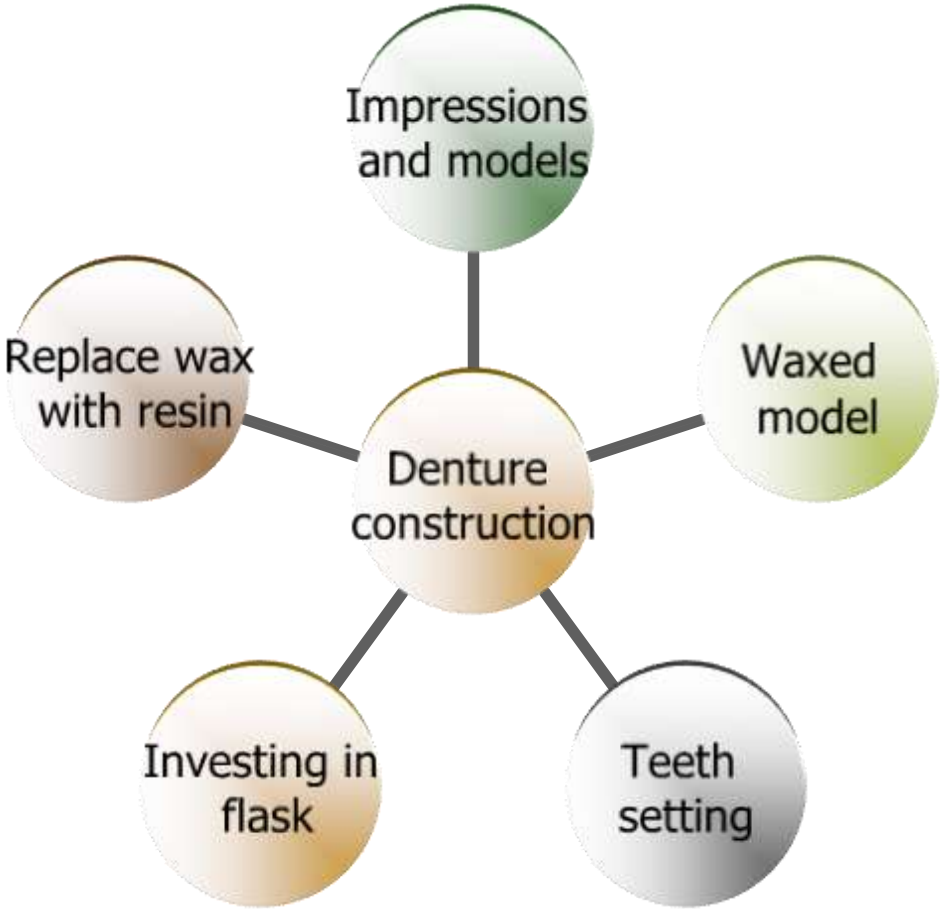
Denture base resins

Denture construction



Old materials used to construct dentures

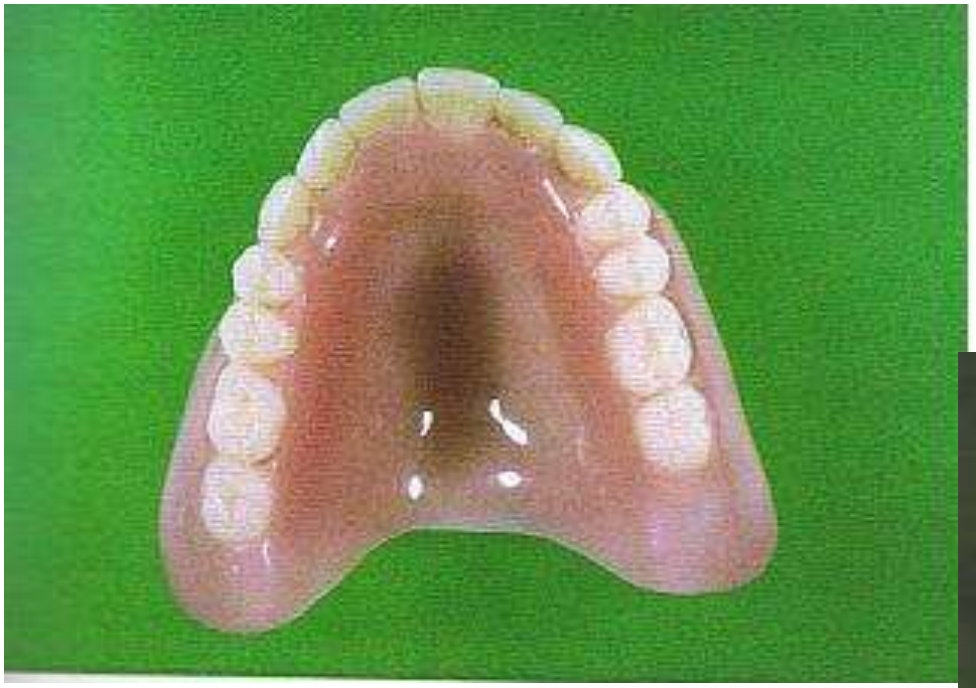
Material	Disadvantage
Cellulose products	Warpage, bad taste, blisters staining (leaking camphor), and loss of color
Phenol formaldehyde	Loss of color, difficult to process
Vinyl resins	Low fracture resistance
Vulcanite	Inferior esthetics

The material of choice?

- Acrylic resin (polymethyl methacrylate)
- Why?
- Desirable qualities:
  - Good esthetics
  - Cheap
  - Easy to process
- Disadvantages:
  - Not strong enough
  - Susceptible to distortion
  - Low thermal conductivity
  - Radiolucent

Dental uses

- Denture base material
- Denture repair
- Denture teeth
- Soft liners
- Construction of customized trays
- Soft tissue replication on cast metal framework



Acrylic denture

Acrylic resin

Composition

- Heat cured
- Cold cures
- Light cured
- Pour and cure resins

Continue,

- The reaction is an addition polymerization reaction
- to convert MMA (methyl methacrylate) to PMMA (polymethyl methacrylate).
- Mono= single
- Poly= many

Polymerization & crosslinking

- Polymer- large long chain molecules formed by chemically joining smaller molecules called monomers
- Copolymer: is formed when two or more different types of monomers join together
- Crosslinked polymers: adjacent polymers that bond together by side chains:
  - Weak bond between side chains leads to a easily manipulated and stretched polymer
  - If bond is highly charged, resulting polymer is stiffer

Polymerization

1. Addition polymerization:
    1. Activation: by producing *free radicals.* activators:
        1. Tertiary amine
        2. Heat
    2. Initiation: when an initiator such as benzoyl peroxide is decomposed and free radicals are produced.
    3. Propagation: occurs when free radicals break the bond between carbon atoms in monomer and adjacent monomers bond together
    4. Termination: occurs when monomer units are used up, or free radical is tied up by a reaction

Polymerization

2. Condensation polymerization: usually more than one type of monomer is used. The reaction produces by-products such as water, hydrogen or alcohol.

Heat cured resins

- Powder:
  - Beads or granules of PMMA
  - Initiator: benzoyl peroxide
  - Pigments
  - Opacifiers: titanium/zinc oxide
  - Plasticiser: dibutyl phthalate
  - Synthetic fibers: nylon/acrylic

I. Heat cured resins

- Liquid:
  - Methyl methacrylate monomer
  - Crosslinking agent: ethylene glycol dimethacrylate. This component improves mechanical properties

