Dental Materials

1950's Dentistry Defined
The art and science of repairing or replacing lost, damaged, or diseased portions of the human dentition

Present Day Definition
- Repairing/replacing lost and diseased portions of the dentition.
- Preventing their breakdown.
- Restoring or creating esthetic beauty in the dentition.

Restorations in Dentistry
- Replacing what is lost through disease or traumatic injury
- Recreating contours and appearances that nature provided
- Improving on what formed naturally.

Silver Amalgam
- Restores decayed surfaces.
- Used in posterior teeth

Direct Composite
- Tooth colored restoration
- Always used on anterior teeth

- Some posterior applications

Indirect Restorations
- Castings made using impressions and models
- Use of lost wax technique
- Gold or composite

Full Coverage
- Called caps or crowns
- Made of all metal, metal covered by porcelain, or all porcelain

Prosthesis

An artificial replacement for lost tissue. Ex. A complete denture or an artificial limb.

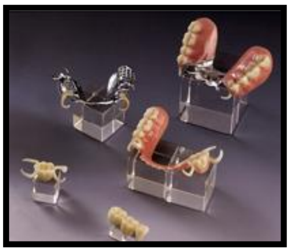
Prosthodontics

The area of dentistry specializing in prosthetics.

Fixed Bridge

- Replaces one or more missing teeth.
- Cemented to place.
- Abutments/pontic

Removable Partial Denture

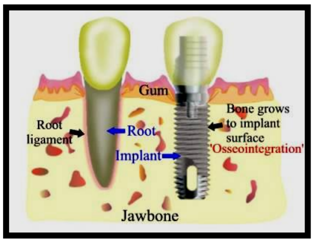


- Made of cast frame and acrylic saddles and teeth.
- Anchored by clasps

Complete Dentures

- Fully edentulous patient.
- Acrylic bases and acrylic or porcelain teeth.

Dental Implants



- Titanium root form posts.
- Holds in single crown, overdenture, fixed bridge

Material Science
Is that part of the physical sciences that seeks to explain the properties and performance of materials by examining their internal structure.

Biomaterials
Are man made materials used to replace tissues or functions in intimate contact with living tissues.

Dental Materials
Are biomaterials used in or around the oral cavity.
The goal is to understand why materials behave the way they do and what the clinician can do to maximize the performance of these materials.

Classification of dental materials
1. Restorative materials: used to replace lost oral tissues. These include filling and crowns, dentures, and maxillofacial prosthesis.
2. Impression Casts and Models: used to produce replica for oral tissues.
3. Cements: include
   - -Luting agent: used to gluing crowns and bridges.
   - -Bases and Liners: insulating layer under the restoration.
4. Temporary Materials: used for a limited period of time like temporary crowns and temporary restorations.
5. Preventive Materials: used to prevent decay or trauma like pit and fissure sealant, mouth guards, fluoride trays.
6. Polishing Materials: used to remove a thin layer of the restoration surface or remove plaque from natural teeth.
7. Implants: specialized materials used to replace the root portion of lost teeth.
8. Specialty Materials: are unique to certain field of dentistry like sutures in oral surgery and rubber bands in orthodontics.

Properties of Dental Materials

Importance of Studying Properties of Materials

- Materials used to replace teeth or parts of teeth must withstand oral environment and forces of mastication
- Materials must be cleaned and polished by a variety of materials
- Clinical experience and research relate clinical success to certain properties of materials
- Critical physical properties are established which protects the public

