Dental amalgam: characteristic, toxicity and clinical use

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250 years of EXCELLENCE in medical education, research & innovation and healthcare

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http://semmelweis.hu

FACULTY OF DENTISTRY
Department of Conservative Dentistry

Caries therapy Requirements

- Biocompatibility
- Adequate mechanical properties:
  - press, strain, flex coefficient, resistivity
  - elasticity
  - surface hardness
  - abrasion resistance
- Shape/form and volume stability
  - tooth-similar thermal expansion

Caries therapy Requirements

- Resistance against humidity, indissolubility, bonding
- Thermal and electrical isolation
- Antiseptic effect, caries-prophylactic properties
- Radiopacity
- Tooth-similar optical properties
- Simple application, finishing, polishing
- Easy removal
- Low price

Restorative dental materials

- Temporary restorative materials
- Liners and bases
- Definitive restorative materials
  - Direct restorative dental materials (plastic)
    - Amalgams
    - Cement
    - Cermet Cement
    - Polymers
    - Composite
  - Indirect restorative dental materials (solid)
    - Metal
    - Ceramic
      - Glass-ceramic
      - Direct Ceramic (Cerec ...)
      - Gold-ceramic
    - Composite

Indirect restorations

Inlays - Onlays

Metal

Ceramic

Glass-ceramic

Direct Ceramic (Cerec)

Gold-ceramic

Composite

Amalgam

An alloy of mercury with any other metal

Dental amalgam:

mercury and silver-tin alloy,

plus copper and zinc

biner, tertier, quaterner etc.

amalgams

Classification

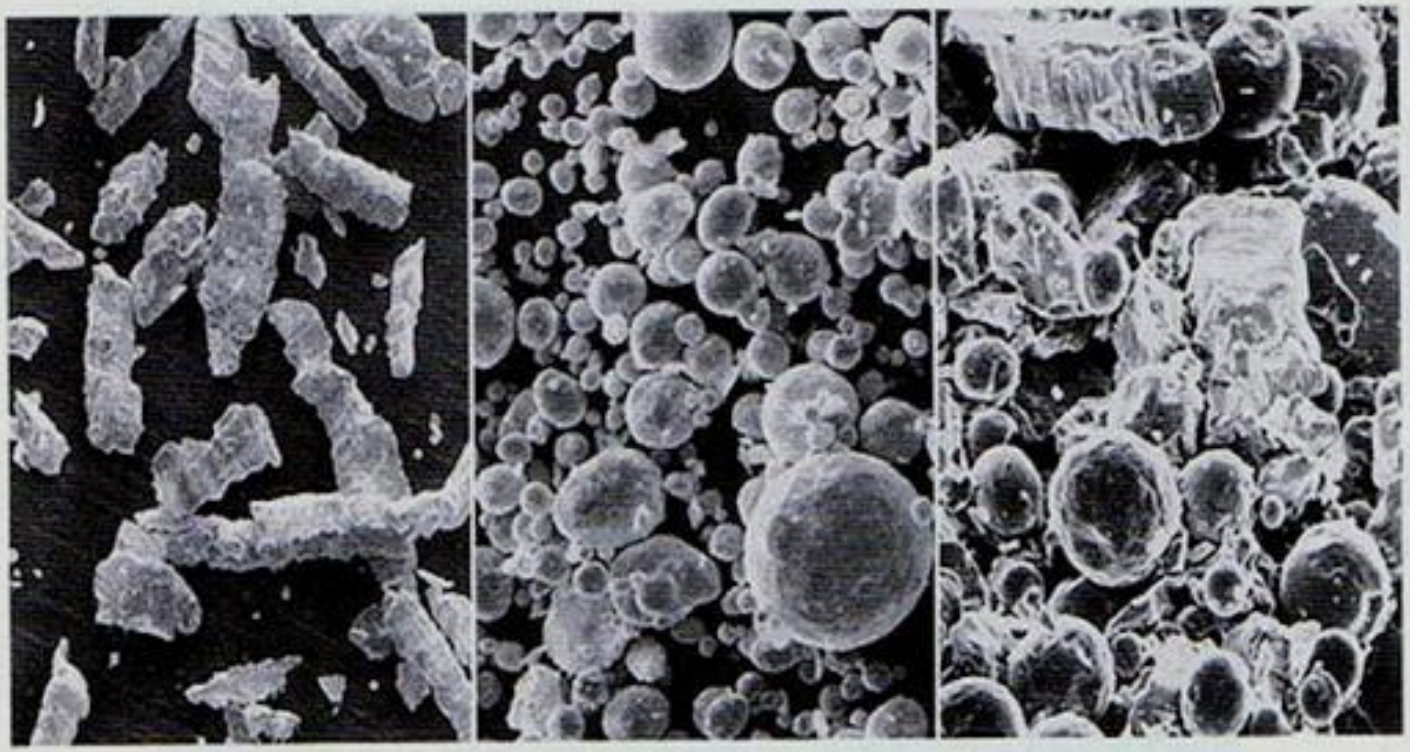
in terms of

- Dental amalgam alloy particle geometry and size
- Copper content
- Zinc content

Classification

in terms of

- Dental amalgam alloy particle geometry and size
  - filings
  - lathe-cut particles
  - spherical
  - mixed geometries
- Copper content
- Zinc content



Micrographs of alloy particles. **A,** Irregular. **B,** Spherical. **C,** Admixed with irregular and spherical particles.

by milling an ingot

by atomizing liquid alloy

mixture

Classification

in terms of

- Dental amalgam alloy particle geometry and size
- Copper content
  - Low-copper dental amalgams 2-5 %
  - High-copper dental amalgams 12-30 %
- Zinc content

Classification

in terms of

- Dental amalgam alloy particle geometry and size
- Copper content
- Zinc content
  - Zinc-containing
  - Zinc-free

Materials properties

- Physical properties
- Mechanical properties
- Chemical properties
- Biological properties

Materials properties 1.a.

- Physical properties
  - →Mass
  - →Thermal
  - →Electrical
  - →Optical
  - →Surface properties
- Mechanical properties
- Chemical properties
- Biological properties

Materials properties 1.b

- Physical properties
  - Coefficient of thermal expansion/contraction
    - → percolation (egress/ingress of fluids)
    - → heat flow – thermal conductivity
  - Electrical conductivity
  - Mass properties density
  - Optical properties – color, radiopacity
  - Surface properties

Materials properties 2.

- Physical properties

- Mechanical properties
  - →Stresses and strains within a material as a result of an external force
  - →Response to loading, compression, tension, shear, torsion, flexion, hardness
- Chemical properties
- Biological properties

Materials properties 3.

- Physical properties
- Mechanical properties

- Chemical properties
  - →Chemical and electrochemical interactions
  - →Chemical and electrochemical corrosion

- Biological properties

Materials properties 4.

- Physical properties
- Mechanical properties
- Chemical properties

- Biological properties

  Characterization of

  - toxicity (threshold level) and
  - sensitivity reaction during clinical use

Jörgensen - equation

$$8\ Ag_3Sn + 33\ Hg = 8\ Ag_3Hg_4 + Sn_8Hg$$

γ γ_1 γ_2

γ_2 phase is responsible for:

- Corrosion
- Discolouration
- Marginal fracture
- Creep

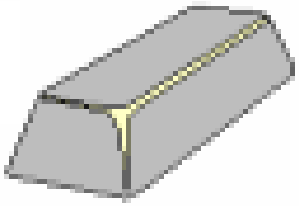
$Ag_3Sn + Cu_3Sn + Hg$ →

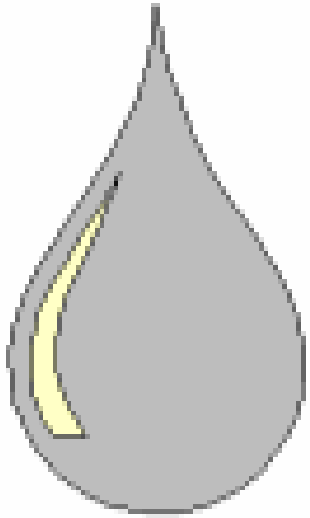
γ ε (epsilon)

$Ag_2Hg_3 + Cu_6Sn_5 + res.\ Ag_3Sn$

γ_1 ή (eta) γ

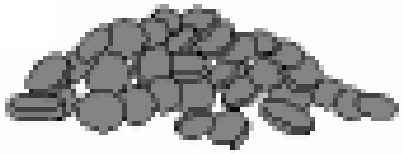
silver





copper

tin

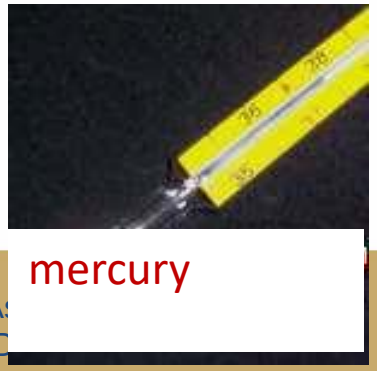


mercury

silver

copper

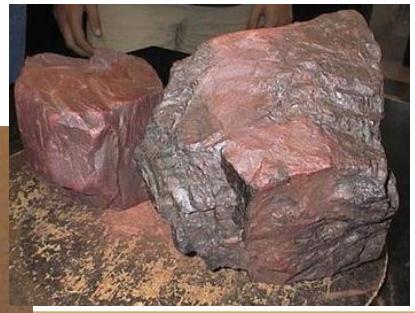
tin



mercury

Conventional amalgam fillings compound (FDI)

