DENTAL AMALGAM
PART 2

LEARNING OBJECTIVE

OBJECTIVES :

1. To know about the recent advantage with amalgam alloy.
2. Mercury toxicity and biocompatibility
3. Failure of amalgam

CONTENT

- Manipulation
- Modification
- Mercury hygiene and mercury toxicity
- Failures of amalgam

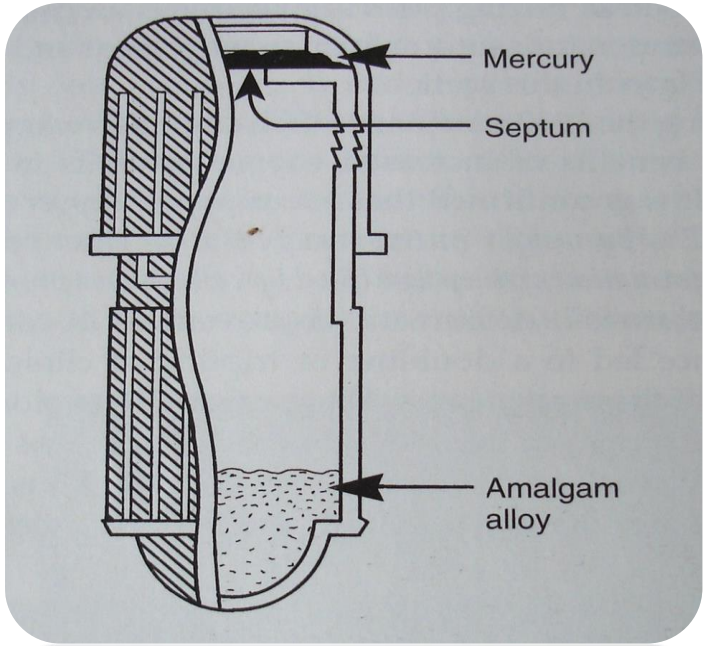
PROPORTIONING OF ALLOY TO MERCURY:

- Weighing and triturating:

  Ideal but time consuming

- Pre-weighed capsules of alloy powder and Hg separated by a membrane:

Disposable capsules containing pre-proportioned amounts of mercury and alloy are widely used. Just before the mix is triturated the membrane is ruptured by compression of the capsule.



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Techniques for proportioning:

1) High Mercury Technique-

- The initial amalgam mix contains more mercury than needed for the amalgamation process. This produces a very plastic mass.
- The excess mercury is removed by squeezing in a squeeze cloth prior the placement.
- Mercury is continued to be removed from the amalgam, by condensation in increments.
- This allows excellent cohesion between the increments.

2) Eames technique

- It is also known as minimal mercury technique.
- Adequate mercury must be present to provide a plastic and coherent mass, without the need for removal of mercury during condensation.
- The initial mix contain mercury and alloy in a ratio of 1:1. This facilitates the formation of a cohesive mass after trituration, without the need to remove excess mercury from the mix, although, it still needs to be squeezed out during the incremental condensation.
- The proportioning of the alloy is done by weight. This is because volume proportioning can be misleading due to trapped air and voids in the mass.

Anusavice KJ, Shen C, Rawls HR. Phillips' science of dental materials. Elsevier Health Sciences; 2013

TRITURATION

Originally the alloy and mercury were triturated, by hand with a mortar and pestle

Today mechanical amalgamation saves time and standardizes the procedure.

Objective of Trituration:

1. To achieve a workable mass of amalgam within a minimum time, leaving sufficient time for its insertion into a cavity preparation and carving the tooth anatomy.
2. To remove oxides from the powder particle surface, facilitating direct contact between the particles and the mercury.

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3.To pulverize pellets into particles that can be easily attacked by the mercury.

4.To reduce particle size so as to increase the surface area of the alloy particles per unit volume , leading to a faster and more complete amalgamation.

5.To dissolve the particles or part of the particles of the powder in mercury , which is a required for the formation of the matrix crystals.

6.To keep the gamma1 matrix crystals as minimal as possible yet evenly distributed throughout the mass for proper binding and consistent adequate strength.

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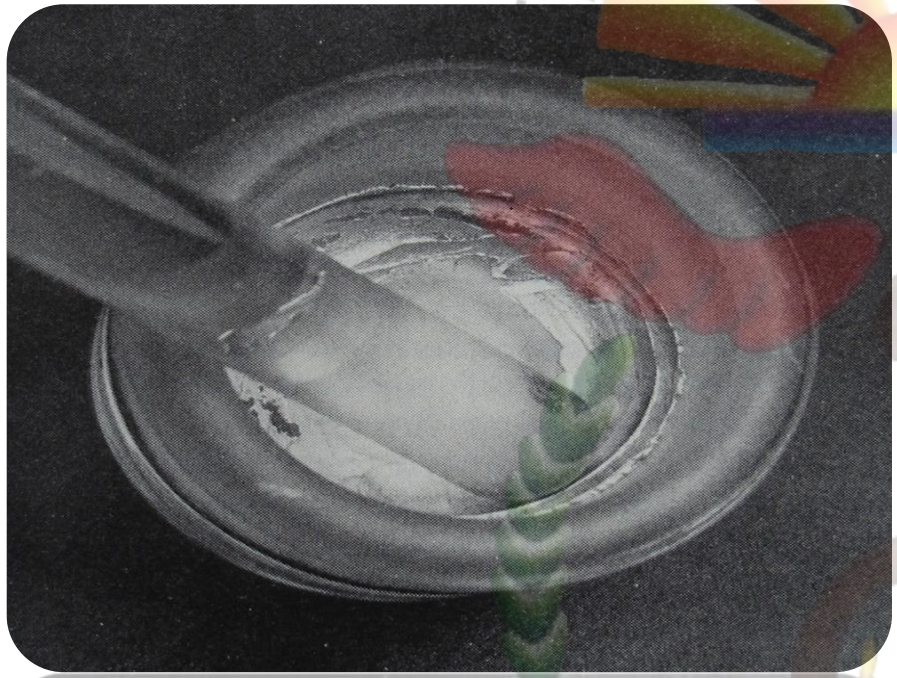
- Methods:

