

Operative dentistry

Lec: 1&2 February 2020

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Dental Amalgam:- Is a kind of restorative materials that produced by mixing liquid mercury and metal alloy powders to give a plastic mass, which hardens in the prepared tooth cavity following a reasonable working time. Dental amalgam is a very old restorative material but still the most widely used material in operative dentistry.

Amalgam alloy: - Is a blend of different metal elements, which are miscible in a liquid state.

Advantages of dental amalgam: -

- An adequate compressive strength.
- Insoluble in oral fluid.
- Has a good adaptability to the walls and the floor of the cavity.
- Compatible with oral tissue.
- Durable.
- Dental amalgam is the least time consuming to place and has the lowest cost.

Disadvantages: -

- Low tensile and shear strength, therefore, amalgam should be always supported by tooth structure.
- Inharmonious color.
- Creep: a slow change in shaped caused by compression. Amalgam could be pushed by adjacent and apposing teeth to cause open, chipped and overhanging margins. Recurrent decay would then result.
- Has a high thermal conductivity.

- Susceptible to tarnish which is the discoloration of the surface of amalgam restoration by chemical attack of component in food or in saliva.
- Electrical conductivity (Galvanism).
- Dental amalgam does not adhere to tooth structure, so mechanical retention means are needed (undercuts, grooves).

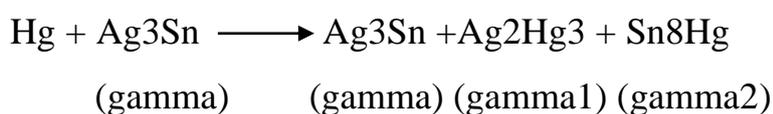
Composition: -

- 1- Mercury: it's a dense liquid metal, highly toxic, shiny surface. Improper handling of this material is health hazard by inhalation or absorption through the skin.
- 2- Amalgam alloy:

I) Conventional silver tin system:

Composition	Properties
69% silver (Ag)	↑ strength expansion setting rate ↓ corrosion creep
26.2% tin (Sn) (↑ reaction rate)	↓ strength expansion setting rate
3.6% copper (Cu)	↑ strength and hardness corrosion ↓ creep substitutes for silver
0.8% zinc (Zn) scavenger prevent formation of metal oxide	Deoxidizes Reduce the brittleness of the alloy. Cause delayed expansion with water.

The Amalgamation reaction: the reaction between mercury and alloy



Gamma	Strongest, intermediate corrosion resistance.
Gamma 1	Intermediate strength, high corrosion resistance.
Gamma 2	Low strength, greater creep, low corrosion resistance.

The hardening of amalgam is the result of:

- Wetting of the alloy particles by mercury.
- Dissolution of silver and tin in mercury.
- Diffusion of mercury into the alloy.
- Precipitation of gamma1 and 2 from the liquid phase.
- Crystal growth of 1 and 2.

II) High Copper alloy: 12-30% Cu.

These are formed in 2 ways:

- 1- The three constituents, silver, tin, and copper are melted together to form a single, high copper alloy (single composition copper enriched alloy).
- 2- Particles of Ag/Cu alloy are mixed with particles of conventional type this is an admixture e.g. dispersalloy (dispersion-modified copper enriched alloy).



Advantages of high copper alloy: -

- Low creep, tarnish, and corrosion.
- ↑ Compressive strength.
- ↓ Dimensional change.
- Improve marginal integrity.
- Less release of mercury.

Particle size and shape of amalgam alloys: -

1) Shape

A. Lathe cut alloy.

The particles are irregular in shape and require more mercury during mixing. The high mercury concentration affects the mechanical property of such amalgam restoration. However, this amalgam type has less plasticity and resists condensation forces providing better contouring and marginal adaptation than other types.