Continue,

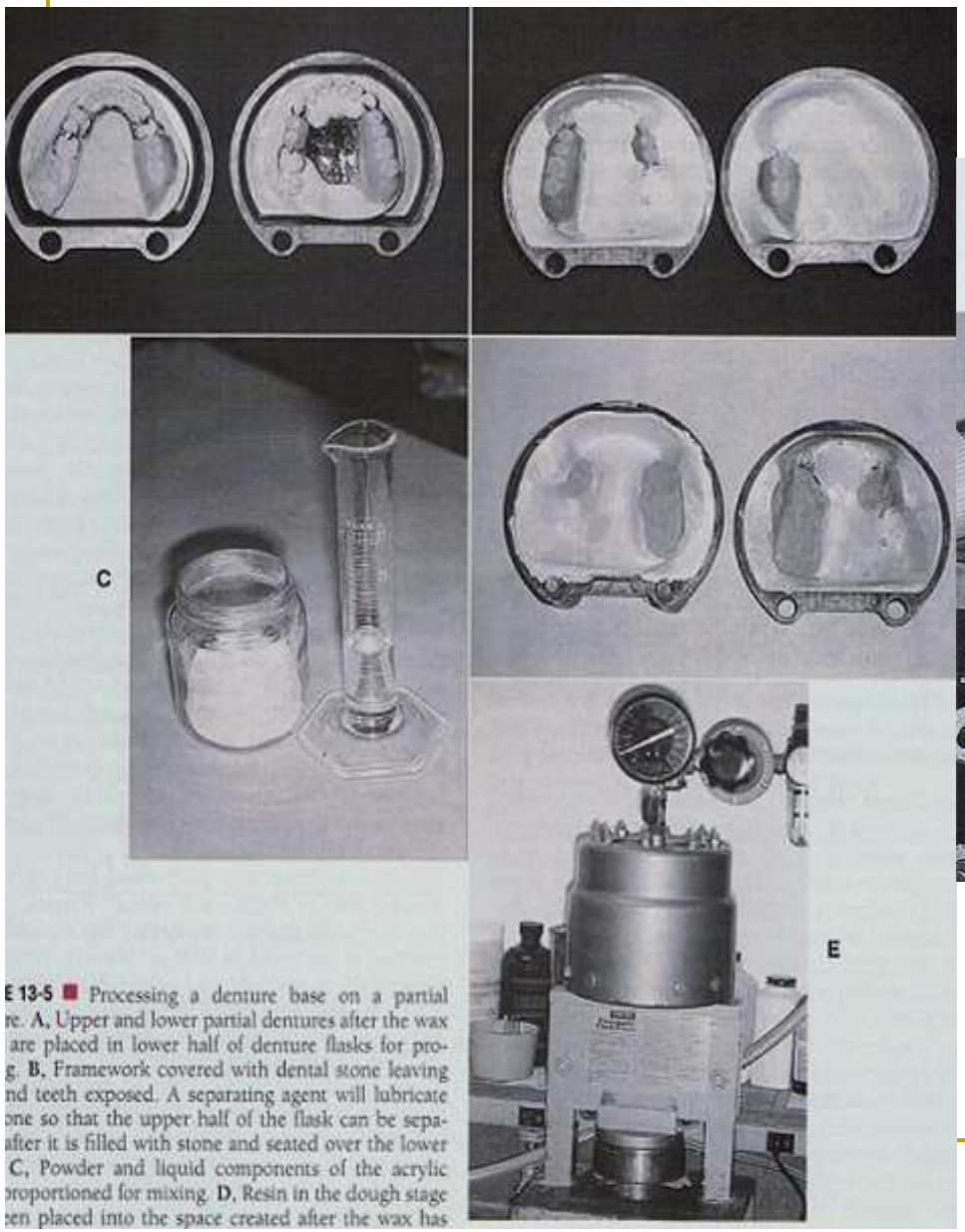
- MMA monomer:
  - Volatile
  - Flammable
- Precautions:
  - Kept in a sealed container
  - Dark container away from light source or heat source
  - No contact should be allowed with the polymer beads (carry benzoyl peroxide initiator)