- Ag min 65 %
- Sn max 29 % time of plasticity ↑
  shrinkage ↓
- Cu max 6 % hardness
- Zn max 2 % colour stability
- Hg max 3 %



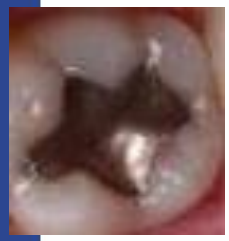




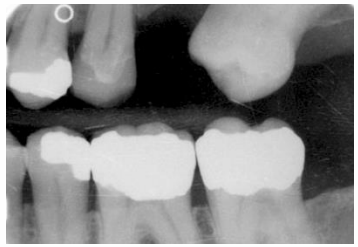




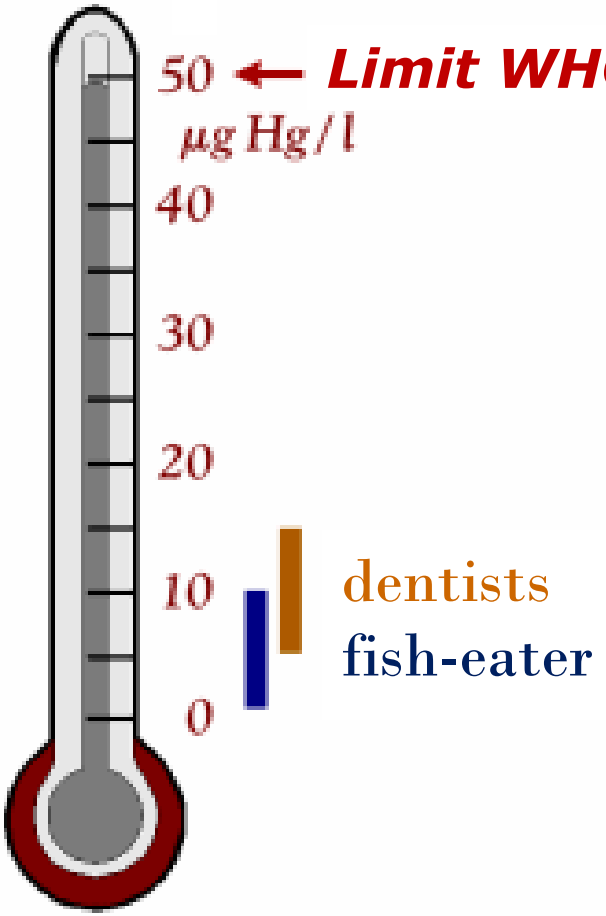

Properties of dental amalgams



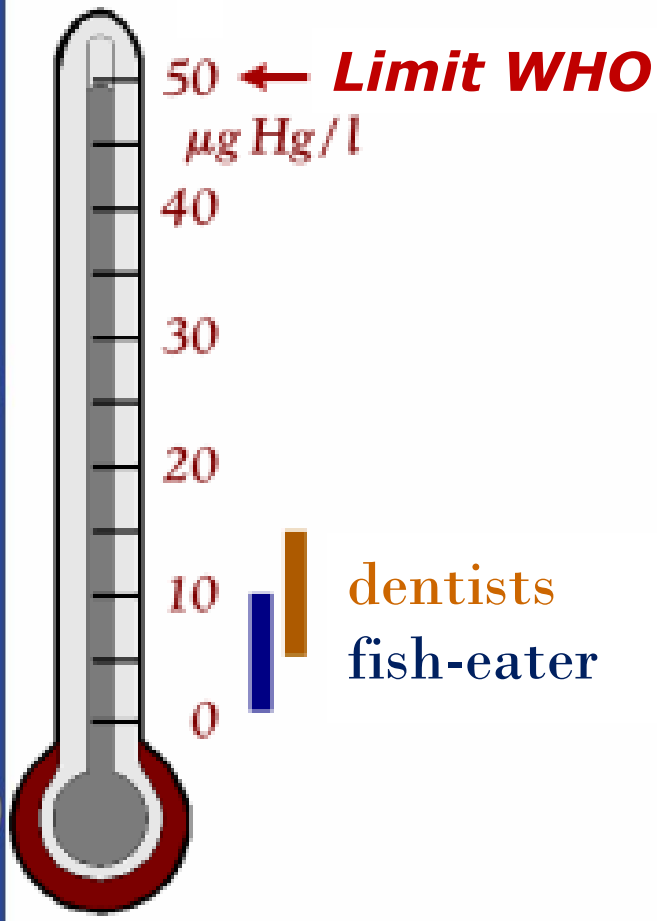
1. volumetrical stable
2. indissoluble
3. mechanical resistance
4. ductility
5. *thermal and electrical conductivity*
6. *corrosion*
7. non-toxic!!!! (inorganic)
   sensitivity (allergy): rare
8. radiopacity
9. *colour*
10. amalgam with F^-content
11. price



Mercury in urine



Toxicology of amalgam



- Also the American Dental Association U.S. Centers for Disease Control and Prevention and World Health Organization all agree that based on extensive scientific evidence, dental amalgam is a safe and effective cavity-filling material.

Toxicology of amalgam

Minamata disease

- **Chisso-Minamata disease**, is a neurological disease caused by severe mercury poisoning. Signs and symptoms include ataxia, numbness in the hands and feet, general muscle weakness, loss of vision, and damage to hearing and speach. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb.

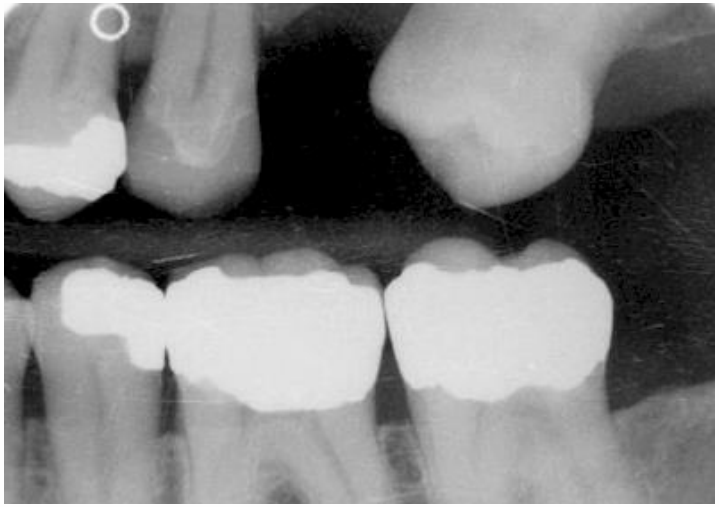
Minamata disease

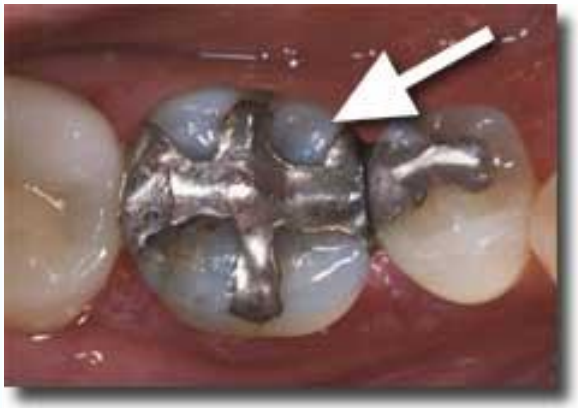
- It was caused by the release of the industrial wastewater from the Chisso chemical factory.
- The inorganic mercury in the wastewater was metabolized to organic methylmercury by bacteria in the sediment.
- This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and was eaten by the local population, and animals, and resulted in mercury poisoning.

- The human and cat, dog, pig deaths continued for 36 years, Chisso and the Kumamoto prefectural government did little to prevent the epidemic.
- The animal effects were severe enough in cats that they came to be named as having "dancing cat fever".