  -With mortar and pestle (hand trituration)

  -mechanical amalgamator



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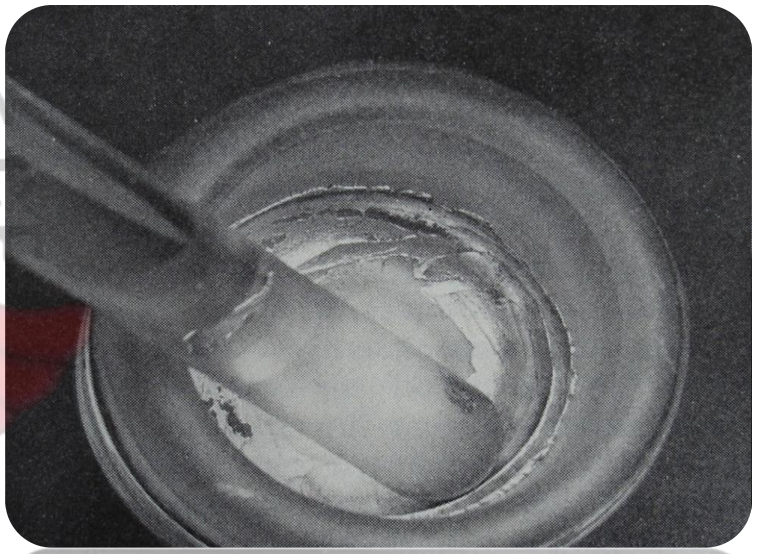
- Glass mortar is of parabolic shape, and a pestle is used.

Mixing Time → 30-40sec

Force → 800-900 gm



- Mixed mass should be:
  - homogeneous,
  - smooth,
  - should not stick to walls of mortar and pestle
  - should form a lump.

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Mechanical Trituration: (Amalgamator)

- Capsule serves as a mortar.
- A cylindrical metal or plastic piston of smaller diameter than the capsule is inserted into the capsule which serves as the pestle.
- Alloy & mercury are dispensed into the capsule
- The arms holding the capsule oscillate at high speed thus accomplishing trituration.
- Reusable capsules are available with a friction fit and screw cap lids.

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- Pestles may be plastic or metal. The diameter and length of the pestle should be considerably less than the capsule. If the pestle is too large, the mix is not homogeneous.

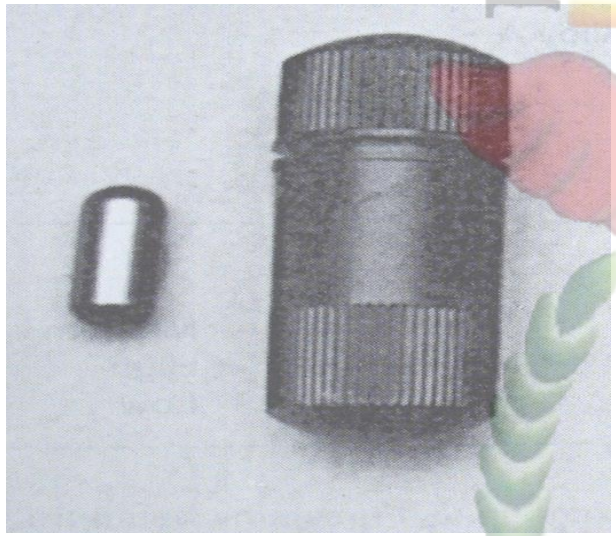

Fig A: satisfactory size between a capsule and pestle

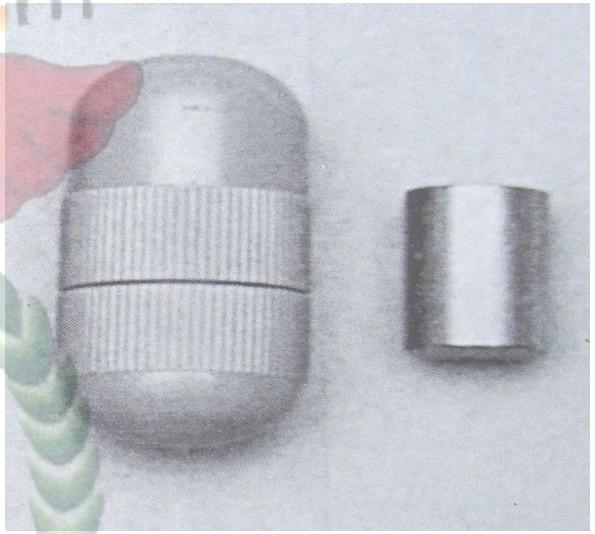

Fig B: unsatisfactory size between a capsule and pestle

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MULLING

- It is a continuation of trituration.
- Can be accomplished in two ways:-

  a) By kneading the plastic amalgam mix in a piece of rubber dam.

  b) By triturating the mix in a pestle free capsule for 2-3 seconds after the specified time.

- It is done to improve a uniform mass and get single consistent mix.

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CONDENSATION

- Refers to the incremental placement of the amalgam into the prepared cavity and compression of each increment into the others.

- Amalgam should be condensed into the cavity within 3 min after trituration.

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Objectives:

- To adapt amalgam to the cavity walls.
- To remove excess Hg.
- To bring Hg on the top of each increment so as to bind the increments to one another (increasing dryness technique).
- To increase the density of the restoration by development of an uniform compact mass with minimal voids.
- To increase the rate of hardening so that carving operation need not be unduly delayed.