TABLE 13-1

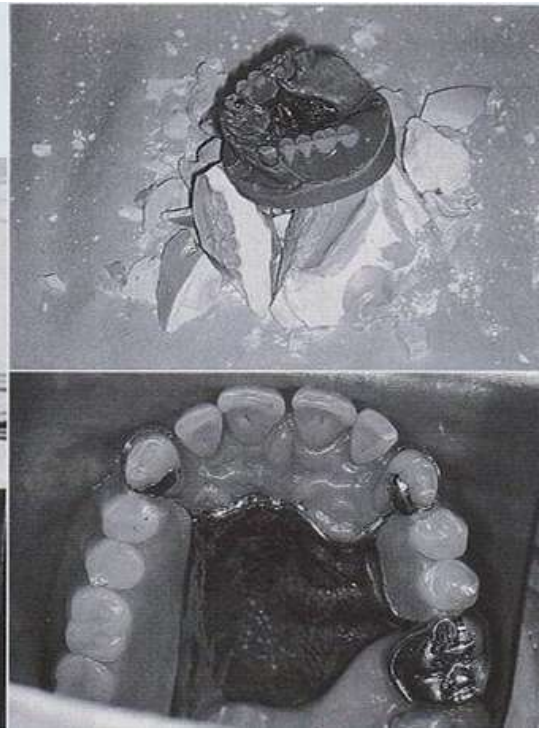
Properties of Heat-Cured Acrylic Resins (PMMA)

Polymerization shrinkage (by volume)	6%
Polymerization shrinkage (linear)	0.2%-0.5%
Coefficient of thermal expansion	More than twice that of composite
Compressive strength	76 MPa (11,000 psi)
Tensile strength	55 MPa (8000 psi)
Hardness (Knoop)	15-18 kg/mm^2
Biocompatibility	Good
Thermal conductivity	Poor
Wear resistance	Fair
Fatigue resistance (to flexing)	Good
Impact resistance (to breakage when dropped)	Poor

FLASKING STEPS



E 13-5 ■ Processing a denture base on a partial re. A, Upper and lower partial dentures after the wax are placed in lower half of denture flasks for pro- g. B, Framework covered with dental stone leaving nd teeth exposed. A separating agent will lubricate one so that the upper half of the flask can be sepa- after it is filled with stone and seated over the lower C, Powder and liquid components of the acrylic proportioned for mixing. D, Resin in the dough stage en placed into the space created after the wax has



Flasking and Heat curing

- Flasking
- Dewaxing
- Application of separating medium (water soluble alginate solution
- Placing acrylic dough
- Packing and removing excess
- Heat curing under pressure

- Processing at 74°C for 8 hours or longer
- Processing at 74°C for 8 hours then increasing temperature to 100°C for 1 hour
- Processing at 74°C for 2 hours and raise temperature to 100 for 1 hour.
- Cooling should be slow to avoid warpage

Heat curing, continue

- In addition to previously mentioned curing methods, curing may be done in microwave, where the flasks used should be non metallic.

Setting stages

- Sandy stage: immediately after mixing
- Sticky or stringy stage
- Dough stage: mix is cohesive and less tacky, easy to manipulate (time to pack in the moulds)
  - Dough stage period is the working time.
  - Time taken to reach dough stage is doughing time
- Rubbery stage

Continue,

- The previous composition allows for:
  - Processing by the dough technique
  - Minimal polymerization shrinkage
  - Heat generation is minimal

Continue,

- Dough technique:
- The powder-liquid mix is used, when it reaches the dough stage,
- it is used to pack the flask containing the teeth and the set plaster which will then be closed under pressure.
- Manipulation of the mix in the dough stage is easier and produces better results.

Continue,

- Polymerization shrinkage: is reduced due to the presence of pre-polymerized grains or beads rather than the monomer itself.
- Heat generation occurs due to the polymerization reaction (80 kJ/mol). This is reduced due to the presence of the already polymerized resin.