Rules of protection in dentistry

- - no removal or new amalgam filling in pregnants an children
- - rubber dam and exhaustor by treatment with amalgam
- - amalgam only in capsules (machine-made mixing)
- - finishing, polishing with water-cooling
- - effective suction
- - amalgam separator at the unit
- - airing the room
- - contaminated cotton rolls - hazardous waste –closed storage





- initial contraction (1 h)
- transient expansion (1-3 h)
- final contraction (24 h)
  - flow 3-24 h
  - creep after 24 h
- delayed expansion –
  mercuroscopic expansion

Stages and steps in cavity preparation

- Initial cavity preparation stage
  1. Outline form and initial depth
  2. Primary resistance form
  3. Primary retention form
  4. Convenience form

- Final cavity preparation stage

Stages and steps in cavity preparation

- Final cavity preparation stage

5. Removal of carious dentin and .....
6. Pulp protection
7. Secondary resistance and retention forms
8. Finishing external walls
9. Cleaning

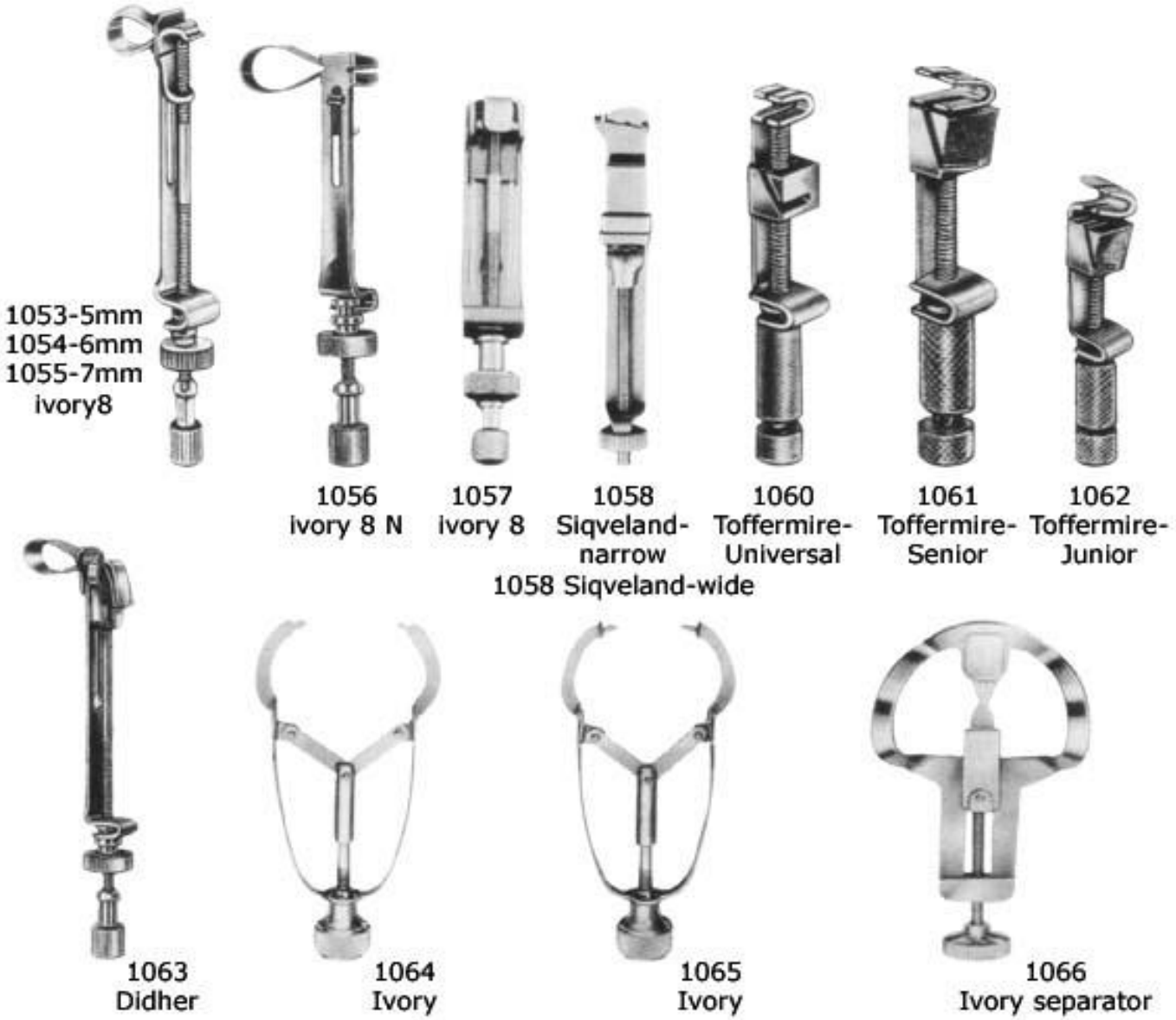
Stages and steps in cavity preparation

1. Slightly rounded configuration
2. Convergence occlusally of vestibular and oral walls
3. Gingival wall is min 1.2mm wide
4. Occlusal width and depth of the restauration 1.5-2 mm
5. Gingival extension
6. Margin of the cavity cca 90^{o}
7. V-shaped side-fissure

Restauration with amalgam

- Preparation of the cavity
- Isolation
- Matrices and matrix retainer
- Wedge placement
- Trituration
- Insertion, condensation
- Carving, burnishing

- Finishing, polishing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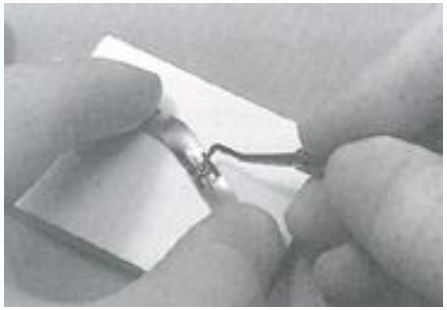
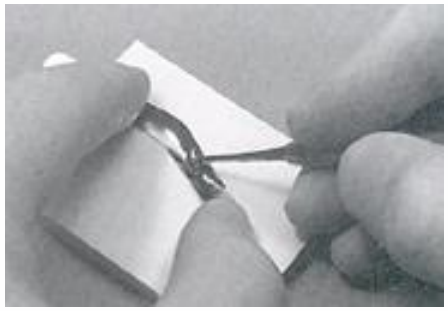
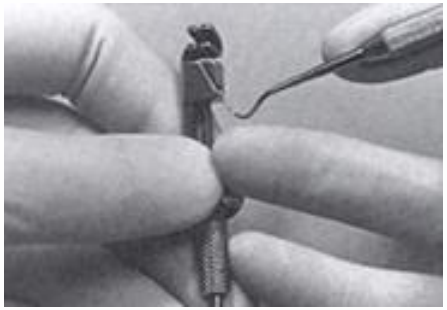
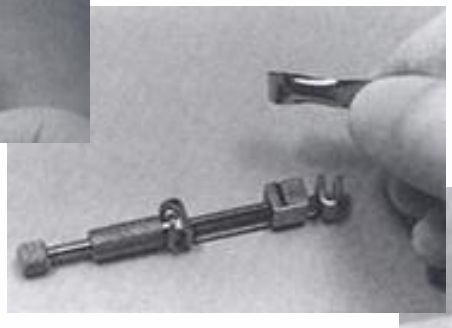
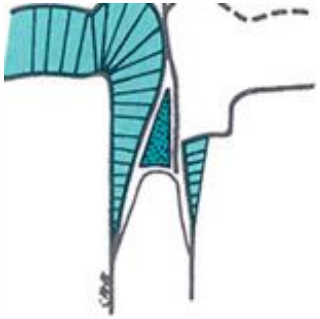