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Hand condensation:

The amalgam mixture should never be touched with bare hands because :

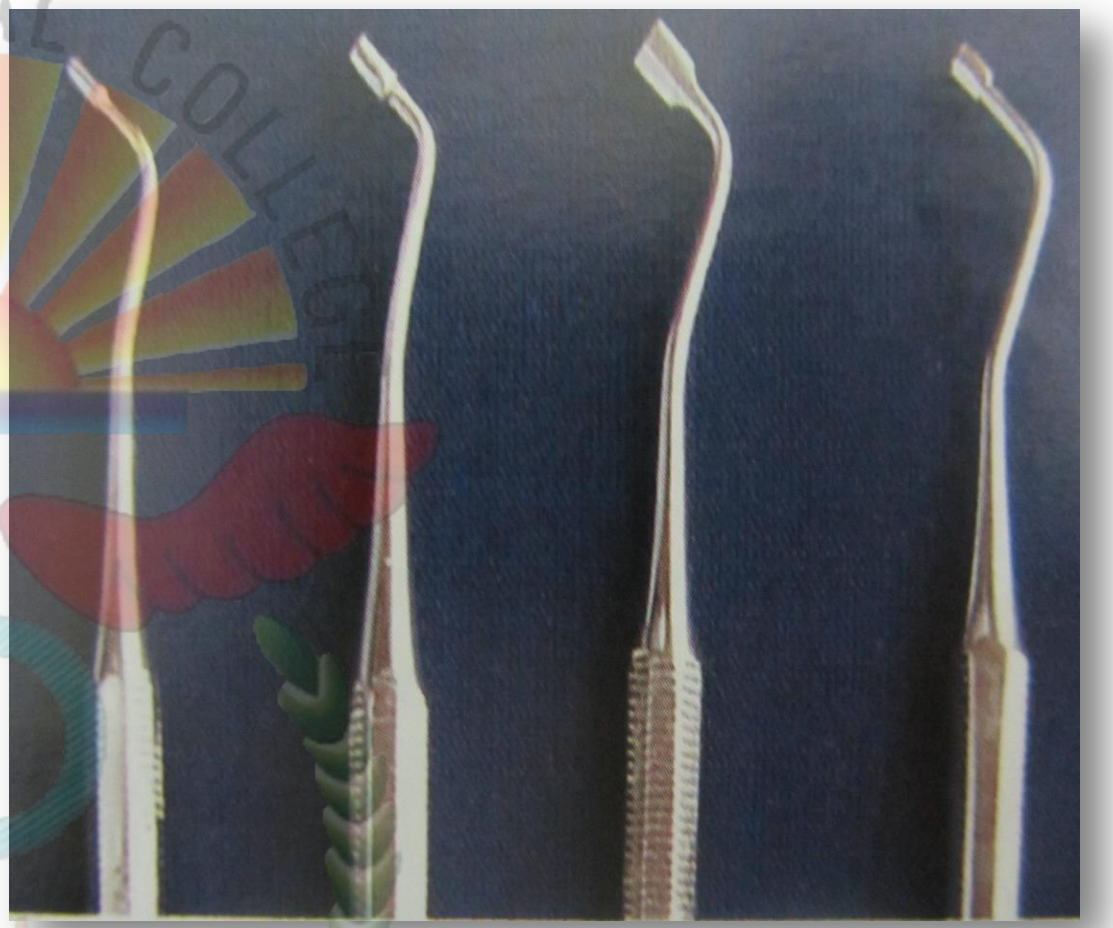
-The freshly mixed alloy contains free mercury.

-Moisture on the surface of the skin is a source of contamination of the amalgam

- It should immediately be condensed with sufficient pressure to remove voids and to adapt the material to the walls, once inserted.
- The initial condenser should be small enough to condense into the line angles.

Condenser: Are instruments with serrated tips of different shapes & sizes

- The shapes are round , trapezoidal, triangular, circular or square
- Condenser type is selected as per the area & shape of the cavity
- Smaller the condenser, greater is the pressure exerted on the amalgam



Round , Trapezoidal, Parallelogram, Elliptical Condenser

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Condensation pressure:

- “The area of the condenser point & the force exerted on it by the operator govern the condensation pressure.”

- Smaller the condenser, the greater the pressure exerted on the amalgam.

- If condenser point is too large, then the operator cannot generate sufficient pressure to condense the amalgam adequately & force it into retentive areas.

- Force in the range of 13.3-17.8 N(3-4 lbs) Recommended forces → upto 15lbs.

- small condenser (0.8mm) is used at the initial stages of condensation to pack into retentive grooves and cavo surface margins.
- Medium sized condensers should be used to pack the bulk of the restoration.
- Large size is used for the last portion of the occlusal surface.
- Smooth condensers slide across the amalgam while serrated ones has more grip on the amalgam surface and helps in bringing a layer of mercury to the surface.

Mechanical Condensation:

"Condensation of the amalgam is performed by an automatic device."

Useful for irregular shaped alloys when high force is used.

Various mechanisms are employed for these instruments:

- impact type of force(pneumatic type)
- rapid vibration.

Advantages are:

a) less energy is needed than for hand condensation.

b) the operation may be less fatiguing to the dentist.

BURNISHING

It is a process of rubbing usually performed to make a surface shiny and lustrous

It is an adjunct to condensation as it further adapts and compacts the amalgam mass along the walls of the cavity.

- The objectives of burnishing are:

1. It further reduces the size and number of voids on the critical surface and marginal areas of the amalgam.
2. It brings any excess mercury to the surface , to be discarded during carving.
3. It will adapt the amalgam further to cavosurface anatomy.
4. It conditions the surface of amalgam for carving step.

Fig: ball shaped, egg shaped, beaver tail shaped burnisher

PRECARVE BURNISHING

- After condensing with amalgam condensers, the amalgam maybe further condensed and shaping of the occlusal anatomy begun with a large burnisher such as an ovoid burnisher.
- This is done with use of heavy strokes, made in mesiodistal and faciolingual directions.
- This produces denser amalgam at the margins of the restorations.
- Mainly useful for high copper amalgams.