II. Cold cure resin

- Composition: identical to heat cure resin except polymerization is initiated by tertiary amine (e.g. sulfinic acid or dimethyl-*p*-toluidine). They contain an inhibitor (hydroquinone) that destroys free radicals to prolong working time

Cold cure resin used for making special trays

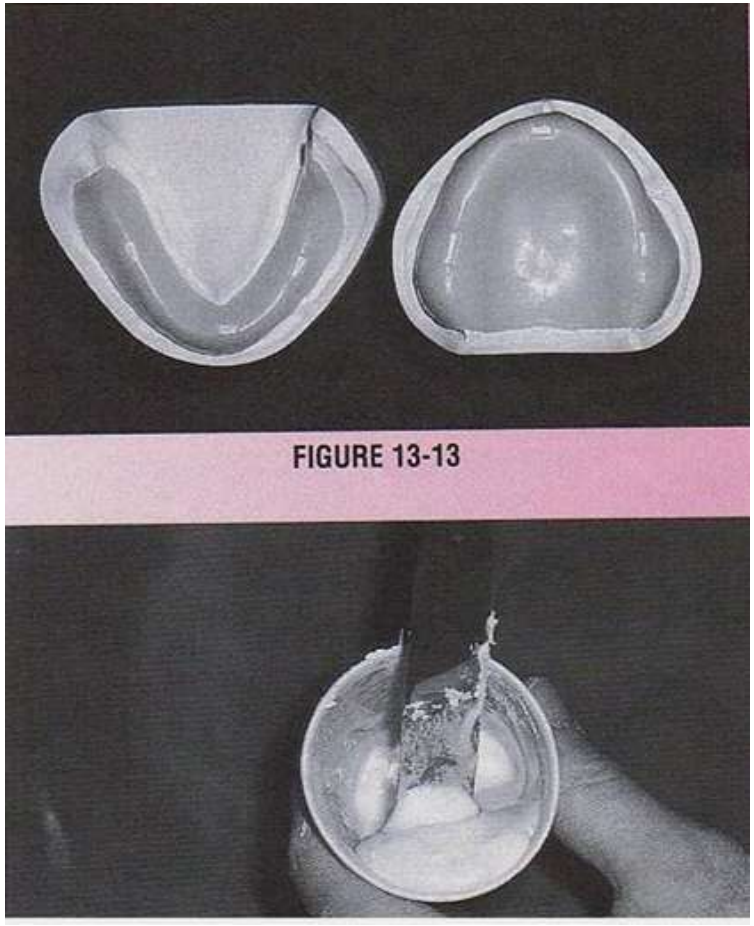


FIGURE 13-13

Cold VS heat cure

- Smaller polymer beads are used in cold cure resin to ease dissolution in monomer.
- Cold curing method results in a polymer with a lower molecular weight leading to:
  - Lower strength
  - Residual uncured monomer
  - Lower color stability, more prone to yellowing
  - More prone to creep and therefore distrortion

III. Pour and cure resin: not used much. Mixed and poured into a mould of hydrocolloid. Excellent reproduction of details but inferior to cold and heat cure resin in other aspects

IV. Light cure resin (blue light): used as denture hard relining material, repair material, construction of trays.

Composition:

- UDMA
- Colloidal silica to control flow
- Filler of acrylic beads

Manipulation

1. Powder:liquid, **THE GOLDEN RULE**: always use powder:liquid ratio recommended by manufacturer. (2.0/1.0 wt %, 1.6/1.0 vol.%) to keep polymerization shrinkage at 5-8%
   - Too much powder?
   - Too much monomer?