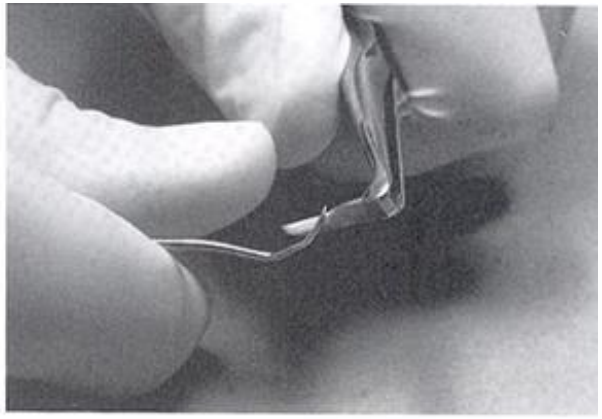


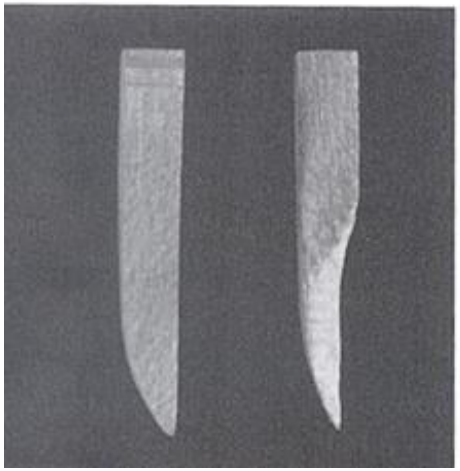


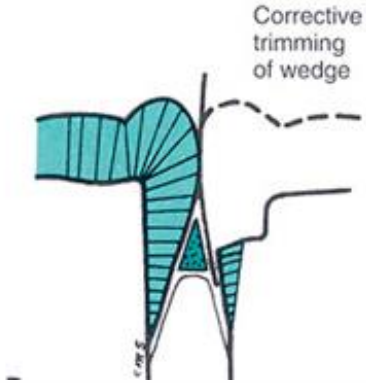


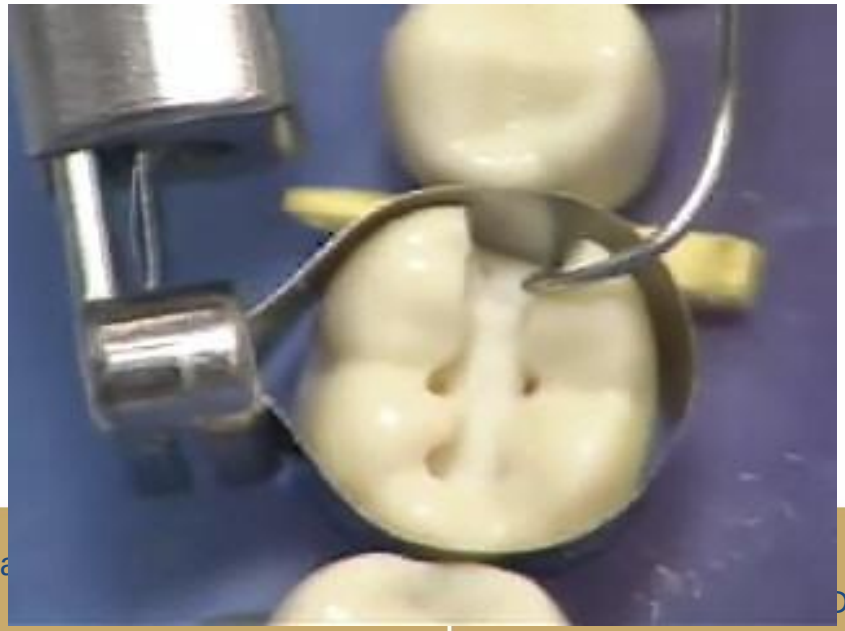


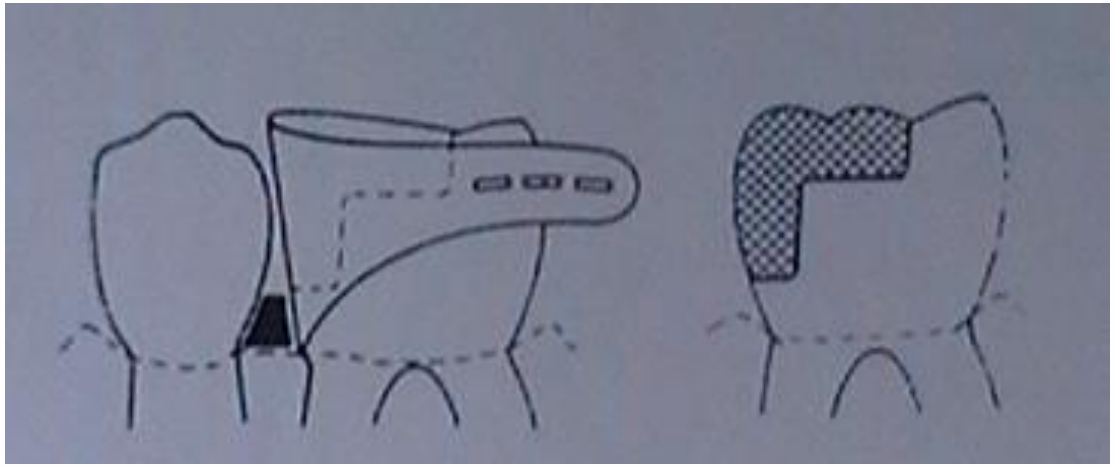
Tall triangular wedge incorrect for minimally extended gingival margin