CARVING

- Using remaining enamel as a guide, carve gently from enamel towards the center and recreate the lost anatomy of the tooth.
- Amalgam should be hard enough to offer resistance to carving instrument
- A scarping or "ringing" (amalgam crying) should he heard.
- If carving is started too soon, amalgam will pull away from margins.

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Objectives:

- To produce a restoration with
  Proper physiological contours.
- Minimal flash (no overhangs).
- Functional, non-interfering anatomy.
- Adequate, compatible marginal ridges.
- Proper size, location, extent and inter-relationship of contact areas.
- Physiologically compatible embrasures.
- No interference with integrity of periodontium.

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POST CARVE BURNISHING

- Final Burnish (Post carve burnishing):
- It is done after carving is complete and occlusion is adjusted
- Use a large burnisher , burnish outwards towards the margins
- provides shiny smooth surface removing scratches and irregularities
- Heat generation should be avoided
- If temperature raises above 60˚C, causes release of mercury accelerates corrosion & fracture at margins

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FINISHING AND POLISHING

- Finishing of amalgam restoration involves removal of marginal irregularities defining anatomical contours and smoothening the surface roughness of restoration.

- Polishing is done to achieve a smooth, shiny luster on surface of amalgam restoration.

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Objectives Of Finishing:

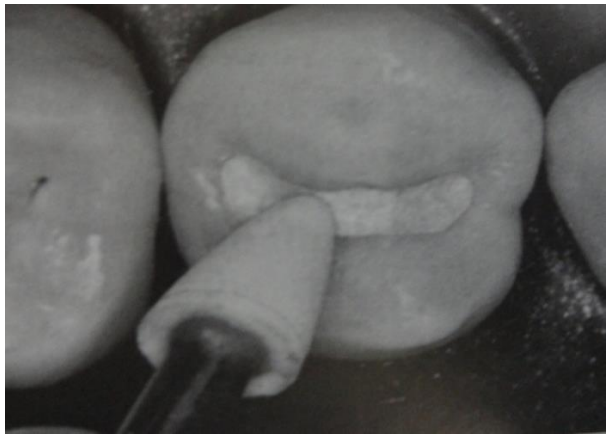
- Remove superficial scratches, pits & irregularities→ minimizes corrosion & prevents adherence of plaque.
- To correct discrepancy

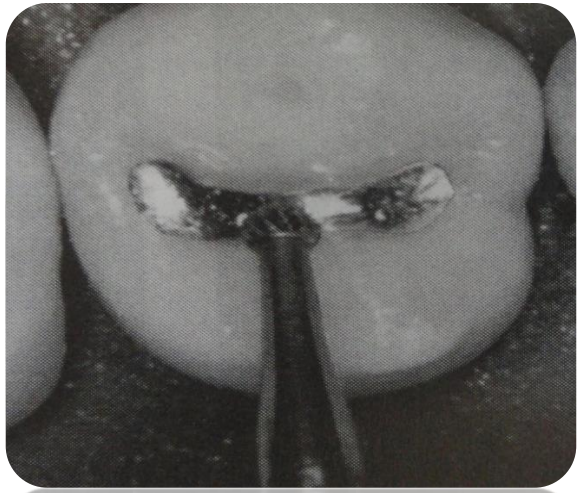
  -a pointed white fused alumina stone

  -green stone is used
- Further smoothening:

  -using light pressure with a suitably shaped round finishing bur.

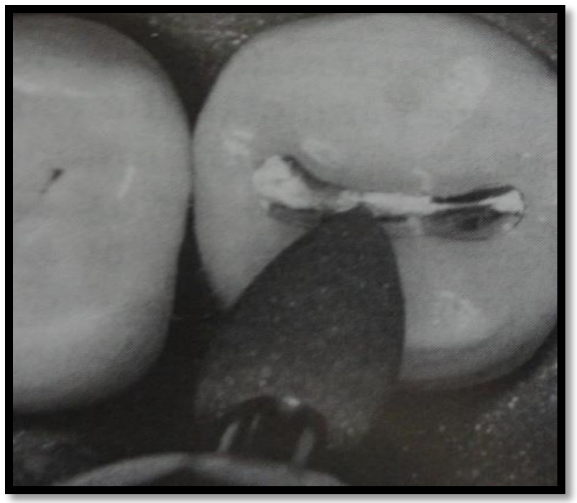
  -removes the scratches from the green or white stone using light pressure with a suitably shaped





POLISHING

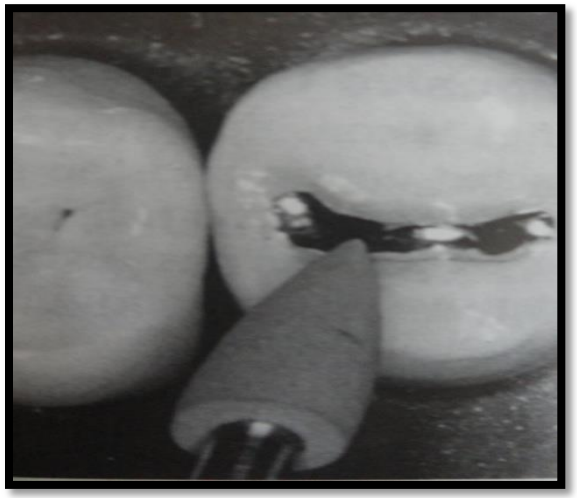
Initiated by coarse abrasive rubber point at slow speed and an air water spray.



Diminishing grades (increased fineness) of abrasives are used for polishing.

Final polishing →

- rubber cup with a flour of pumice .
- tin oxide followed by a high luster agent like precipitated chalk.