Manipulation

2. Control of color: pigments responsible for the color are incorporated into the polymer, sometimes on the beads surface and can be washed away if incorporated into monomer too quickly
3. Mould lining: to prevent penetration of resin into plaster, **separating medium** used e.g. sodium alginate, tin foil

Manipulation

4. Processing: porosity, processing strains.
   - Porosity: caused by,
     1. Polymerization shrinkage (contraction porosity)
     2. Volatilization of monomer (gaseous porosity)
     3. Granular porosity, due to loss of monomer while resin mix is left to stand until dough stage is reached. Also if the resin mix is dry

Continue,

1. Contraction porosity: **occurs due to monomer contraction by 20% during processing.**
   - Processing involves a raise in temperature to initiate polymerization at first and then temperature due to the exothermic reaction
   - During this, resin flows (under pressure) into spaces created by curing contraction (excess resin is important to maintain this pressure)

Continue,

- Once resin becomes rigid, thermal contraction may occur (change from curing temperature to room temperature). Curing temperature for cold cure resin is lower than heat cure resin.
- **Insufficient amounts of resin** packed in the flask may lead to voids or porosity. Also **resin should be packed in the dough stage.** Prior to that the resin would flow too rapidly and pressure is lost

Porosity

2. Gaseous porosity:
    1. Caused by a **rise in the resin temperature during curing above 100°C (> boiling temperature of resin)**
    2. Gaseous monomer forms and causes gaseous porosity
    3. This is avoided by allowing a slow and controlled rise in temperature

Continue,

- Processing strains:
  - Internal strains occur **during processing of resin**
  - If allowed to relax, warpage, distortion and crazing (tiny surface defects) occur
  - Some are relieved as the material flows but thermal contraction strains may remain. This can be minimized by:
    - Slowly cooling flask
    - Using acrylic rather than porcelain teeth to ensure compatible shrinking

Properties of resin

- Biocompatibility:
  - High, however, allergy may occur due to leachable components mainly the monomer and benzoic acid.
  - Allergy is mainly associated with cold cure resin due to high residual monomer
  - As a replacement, denture bases maybe constructed from polycarbonate

Properties continue,

- Dimensional stability and accuracy:
  - What is the difference between retention and stability?
  - It is important for the denture to be retained intraorally. Why?
    - Accurate fit to ensure good adhesion (large surface area) and cohesion (accurate fit)
    - To ensure good peripheral seal

Properties continue,

- Mechanical properties:
  - Creep is a problem, minimized by crosslinking agents
  - Dentures are prone to fracture
  - Commonly, midline of upper denture
  - Mainly caused by:
    - Trauma, leading to cracks then failure
    - Poor quality processing: lack of bonding between resin and teeth
    - Crazes

Tensile strength	50 MPa
Elastic modulus	Low
Flexural modulus	2200-2500 MPa

Mechanical properties continue,

- Solution to patients who commonly fracture dentures:
  - High impact resistant resin (contain rubber toughening agent), decrease crack, but may lower flexural modulus and lead to fatigue due to excessive flexure
  - Incorporation of fibers to produce fiber reinforced resin:
    - Carbon fibers: difficult to handle, poor esthetics
    - Aramid fibers: lack of bonding with resin
    - Ultra high molecular weight polyethylene fibers, UHMPE: low density, neutral color, biocompatible, bonds to resin but processing is time consuming
    - Glass fibers: most promising, incorporated as short fibers or loose form

Physical properties

Thermal conductivity	Very low, disadvantage: Isolates tissue from temperature sensation
Coefficient of thermal expansion (CTE)	High, if teeth are from porcelain, differential expansion → loose teeth
Water sorption & solubility	Absorb water 1-2% wt. slowly. Insoluble in oral fluids

Relative merits of soft liners

TABLE 3.2.5 Relative merits of soft liners

Silicone rubber	*Acrylic*
Highly resilient	Less resilient
Retains softness	Goes hard with time
Requires bonding agent	Self-adhesive
Susceptible to growth of *Candida albicans*	More resistant to bacteria
Weak bond	Permanent bond
Poor tear strength	Acceptable tear strength
No permanent deformation	Susceptible to creep

Tissue conditioners/temporary soft liners

- Usually needed in cases of tissue injury such as inflammation or ulceration.

