fracture resistance of the tooth will increase.

8- Mercury toxicity: - highly toxic, Improper handling is health hazard .

The mercury has a bad effect on CNS also may cause contact dermatitis.

A) Freshly mixed amalgam and mercury should not be touched by hands, because mercury will be absorbed by skin.

B) Dentist: and assistant subjected to the vapor of mercury in atmosphere which increases with increasing temp, especially when sterilizing the instruments with mercury contamination. So Instruments should be cleaned well.

C) Wearing a mask and gloves will protect the dentist and the assistant from mercury toxicity.

Increased Hg means increased matrix which means increased Gamma-2; the content of Hg in the final restoration is of great importance; if it is high; the compressive strength of the amalgam will be decreased and the setting time increased; which will result in a great risk of fracture of the restoration in the early stage of setting. Also the corrosion tendency and creep will be increased.