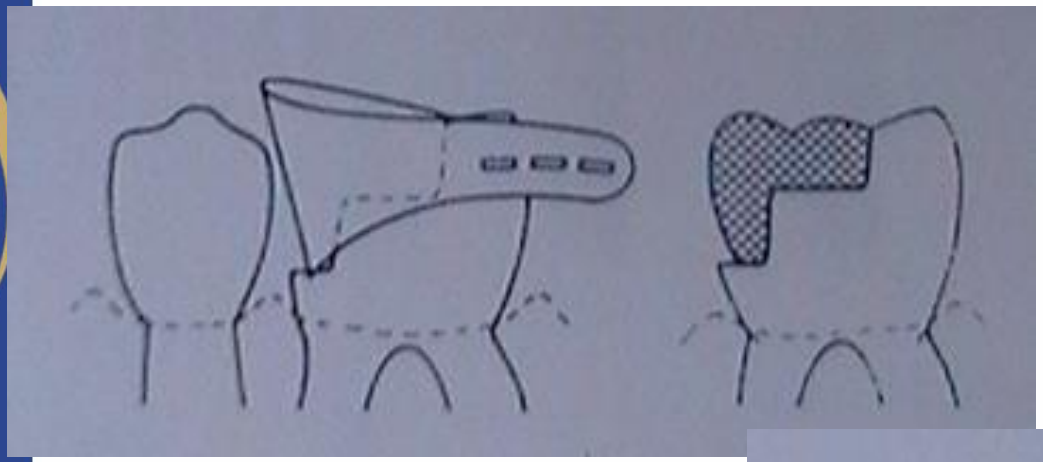


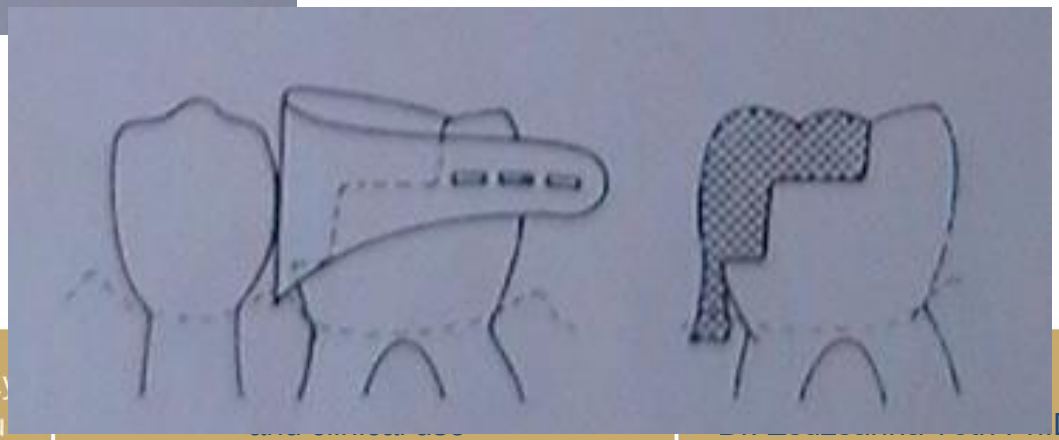


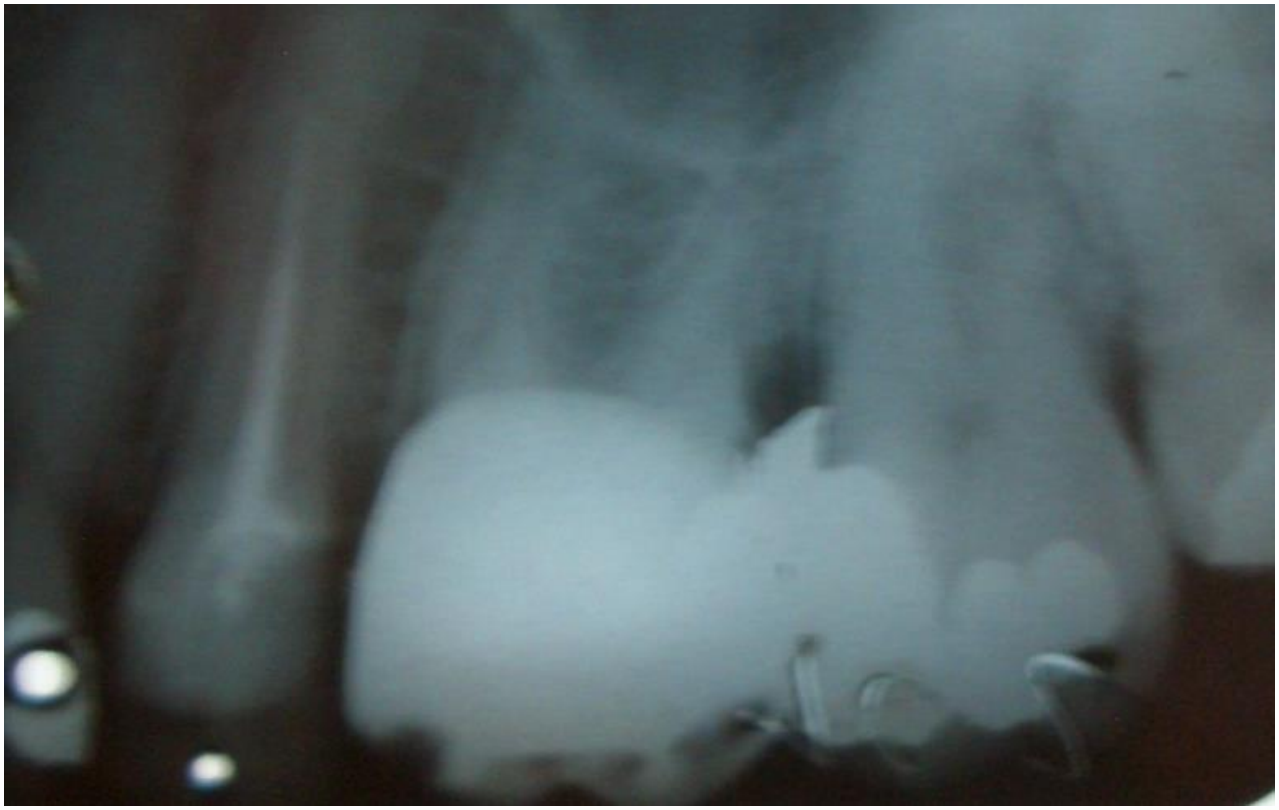


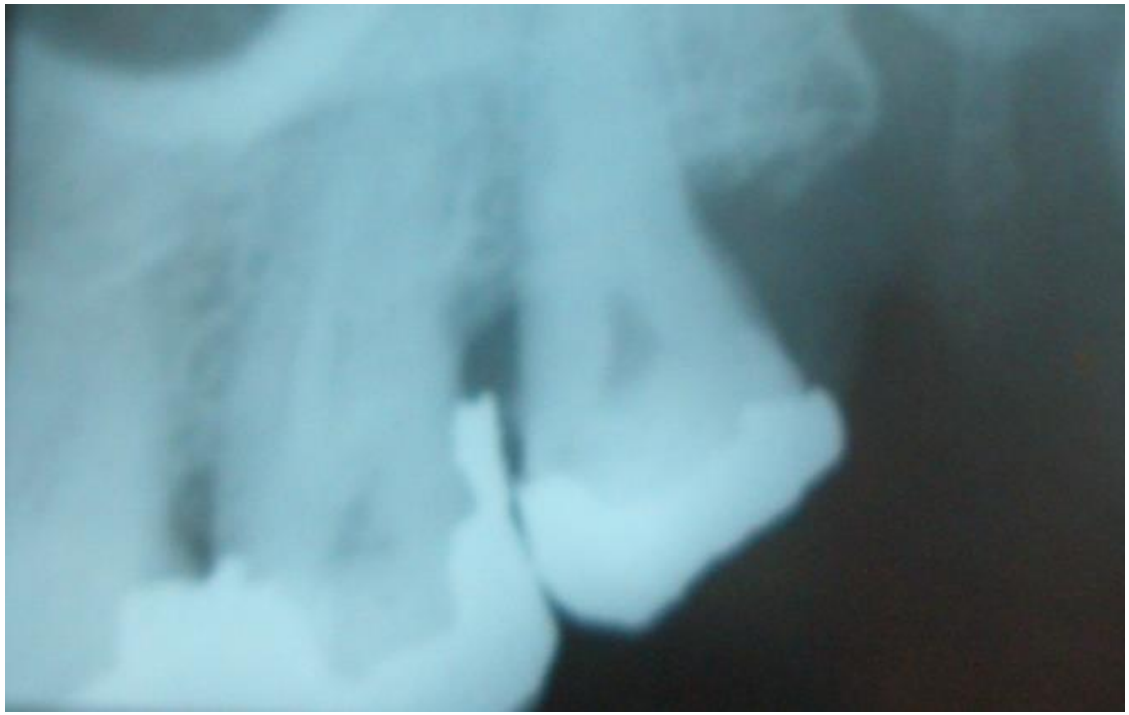