Shofu Polishing Kit:

- Available as brownies, greenies, super-greenies.
- They are abrasive impregnated burs and cups

Advantages:

- Easy to use
- Easily adaptable to all the areas if the restoration
- Less messy than pumice and tin oxide

Disadvantages:

- Expensive
- Heat generation

GALLIUM BASED ALLOY

- Gallium was discovered in 1875.
- It is a metal with similar atomic structures and characteristics to mercury and has a melting temperature of 29°C. Hence, by 1928 Puttkammer suggested gallium as a substitute for mercury.
- Recently, 2 Gallium based restorative alloys have become available.

  1. Gallium Alloy GF II
  2. Galloy

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Advantages:

- Creep resistance complies with ISO requirements
- Gallium amalgam expands after trituration, it provides better marginal seal than silver amalgam
- Setting time is less so it can be finished and polishes after one hour.

Disadvantages:

- Handling of gallium is difficult because it has tendency to stick to the instruments
- Extreme technique sensitive.

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BONDED AMALGAM RESTORATIONS:

- To compensate for some of the disadvantages presented by amalgam a clinical technique that bonds amalgam to enamel and dentin was introduced by Baldwin in 1897.
- The agent used are adhesive resin system which contain monomer like 4-META (methyacryloxy ethyl trimelliate anhydride)

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- **Advantages:-**

I. It permits more conservative cavity preparations because it does not always require additional mechanical retention.

II. It eliminates the use of retentive pins

III. It reduces marginal leakage to minimum.

IV. It reinforces tooth structure weakened by caries and cavity preparation.

V. It reduces the incidence of postoperative sensitivity

VI. It reduces the incidence of marginal fracture.

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Disadvantages:

- Technique sensitive as the adhesive resin may stick to the condenser, matrix, etc. Making amalgam placement quit messy.
- Inco-operation of resin into amalgam may lower its mechanical strength.
- Long term durability of bond between the amalgam and the tooth is not well known.

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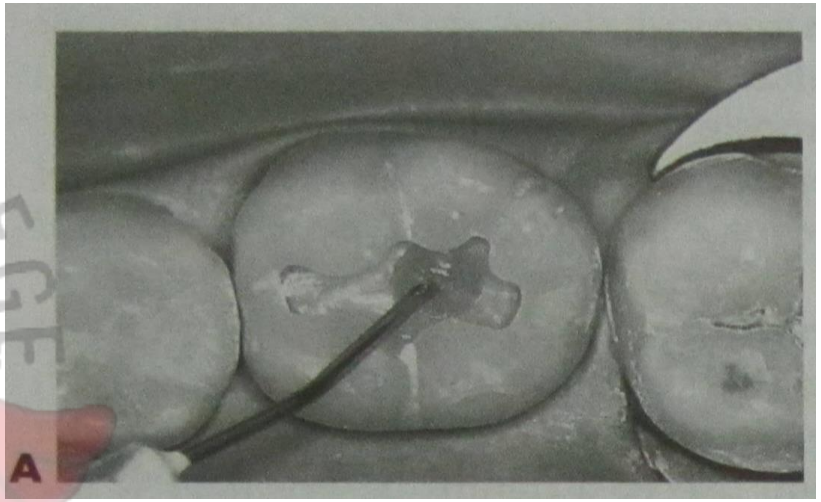
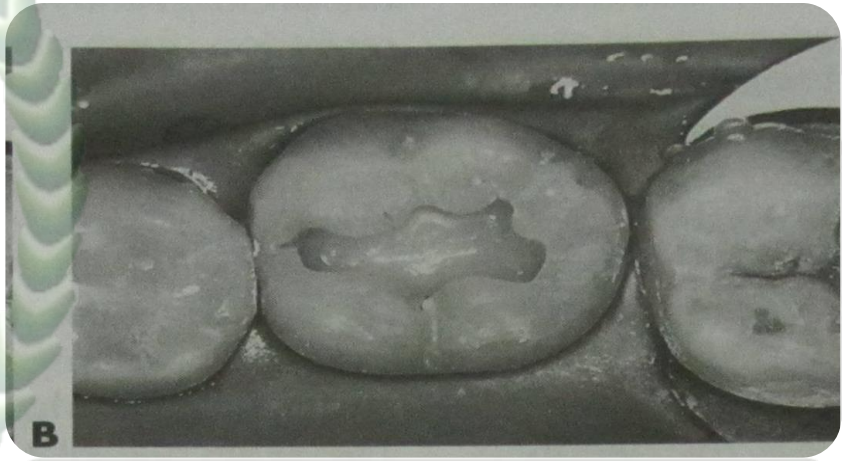
Technique of bonded amalgam:

- generally acid solutions such as 10% phosphoric acid or 3 % ferric acid is applied to desired cavity preparation.
- Acid etching removes the smear layer, and opens the intertubular and peritubular dentine.
- followed by removal of hydroxyapatite crystals leaves a collagen meshwork that can collapse and shrink because of the loss of inorganic support



10% phosphoric acid or citric acid and 3% ferric acid



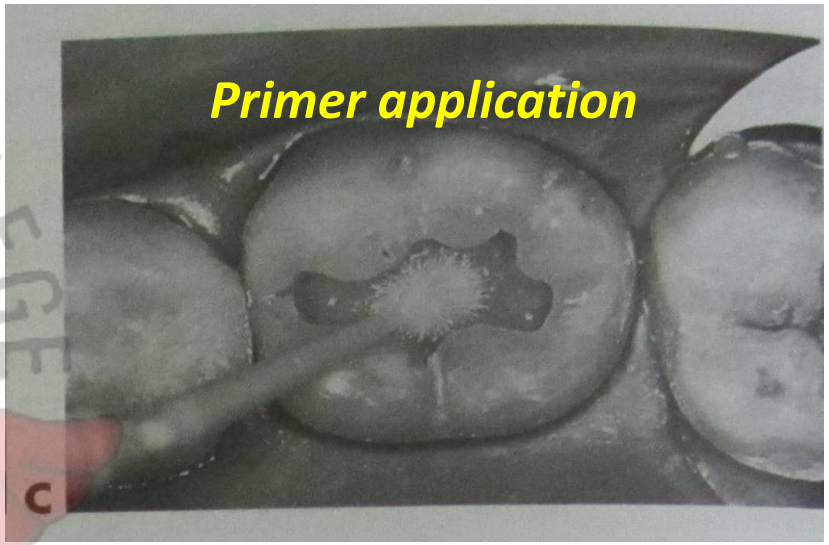
The Development of Resin-bonding for Amalgam Restorations, J. C. Setcos,1 M. Staninec2 and N. H. F. Wilson3, British Dental Journal VOL 186 April 1999