PROPERTIES OF DENTAL MATERIALS

I. Physical Properties
II. Thermal Properties
III. Electrical Properties
IV. Optical Properties
V. Mechanical Properties

I. Physical Properties

1. Density

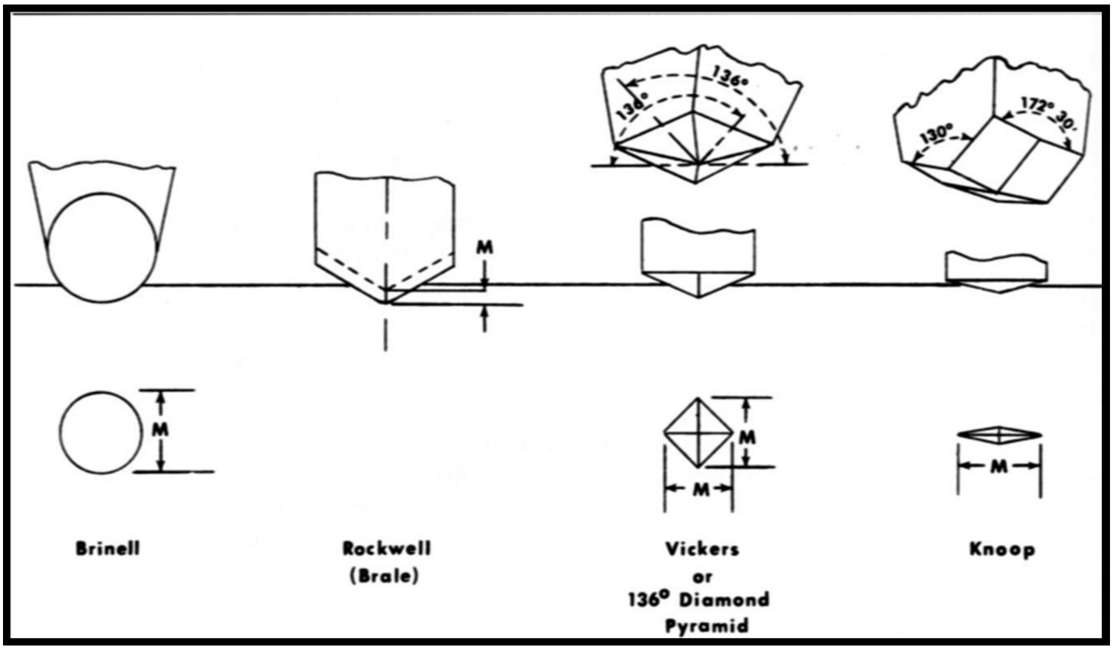
- The amount of mass of a material in a given volume.
- Density units are g/cm2.
- Metallic maxillary prosthesis should be as thin as possible

2. Viscosity

- The ability of a material to flow.
- Thick liquids flow poorly, thin liquids flow easily.
- Viscosity is measured in grams/meter.second or pois(p)

3. Hardness

- The resistance of a material to indentation.
- It is measured by scientific instruments that press a characteristically shaped tips made of steel or diamond.
- Hardness is calculated based on the size of the indentation, the load on the tip, and the shape of the tip.
- Brinell, Rockwell, Vickers, and Knoop tests.



4. Abrasion Resistance

- Harder materials = more abrasion resistance.
- Restorations must be hard enough to resist abrasion, but not so hard to wear away the opposing teeth.

5. Solubility and Sorption

- Solubility
  - Susceptible to being dissolved
- Sorption
  - Adsorption plus absorption
- Adsorption
  - Natural process where molecules of a gas or liquid adhere to the surface of a solid
- Absorption
  - Passage of a substance into the interior of another by solution or penetration

6. Adhesion

- The force of attraction between the molecules/atoms of *two different* surfaces as they are brought into contact.
- Ex: .Plaque or calculus attaching to tooth structure. Saliva attaching to denture surface and to tissue.
- ❖ Cohesion: Force of attraction between molecules/atoms *within one* material. (Not on the surface).

7. Wettability

- Measure of the affinity of a liquid for a solid as indicated by spreading of a drop
- Observed by shape of the drop of liquid on the solid surface
  - Flatter shape indicates more wetting

II. Thermal Properties

1. Coefficient of Thermal Expansion

- Linear coefficient of thermal expansion: a measure of how much it expands per unit length if heated one degree higher.
- LCTE= Fractional change in length/Change in temperature.
- LCTE = (L2-L1/L1)/T2-T1

Thermal Dimensional Change

- The expansion or contraction of a material due to temperature changes.
- A restoration may expand or contract more than natural teeth with changes in temperature. This leads to leakage at the margins called percolation.

2. Thermal Conductivity

- The rate of heat flow through a material.
- The units of thermal conductivity are calories/second.meter.degree .
- Materials have different rates of conducting heat
  - Metals have higher value than plastics or ceramics Therefore, metals would cause patient to feel more sensitivity
- Enamel and dentin are poor thermal conductors
- In deep restorations, a cement base will be used as an insulator
- Gold causes the most sensitivity

3. Boiling & Melting Points

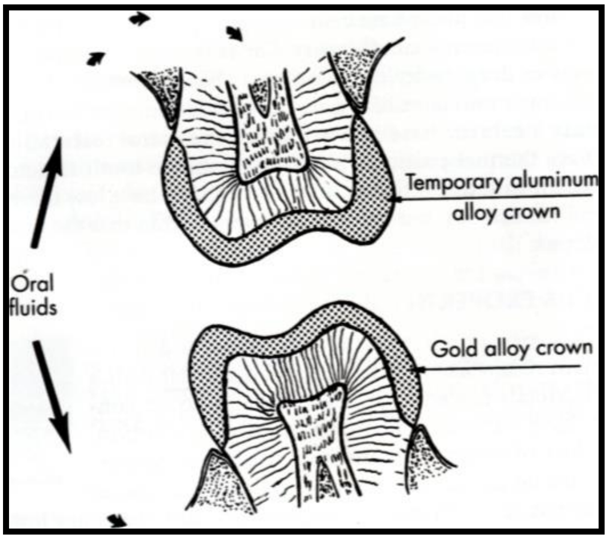
- Any material has its certain and specific boiling and melting points.
- Mixtures have a boiling and melting range rather than a specific boiling and melting points.
- Some materials do not boil or melt, but decompose if heated sufficiently, like wood.