B. Spherical alloy

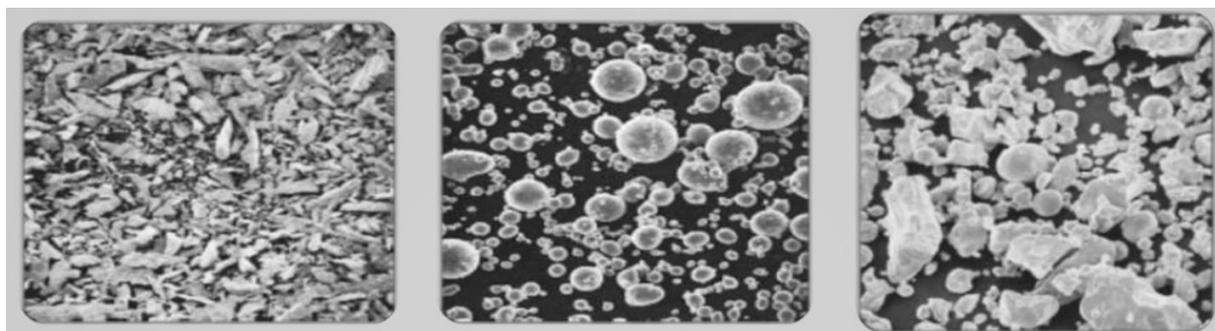
Advantages of spheres particles: -

- 1- Smoother surface.
- 2- It is easier to condense around retention pin.
- 3- Need lower condensation (inaccessible cavities).
- 4- Greater early compressive strength.
- 5- Rapid and complete amalgamation.

But ↑ difficulty in obtaining a good contact point and carving is more difficult.

A. Admixed alloy.

Contains both lathe-cut and spherical alloys to produce amalgam restoration with a smooth surface, good contour and proper marginal adaptation.



Lathe-cut

Spherical alloy

Admixed alloy

- 2) Alloy particle size
- | | |
|--------------|---------|
| A. regular | ↑ 50 Mm |
| B. Fin-cut | 35 Mm |
| C. Micro-cut | 26 Mm |

Amalgams prepared from smaller particles have a shorter setting time (faster amalgamation reaction), smaller setting expansion, and lower gamma₂ content. Smaller particles also lead to a slightly higher compressive strength, lower creep value, and less early stage mercury vapor release, which has a poisonous effect on dentist and patient.

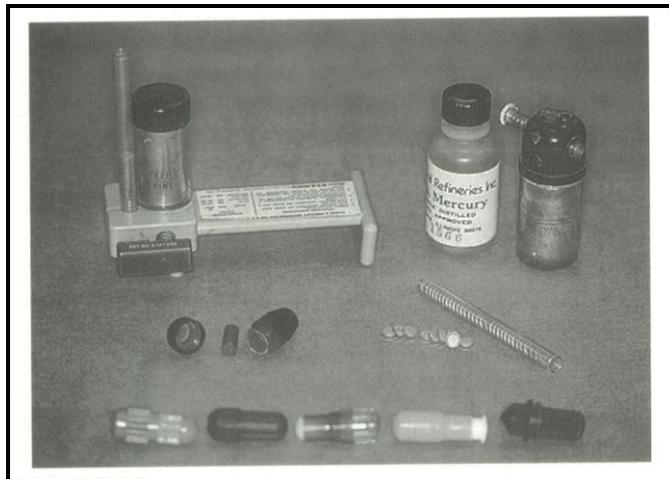
Manipulation: -

- 1) Mercury and alloy ratio: correct proportioning of alloy and mercury is essential for forming a suitable mass of amalgam for placement in a prepared cavity. The amount of mercury and alloy to be mixed is described by M-A ratio. Some alloys require mercury-alloy ratios in excess of 1:1 (1:1 indicate one part of mercury to one part of alloy), whereas others use ratios of less than 1:1, with the percentage of mercury varying from 43-54%. These ratios depend on:
- Alloy composition.
 - Particle size.
 - Particle shape.

Therefore, the manufacturer's recommended ratio should be followed; the setting reaction of dental amalgam occurs at the boundary of alloy particles, each one should be completely covered with mercury to achieve a good amalgam.

2) Proportioning of Mercury to Alloy:

- Alloy and mercury are supplied in a capsule (pre-capsuled) with alloy at one end and mercury at the other end, separated by a diaphragm which is broken just before placing the capsule in an amalgamator.
- Alloy and mercury in bulk for insertion into mechanical amalgamator, this machine volumetrically dispenses portions of alloy and mercury and mixes them together.
- Alloy pellet and mercury dispenser.
- Reusable capsule, amalgam alloy pellets.