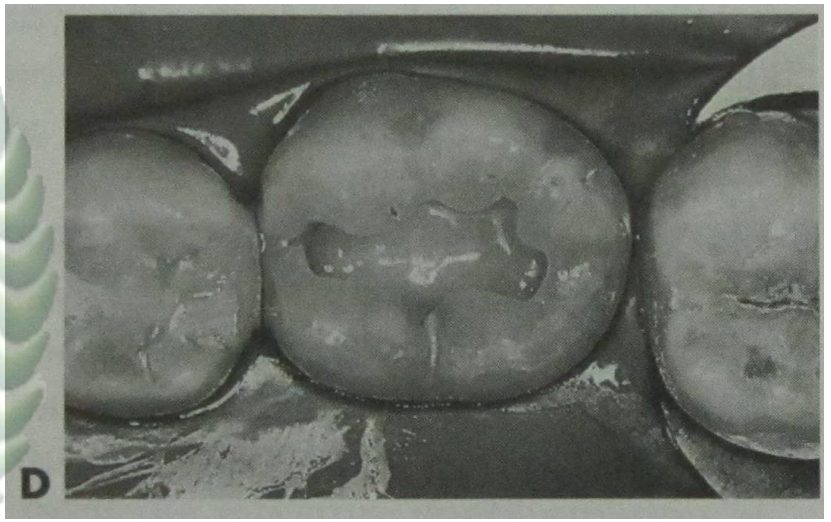
Application of Primers

- primer is applied after rinsing of the conditioner. Primer such as HEMA (hydroxy-ethyl-methacrylate),and 4-methacryloxyethyl trimellitate anhydride is used.
- (4-META) contain two functional groups

- a hydrophilic group and a hydrophobic group. The hydrophilic group has an affinity for the dentinal surface and the hydrophobic (methacrylate) group has an affinity for resin.

The primer wets and penetrates the collagen meshwork, raising it almost back to its original level.



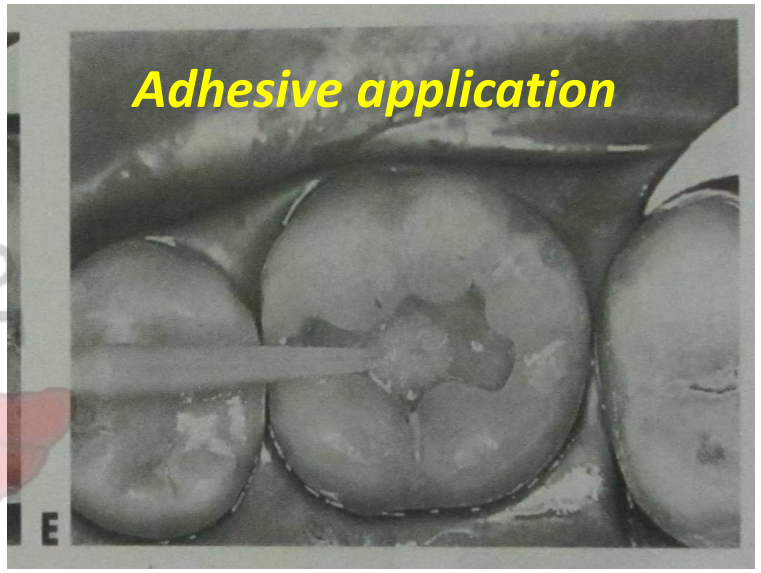


The Development of Resin-bonding for Amalgam Restorations, J. C. Setcos,1 M. Staninec2 and N. H. F. Wilson3, British Dental Journal VOL 186 April 1999

Application of Dentine adhesives

- These are applied by brush or other means to cover the treated surface to permit resin wetting and penetration.
- They are unfilled resins that may consist of hydrophobic monomers such as

  bis-GMA,
- promote adhesion to facilitate wetting of the dentine. Some examples are: Single Bond (3M), One-Step (Bisco)