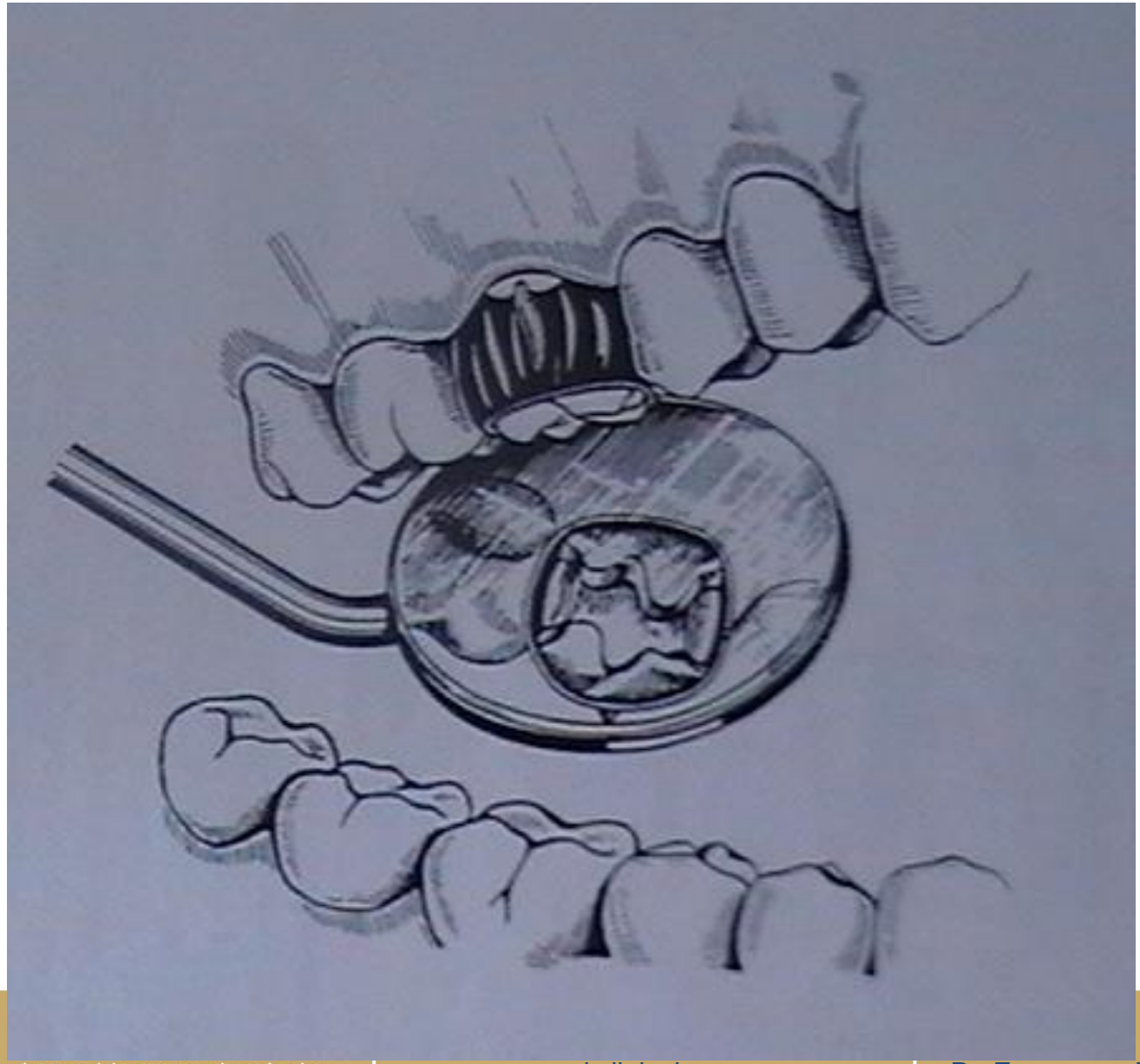










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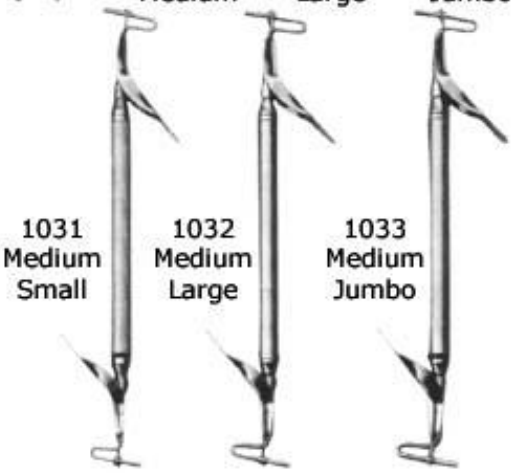