Top row (moving left to right): alloy pellet and mercury dispenser bulk mercury in plastic bottle.

Central row: reusable capsule, amalgam alloy pellets.

Bottom row: several pre-capsuled amalgam products.

Advantages of pre-capsuled amalgam alloy: -

- Ready for trituration and provide more consistent mixes of amalgam
- Safety (mercury doesn't need to be stored in bulk).
- Mixing carried out in a closed capsule (less risk of air contamination by mercury vapor).

- 3) **Trituration:** mixing process of the amalgam alloy powder with the liquid mercury to give a moldable and plastic mass of amalgam alloy.

Mercury must be brought into intimate contact to the particles of alloy so that physiochemical reaction of amalgam can be initiated. Particles of alloy are each covered with an oxide film, which inhibits the wetting of their surface by mercury. Rubbing together particles of alloy in presence of mercury breaks up this film and allows wetting. Mixing can be achieved: -

-Mortar and pestle (hand mixing)

*Absence of dry particles.

*Coherence of amalgam mass

-Mechanical amalgamator: (rapidly, less health hazard).

- 4) **Mulling procedure:** it's a continuation of amalgamation process to produce a more homogeneous amalgam. It's an effective way for collecting triturative amalgam.

Testing of mixture: -

- Amalgam mass should take the print of the thumb and retain it. This indicates normal mixing (shining in appearance).
- Under mixing: dull, crumbly (failed to take the print).
- Over mixing: soupy and tends to stick to the inside of the capsule (failed to retain the print).

Condensation of dental amalgam:-

Objectives: -

- 1) Proper condensation of amalgam promotes adaptation of amalgam to the cavity walls and matrix band.
- 2) Eliminating voids and reducing the amount of residual mercury in the restoration to increase the strength and serviceability of the restoration.

Hand condensing: -

The condensing instrument of choice is a double-ended plastic instrument with flat condensing surface. Instruments available with different shape and size. The diameter of the tip must be such that it can be accommodated on the floor of the cavity at its narrowest point otherwise, condensation of deepest layers is impossible. A force applied to the hand condenser should be as great as possible under the existing clinical condition and should apply on the center of the cavity and then stepping the condenser towards the walls of the cavity and the ends of the fissure. Pressure should be firm, uniform to small increments of amalgam, only when first increment has been condensed adequately, should the next increment be added. It is wrong to suppose that the earlier layers inserted can later be condensed by heavy pressure in the later stages of packing only porosity close to the surface would be eliminated, and voids would remain in the deeper part. The condensation started at the box till we fill the cavity.

As the amalgam level reaches the cavity margins, packing continues to allow an excess to build up over the ultimate level of the finished restoration. (Why)

- ❖ Cover the cavosurface margin completely to avoid exposure of the margins during carving.
- ❖ To do a proper carving, and to remove excess mercury.

Carving:-

May be beginning immediately after condensation before the setting of the amalgam. As amalgam sufficiently firm, the amalgam is carved with sharp carving instrument.

- ❖ The carver is held so that its blade lies across the margin of the filling, half on tooth and half on amalgam, and moving parallel to the margins small increment of the amalgam is removed, defining the margin of restoration.
- ❖ Deep occlusal groove should not be carved into the restoration since these weaken the restoration and cause chipping of the thinned amalgam at the occlusal margins.

❖ In large restorations, cuspal slopes should be carved and fissures may be delineated.

Smooth and uniform surface should be achieved, the occlusion should be checked by asking the patient to place the teeth lightly together. Sometimes, the restoration will feel high to the patient and then brightly mark will be seen on the amalgam surface (high spot should be removed).

Polishing:-

The goal of polishing is to produce a smooth and lustrous surface that reduced the likelihood of corrosion and the ability of plaque to adhere to the surface. Polishing should be done at least 24 hours after it has been placed with finishing burs, disks and cups of suitable size.

Success depends upon the use of a light uniform touch and constant movement of the instrument and care should be taken to retain the carving and avoid overheating.