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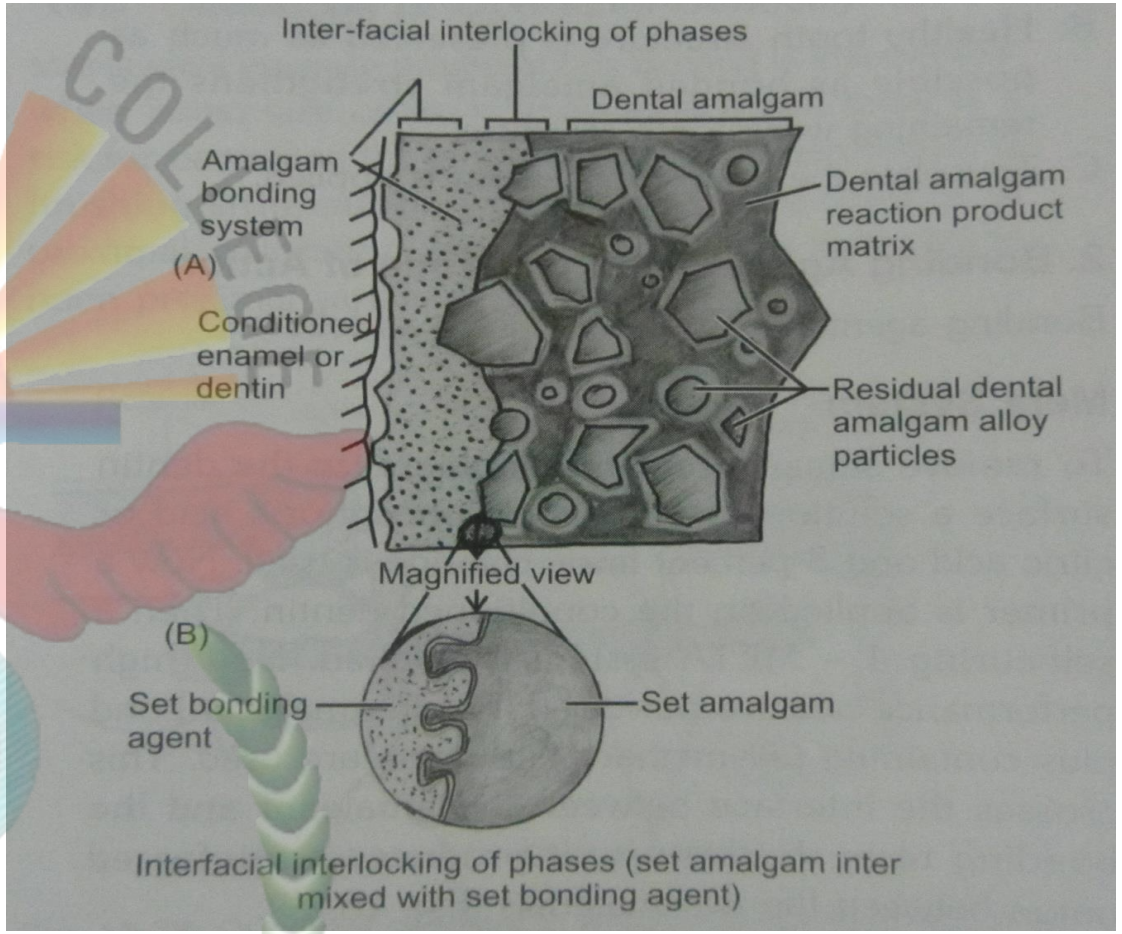
Hybrid layer

- Unfilled resin, when applied, penetrates the primed dentine.
- the primer form an *intermingled layer* of collagen and resin, termed as

Resin-reinforced zone, Resin-infiltrated layer or the Hybrid layer.

- Formation of this hybrid layer, as was described by Nakabayashi et al. in 1982, this is the primary bonding mechanism of most current adhesive systems.



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OTHER USES OF AMALGAM

METAL-REINFORCED GLASS IONOMER CEMENTS

Types

- Silver alloy admixed: Spherical amalgam alloy powder is mixed with type II GIC powder

  Eg: Miracle Mix

- Cermet: Silver particles are bonded to glass particles.

  Done by sintering of a mixture of the two powders at a high temperature.

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FLUORIDE RELEASING AMALGAM

- Have been shown to have anticaries properties sufficient to inhibit the development of caries in cavity walls.
- Concentration of fluoride is sufficient to enhance remineralization
- Greatest concentration of fluoride i.e. about 4000µg/mL in enamel surfaces exposed to fluoride-containing amalgams were found in the outer 0.05µm of the tissue.

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- In dentin, the greatest concentrations, i.e. about 9000µg/ml were found at a depth of 11.5µm.
- However, this release of fluoride decreases to minor amounts after 1 week.
- Forsten L (1976) -- fluoride released from amalgams loaded with soluble fluoride salts was detectable within the first month and thereafter fluoride was not released in measurable amounts.
- Garcia Godoy et al(1990) – fluoride release can continue as long as 2 years (but at a much lower rate than that for GIC).

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Uses:

- Restoration of small cavities as an alternative to amalgam or composite in young patients who are prone to caries.
- For core buildup of grossly destructed teeth.

Advantage:

- Anticariogenic property due to leaching of fluoride.
- More resistant to wear than type II GIC.

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- Disadvantages:-

i. It has not been in use long enough to allow a proper evaluation of its clinical performance.

ii. It increases the cost of amalgam restoration

iii. It increases the time to perform a conventional amalgam and may be technique sensitive.

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MERCURY AND BIOCOMPATIBLITY ISSUE

- Amalgams have been used for 150 years
- About 200 million amalgams are inserted each year in the United States and Europe

- Mercury in dental amalgam may pose threats to the health of patients, to the health of dental care providers and to the environment.

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Mercury is available in 3 forms:

- Elemental mercury (liquid or vapor).
- Inorganic compounds.
- Organic compounds

Concentration:

The Occupational Safety & Health Administration (OSHA) has set a TLV of 0.05 µg/m^3 as the maximum amount of mercury vapor allowed in the work place per week.

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- Lowest dose of mercury that elicits a toxic reaction – 3to7 g/kg body weight
- Paresthesia -- 500 ug/kg body weight
- Ataxia -- 1000 ug/kg body weight
- Joint pain -- 2000 ug/kg body weight
- Hearing loss & death -- 4000 ug/kg body weight

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RISK TO DENTIST AND OFFICE PERSONNEL

Recommendations from the ADA include the following:

- The work place should be well ventilated, with fresh air exchange and outside exhaust
- Use only precapsulated alloy, discontinue use of Bulk mercury & bulk alloy
- Avoid the need to remove excess mercury before or during packing by selecting an appropriate alloy: mercury ratio
- Use an amalgamator with a completely enclosed arm.

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- Mercury and unset amalgam should not be touched by the bare hands.
- Floor coverings should be non absorbent & easy to clean
- Spilled mercury should be cleaned up using trap bottles, tape or freshly mixed amalgam to pick up droplets
- Do not use a house hold vacuum cleaner to clean spilled mercury.
- Skin accidentally contaminated by mercury should be washed thoroughly with soap and water.