1. Tissue conditioners: soft material applied to fitting surface of denture to allow better stress distribution
    1. Composition: PEMA+ ethyl alcohol solvent+ plasticizer.
    2. Needs to be replaced every few days due to leaching out of solvent and plasticizer

Continue,

- Disadvantages:
  - Need for frequent replacement
  - Prone to microorganism colonization
  - Prone to damage by denture cleansers, so patient should be instructed to use plain soap and water

FIGURE 13-7 ■ Short-term soft liners are called tissue conditioners, because they flow and adapt to the tissues as they heal. Seen are components of two tissue conditioners. (Courtesy Dr. Mark Dellinges, School of Dentistry, University of California, San Francisco.)

Acrylic teeth

- Advantages compared to ceramic teeth:
  - Tough
  - Bond to denture base material
  - Easy to grind during occlusal adjustment
  - Do not wear natural, artificial opposing teeth
  - Easily repolished
- Disadvantages:
  - Soft and easily wear
  - Stain over time

Construction considerations

- Constructed in layers to simulate natural color
- Gingival portion is made from minimally cross-linked resin to ensure good bonding with denture base

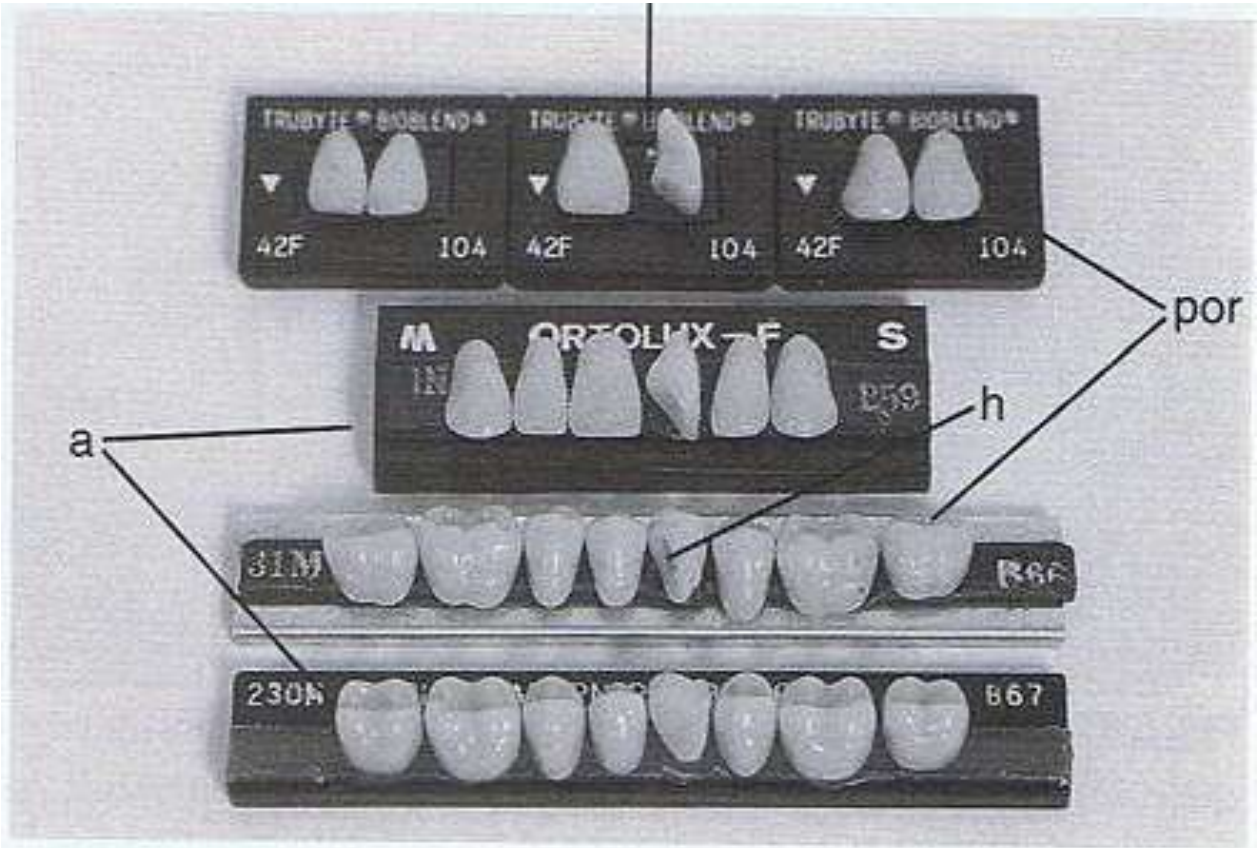


FIGURE 13-8 ■ Plastic and porcelain denture teeth. Porcelain teeth (*por*) do not chemically bond to the denture base, as do plastic teeth (*a*); therefore they have metal pins (*p*) or retention holes (*h*) to lock into the acrylic.

Denture repair

- Chemical-cured acrylic repair material:
  - Broken pieces are fixed by sticky wax
  - Plaster is poured to stabilize denture
  - Fracture site is drilled and fresh acrylic exposed
  - Acrylic resin is added either in bulk or in salt and pepper method and overfilled
  - Then denture is placed in pot in warm water under 20 pound pressure for 20 minutes
  - Excess is removed then polished

Denture repair

- Light-cured repair materials:
  - Same procedure as for cold cure repair material except that the fractured site is treated with a liquid to prevent oxygen inhibited layer of uncured material which will be difficult to polish
  - After repair the denture is placed in intense blue light chamber (triad light curing unit)

Custom impression trays

- Chemical-cured materials:
  - Similar to other chemical cured resins
  - Supplied as powder and liquid
  - Material is mixed and adapted over cast
  - The tray is trimmed to appropriate length