Matrix band and retainer:-

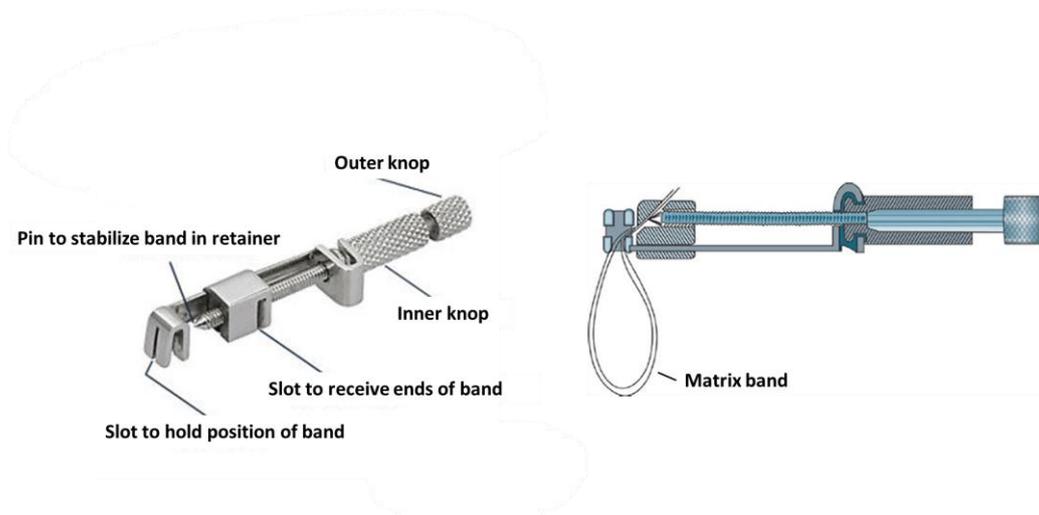
The function of the matrix band:-

- To retain the amalgam in the cavity during condensation.
- To permit close adaptation of the amalgam to cervical and axial margins.
- To help to restore the contact area and external contour of the crown.

Retainers are of 3 types:-

1) Ivory no. 8 and tofflemire retainers.

In these systems, the band encircles the tooth and secured by the retainer. They are indicated when we have 3 cavity surfaces (MOD), or 2 cavity surfaces (class II). The retainer is positioned from the buccal surface of the tooth. Bands used for these retainers have different shapes: universal, right-curved, and contoured. The chief advantage of this type is that it can be firmly adapted to the tooth.



-Tofflemire retainer-



-Ivory no. 8 retainer-



-The band encircles the tooth-



Universal: for general uses

Right-curve: for adequate tooth-restoration marginal seal

Contoured: for subgingival restorations

-Types and indications of the matrix band use for the Ivory 8 and Tofflemire retainers-

2) The band encircles $\frac{3}{4}$ (three- quarters) of the crown and is retained into the free embrasure by a retainer called Ivory no.1. Indicated when the contact points are so tight that it is difficult to place the other types. This system uses short metal bands with two or three holes at the two ends of the band.



-Ivory no.1-

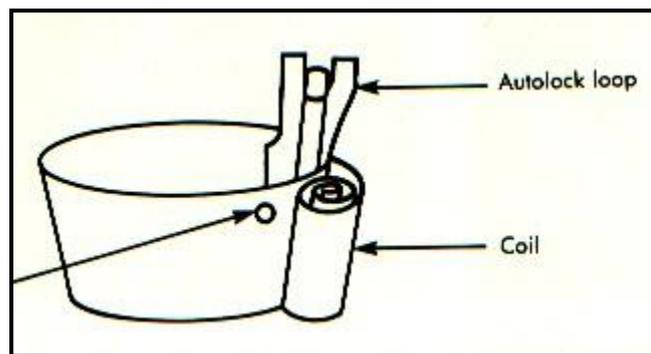


-Matrix bands-



-Ivory no.1 with matrix band in position-

3) In the third type only a matrix band is used without a retainer. Indicated in badly broken teeth, patient with gagging reflex.



The band should be:-

- 1- Strong, smooth, establishes proper anatomical contour.
- 2- Restoration of correct proximal contact relation.
- 3- Easy for insertion and removal.

Wedge:-

Objectives:-

- 1) To hold the band tightly against the gingival margin of restoration (excess contour of the cervical area)
- 2) To prevent overhang amalgam.
- 3) To provide sufficient separation of the teeth to compensate for thickness of the band material. the effective force of the wedge is horizontally directed to the cervical edge of the band, so when the wedge is forcefully driven into place resulting in separation of the approximate teeth, such temporary tooth movement will make up for the thickness of the matrix band material.