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Reasons For Failure Of Amalgam Restoration:

1.Improper Case Selection & Diagnosis

- Extent of Caries
- State of pulp
- Position of tooth in the oral cavity
- Habits & oral hygiene
- Periodontal condition

2. Improper Cavity Preparation

- Inadequate occlusal extension
- Over extension of cavity preparation walls
- Improper depth of cavity
- Pulpal floor
- Butt joints/unsupported enamel rods
- Failure to round off line and point angles
- Improper width of isthmus

- Faulty selection and manipulation of amalgam
  - Selection of alloy and mercury
  - Improper trituration
  - Improper condensation
  - Contamination
  - Over and under carving
  - Improper finishing

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Signs Of Failure Of Amalgam

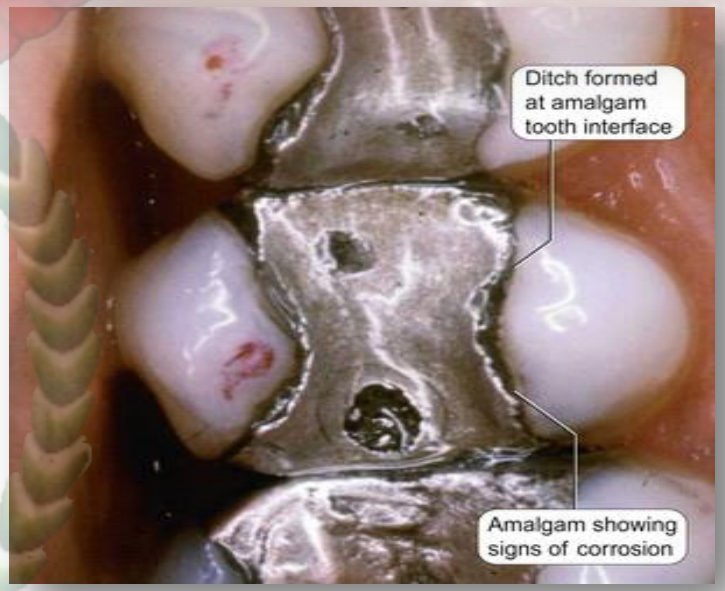
1. Fracture of Restoration-

- At Bulk

-Extrusion of restoration- at isthmus

- Expansion

2.Ditching of Amalgam



3.Tarnish & corrosion

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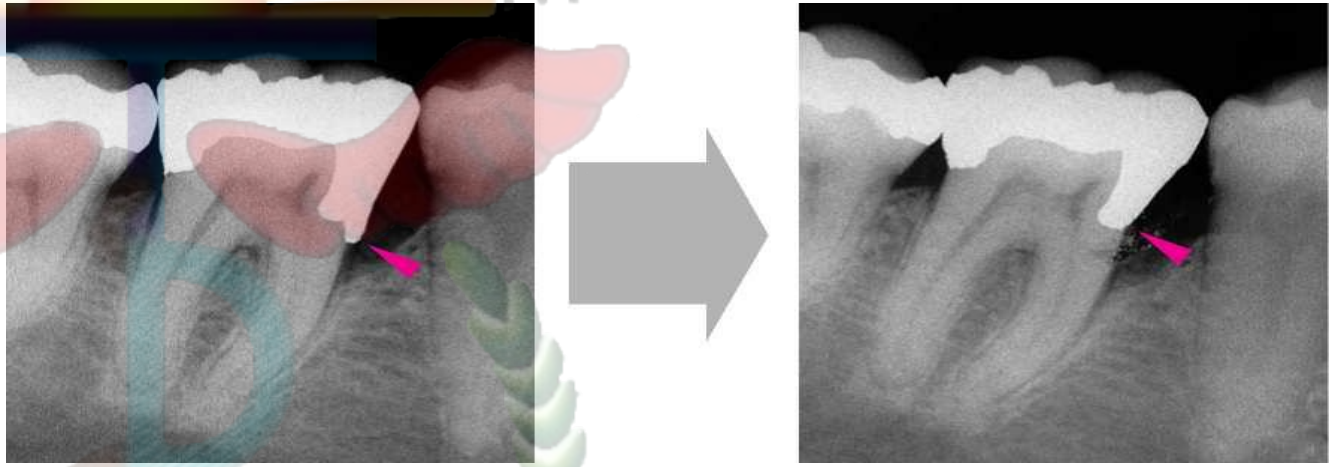
4. Marginal Leakage

- It is clinically undetectable passage for bacteria & bacterial products.

- post operative sensitivity
- Secondary caries
- Pulpal pathology
- Marginal discoloration

5.Proximal overhangs

- Diagnosed by
  - visually
  - tactile
  - radio graphs



- It is site for entrapment Plaque and food debris leading to poor oral hygiene. And result in inflammation of the adjacent soft tissues.

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6.Marginal ridge in competency

- Marginal ridge portion of the amalgam restoration should be compatible with the adjacent marginal ridge
- Both ridges should be approximately at same level and display correct occlusal form

7.Proximal contact area

- Evaluation is done by ,dental floss , mouth mirror
- Presence of open contact contributes in poor inter proximal tissue health and food impaction.

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CONCLUSION

There are certain advantages inherent with amalgam such as technique insensitive, excellent wear resistance, less time consuming, less expensive which are not present in the newer materials, these factors will continue to make amalgam the material of choice for many more years to come.

TAKE HOME MESSAGE

Amalgam is unique in nature as restorative material , and has the longest track record in the field conservative dentistry to know about the basic chemistry, advantages and disadvantages ,mercury hygiene every clinician should have the deep knowledge and clinical skills.

PROBABLE SAQS AND LAQS

1. Compared with amalgams made from admixed high-copper alloys, what are the benefits and risks of the amalgams made from high copper single-composition spherical particles? (LAQ)
2. Discuss the manipulation of amalgam in detail ? (LAQ)

3. What are the modifications of amalgam? (SAQ)