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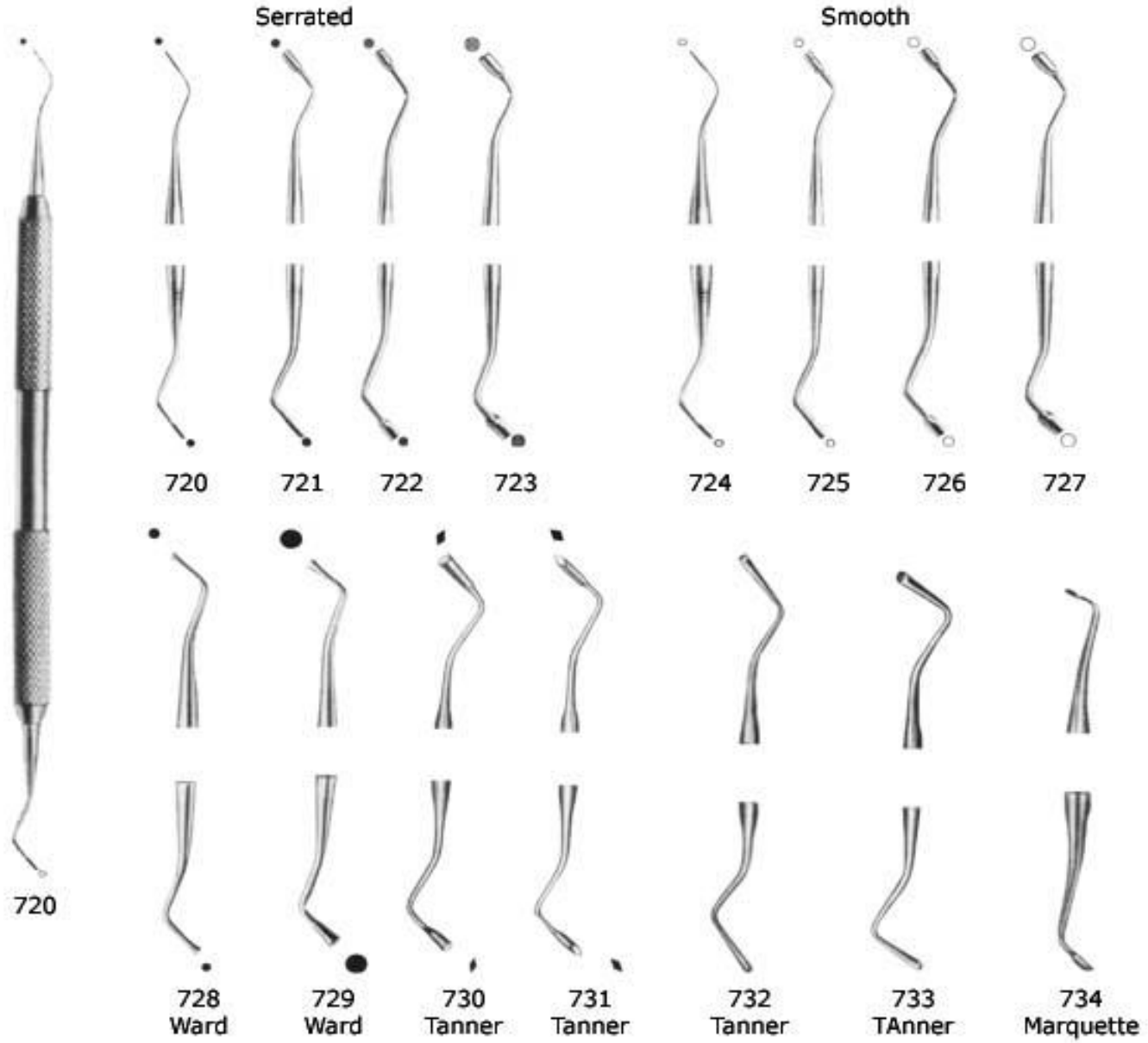
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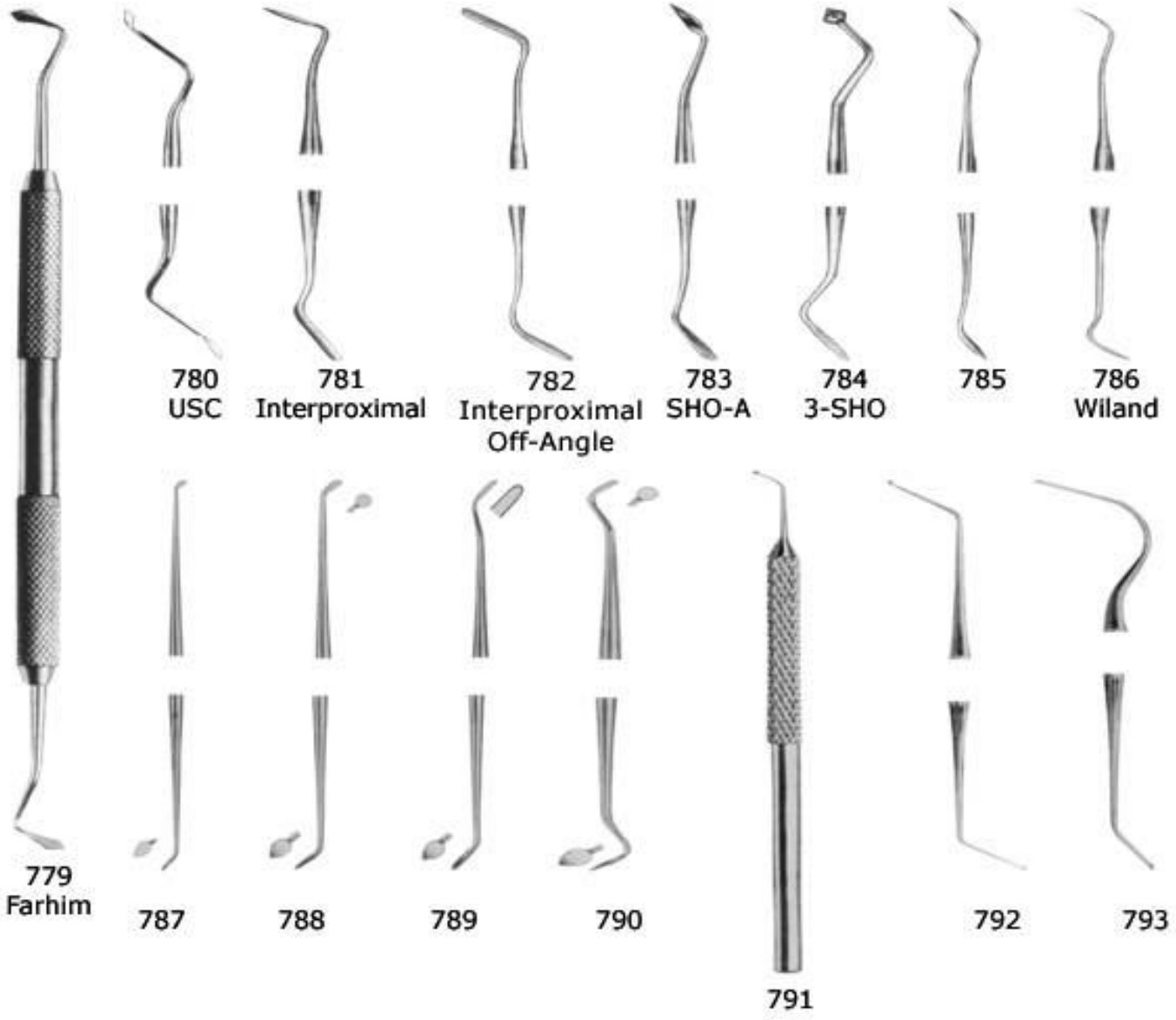
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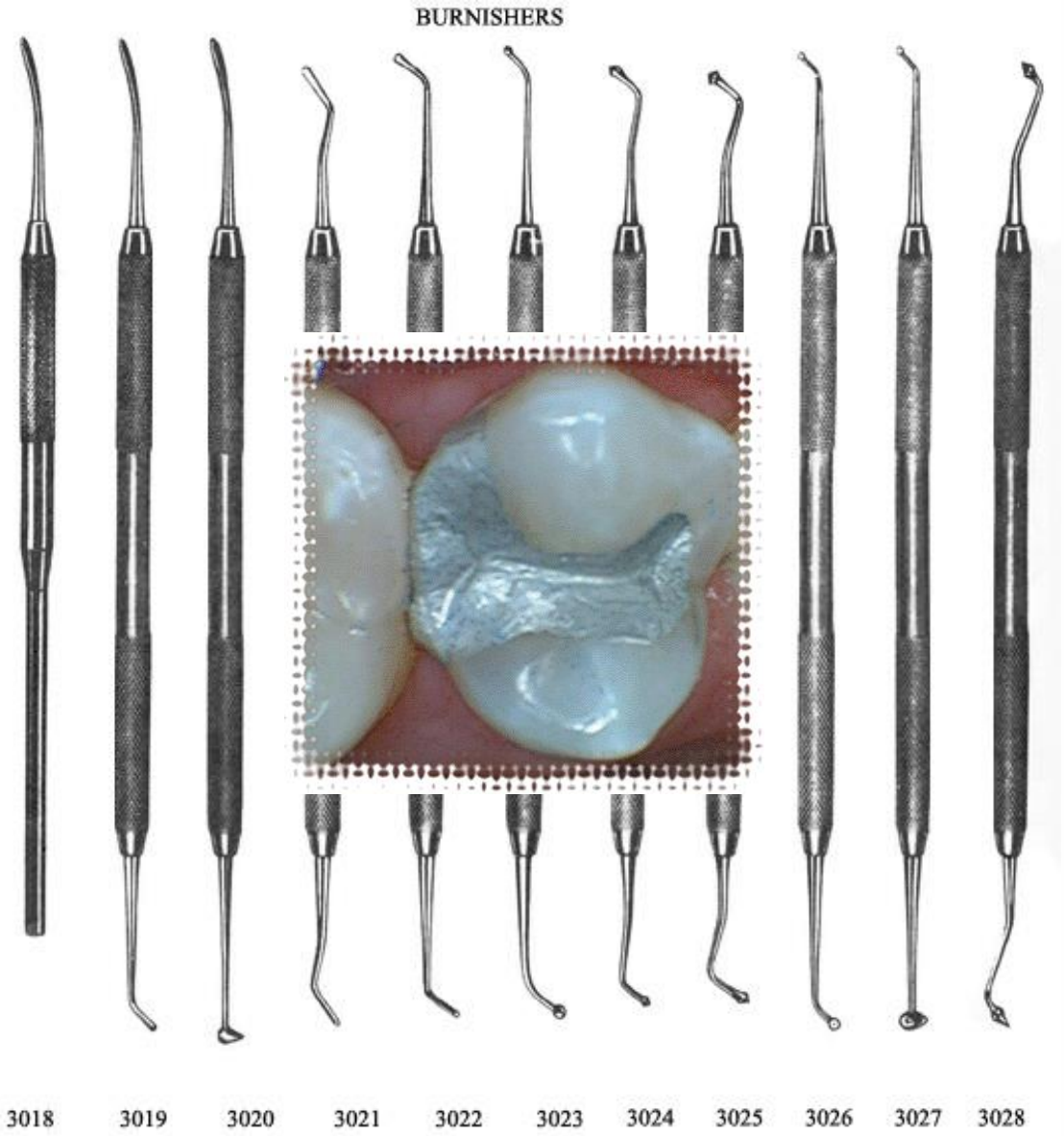
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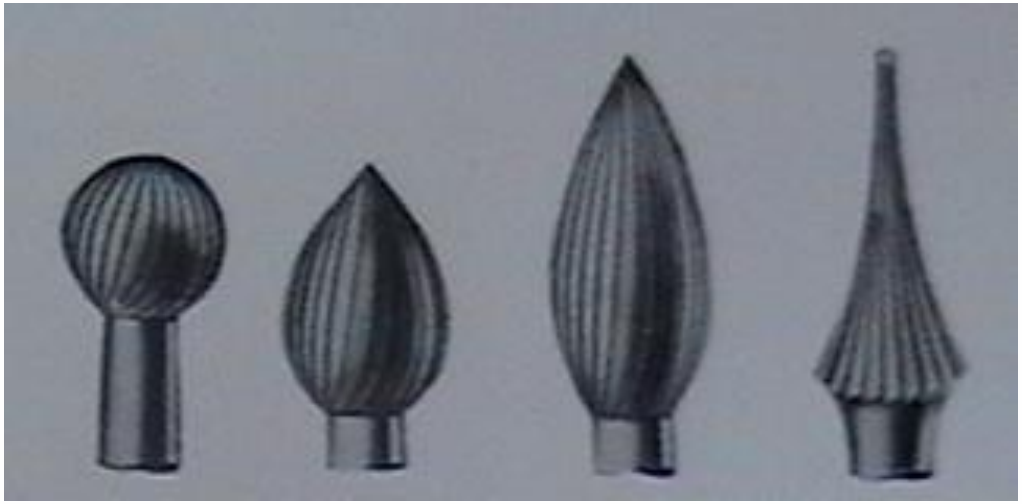