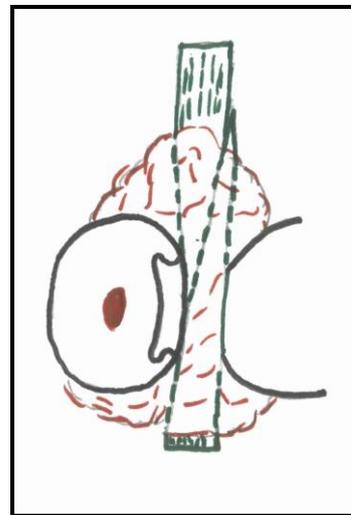
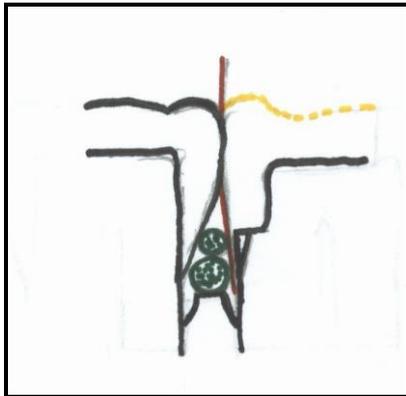
The wedge should be positioned as near as to the gingival margin (just beneath to the gingival margin). If the wedge positioned:

*Occlusal to gingival margin, the band will be pressed into the preparation creating an abnormal concavity.

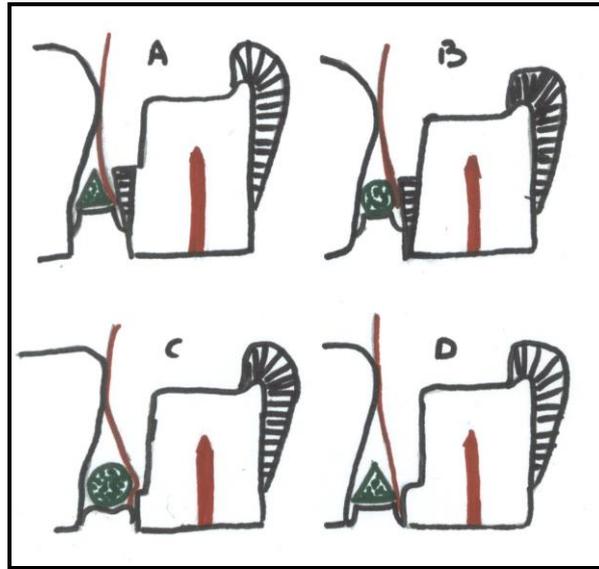
*As far as apical to margin, the band will not be held tightly against the gingival margin result in gingival excess (overhang).



If the wedge is significantly apical of the gingival margin, a second smaller wedge is placed on the first one to wedge adequately the matrix against the margin (in case of recession of interproximal tissue level). Occasionally a double-wedging is permitted if access allows, securing the matrix when the proximal box is wide faciolingually. One from the lingual side and the second from the facial embrasure.



The wedge is either triangular or round. The triangular can be modified (by knife) to conform to the approximating tooth contours. It's recommended for the deep gingival margin, because the base of the wedge will more readily engage enough tooth gingival to the margin without causing excessive soft tissue displacement. The round is preferred with conservative proximal boxes because its wedging action is more occlusal (near the gingival margin) without impinging the soft tissue.



Before inserting the amalgam, a final check should be made for the following points:-

- 1) Is the matrix system stable (by wedge...)
- 2) Does it fit the cervical margin? It should not be possible to insert a probe between the cervical margin and the band.
- 3) Is the height of the band sufficient (1-2 mm above the adjacent tooth, any attempt to remove the band before the reduction of the marginal ridge to its approximate height by contouring its outer incline is an invitation to marginal ridge fracture?)
- 4) Is the cavity clean and dry?

*Contamination with saliva increases leakage of the restoration. Zinc-containing amalgam expands excessively if contaminated by moisture when they are condensed. Zinc reacts with water to produce hydrogen gas. The hydrogen gas causes the amalgam restoration to expand, seeming to push out of the preparation.