- Light cured materials:
  - Supplied in sheets that are adapted over cast
  - Then light cured as previously mentioned
  - Faster and easier to use

Instructions for patients on dentures care

- Denture and teeth should be cleaned with brush
- Liquid soap, mild hand soap, nonabrasive denture cleanser should be used
- Brushed or rinsed after each meal and before soaking in denture soak
- Denture tablets can be used to make a denture soak to remove debris
- Calculus deposits can be softened by soaking denture in white vinegar diluted with water 1:1

Continue denture care,

- Dentures should be soaked over night in commercial or home made soaks
- Undiluted bleach should be avoided since it fades color and corrode metal parts of partial dentures
- Tissue bearing surface should cleaned with soft brushes

In-office care for dentures

- Calculus maybe removed by soaking denture in denture soak in a plastic bag and placed in an ultrasonic cleaner
- Scaling and polishing can also be done

DISINFECTING PROSTHESES

- Properly disinfect all prostheses before trying in the patient's mouth.
- Disinfect at chairside all prostheses going from the patient to the commercial or office laboratory, and package properly for transport.
- Iodophors and synthetic phenols are suitable disinfectants for most prostheses.
- Immerse prostheses for 15 minutes in one of these disinfectants in a denture cup or plastic bag.

Storage of dentures

- Resin is sensitive to water gain and loss
- Dentures should be kept wet to prevent distortion
- Dentures can be stored in water with a bit of mouth wash to freshen it
- The addition of mouthwash containing alcohol should be avoided if soft relining material is present

Precaution for patients with partials or complete dentures

PRECAUTIONS FOR PATIENTS WITH PARTIAL OR COMPLETE DENTURES

- Store dentures in water to prevent warping from loss of moisture.
- Do not clean dentures in hot water because they may warp.
- Avoid soaking dentures in chlorine bleach because it will remove color from the resin and attack metal components of partial dentures.
- Clean dentures over a sink partially filled with water to avoid breaking if dropped.
- Avoid abrasive toothpastes or household cleaners because they will scratch or wear the plastic.

References

- Introduction to dental materials. Chapter 3.2
- Dental materials, clinical applications for dental assistants and dental hygienists. Chapter 13

Thank you