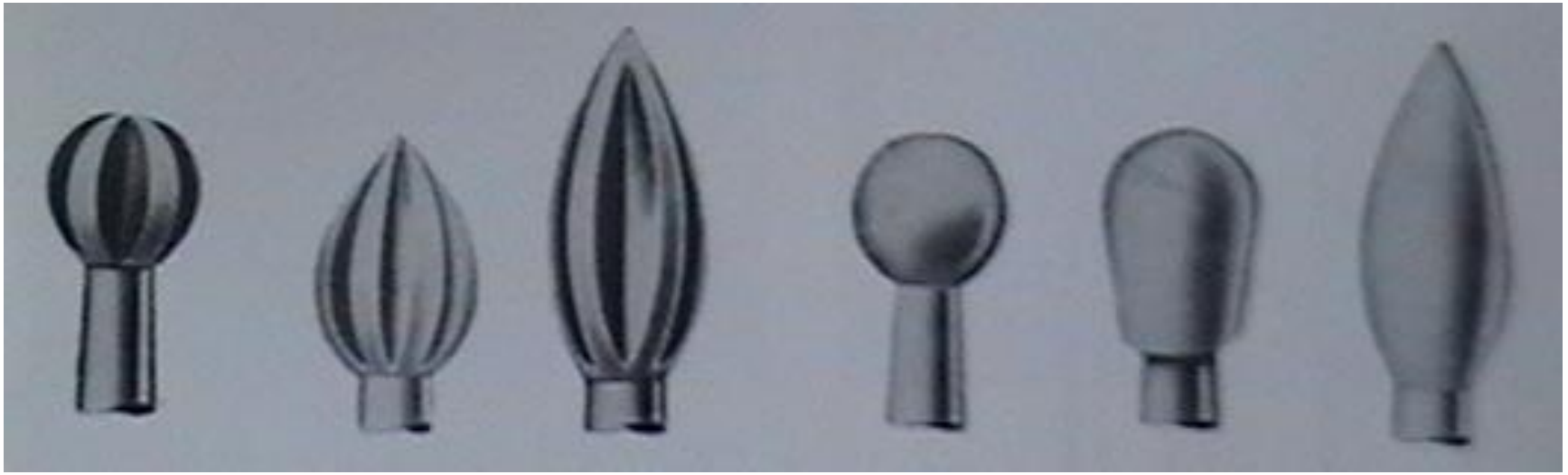


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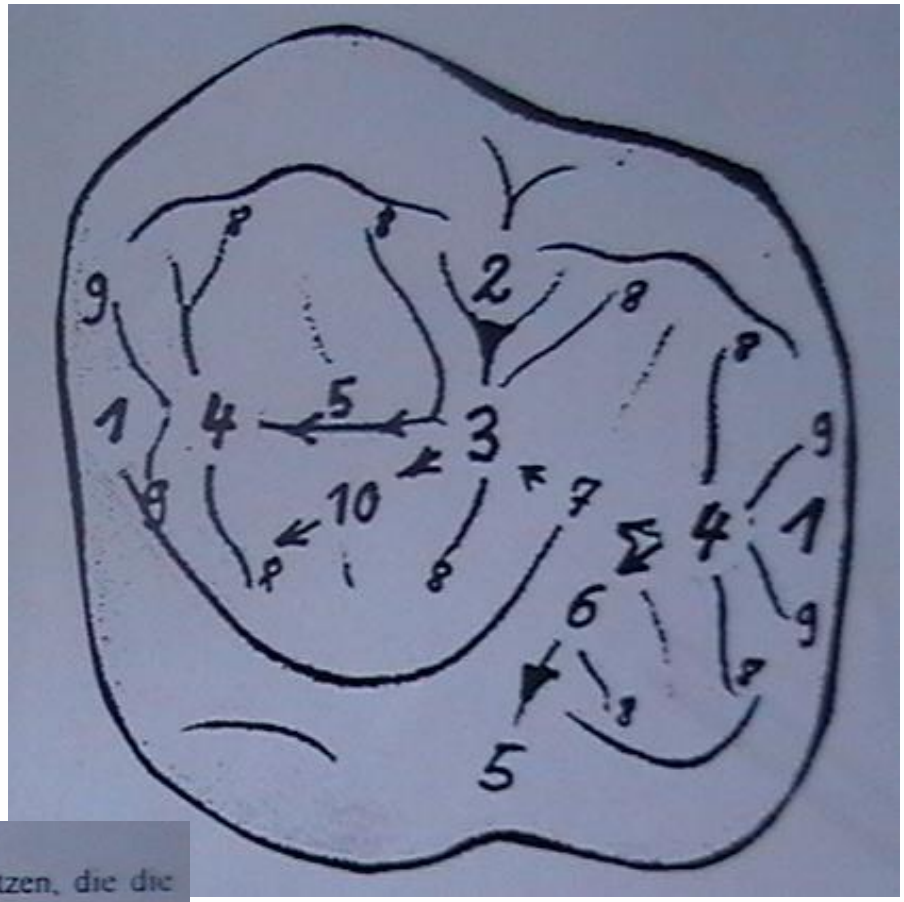
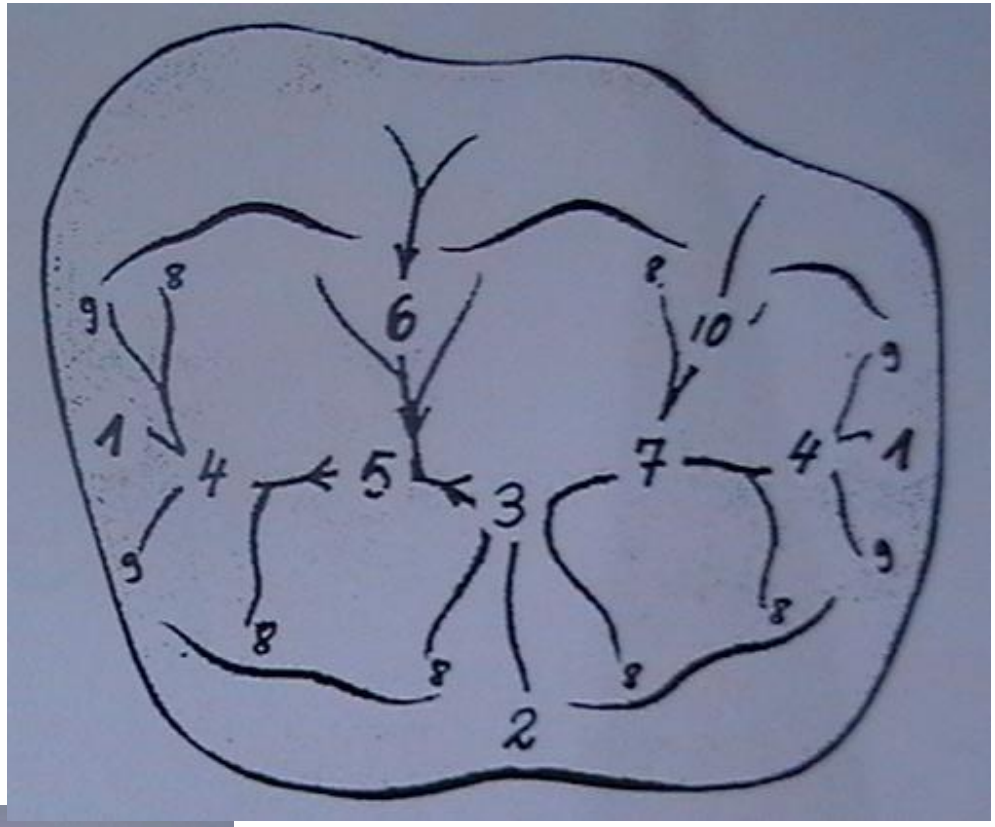


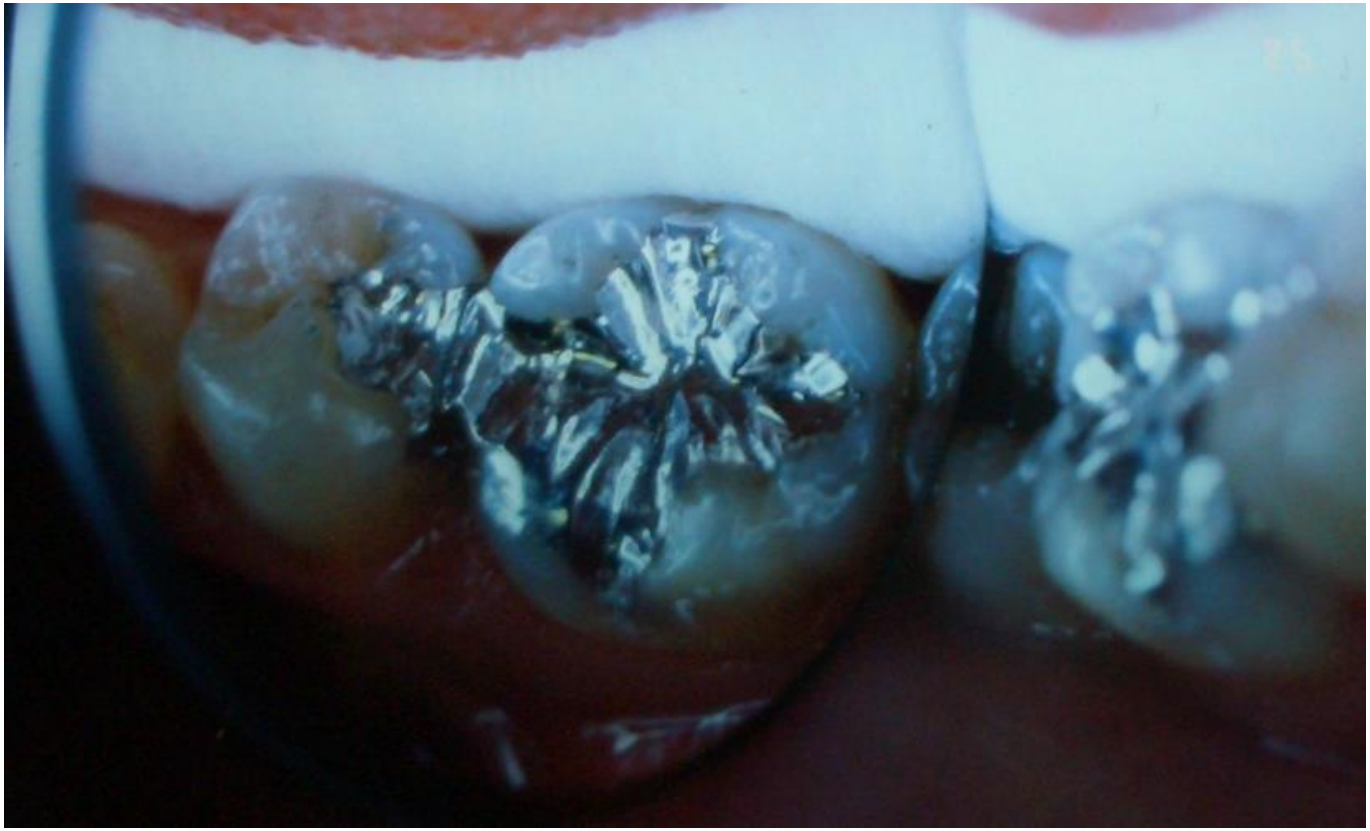
Schrittfolge **Beispiel 1. + 2. OK-Molar**

1. Mesiale und distale Randleiste auf die Höhe zurückschnitzen, die die Randleisten der Nachbarzähne aufweisen.
2. Von der Inzisiur der nichttragenden Höcker zur zentralen Grube (3) hin schnitzen und
3. die zentrale Grube mit genügender Tiefe anlegen.
4. Mesiale und distale Gruben neben den Randleisten anlegen.
5. Zentrale Grube (3) mit der mesialen Grube (4) verbinden.
6. Inzisur aus der distalen Grube (4) nach palatinal hinausziehen (5).
7. Distale Grube (4) mit der zentralen Grube (3) verbinden.
8. Unterteilung der Dreiecksleisten.
9. Unterteilung der Randleisten.
10. Balancespur freischnitzen.



Schrittfolge **Beispiel 1. + 2. UK-Molar**

1. Mesiale und distale Randleiste auf die Höhe zurückschnitzen, die die Randleisten der Nachbarzähne aufweisen.
2. Von der Inzisiur der nichttragenden Höcker zur zentralen Grube hin schnitzen und
3. die zentrale Grube mit genügender Tiefe anlegen.
4. Mesiale und distale Gruben neben den Randleisten anlegen.
5. Zentrale Grube (3) mit der mesialen Grube (4) verbinden.
6. Mesio-buccale Inzisur zur zentralen Grube (3) hinziehen.
7. Distale Grube (4) mit der zentralen Grube (3) verbinden.
8. Unterteilung der Dreiecksleisten.
9. Unterteilung der Randleisten.
10. Balancespur freischnitzen.



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OMHV PIN:

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