4. Vapor Pressure
- A measure of liquid's tendency to evaporate.
- Materials with high vapor pressure at room temperature are useful as a solvent.

III. Electrical Properties

1. Galvanism

- Galvanism
  - Generation of electrical currents in mouth
  - Results from presence of dissimilar metals in mouth
  - Causes pain and tastes metallic



- Corrosion
  - Dissolution of materials in mouth
  - Results from presence of dissimilar metals
  - Roughness and pitting
- Tarnish
  - Surface reaction of metals to components in saliva or foods

2. Electrical Conductivity
- The ability of a material to conduct the electrical current.
- It is important to consider during electrosurgery or electrical pulp testing.

IV. Optical Properties

1. Color and Esthetics
- Light source strikes an object.
- Reflected light comes off the object and is sensed by receptors in the retina of the eye.
- If person not color blind, info from the retina sorted out by brain and colors are "seen".

Munsell Color System
- System to measure colors.

- Based on three indices:
  Hue = What color is it?
  Value = Lightness of the color
  Chroma = Saturation of color.
- Value increases from bottom to top.
- Chroma increases from center outwards

2. Metamerism

- Objects appear to be different colors in different lights.
- Source of great difficulty in shade matching for restorations.

3. Fluorescence

- Material becomes source of light. Emits lights when a beam of light is shined on it.
- Natural teeth display fluorescence. Some porcelains do not. Appear to be missing in black light (UV).

4. Opacity, Translucency, Transparency

- Transparent=Clear, like glass. No light is absorbed.
- Translucent=Part of light transmitted through, part absorbed, part reflected.
- Opaque=All light absorbed.

V. Mechanical Properties

- Physical science and laws of mechanics act on all materials.
- Useful to examine how a material reacts under certain conditions.
- Helps to predict material's usefulness as a restorative.

Three Basic Forces

- A. Tensile = Force that pulls an object apart. Object pulled by this force is under *tension.*
- B. Compression = Force that squeezes an object together. Such an object is under *compression.*
- C. Shear = Force that slides the top of the object over the bottom. Like a deck of cards stacked on table. You put force on the top cards and slide them over the rest of the deck.

Intraoral Biting Forces

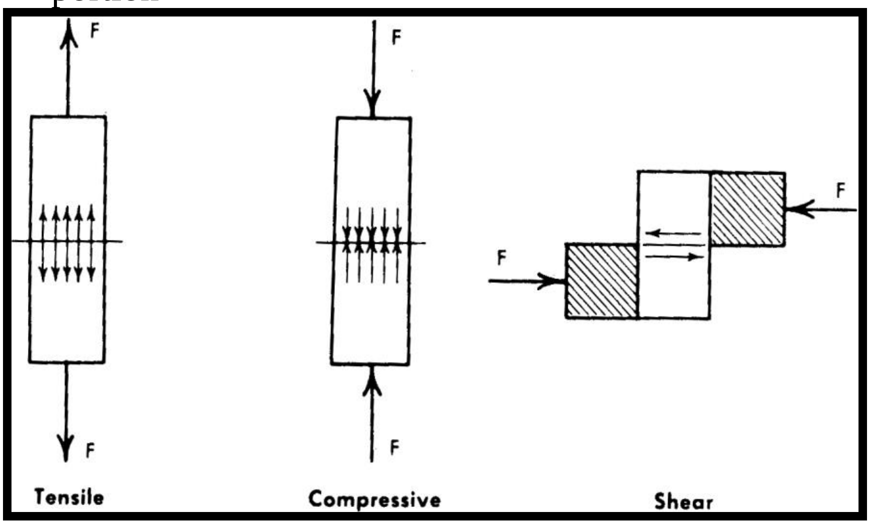
- Greatest in the molar area –580Newtons. (132lbs.)
- Premolars – 310Newtons (70.5 lbs.)
- Cuspids – 220Newtons (41lbs.)
- Partial and complete dentures –111Newtons (25 lbs.)

Stress

- Stress
  - Force per unit area
  - For a given force, the smaller the area applied to, the larger the value of the stress
  - Increased force on a smaller area will cause increased stress and vice versa
  - Stress common in mouth because biting surfaces are small

Tensile, Compressive and Shear Stress

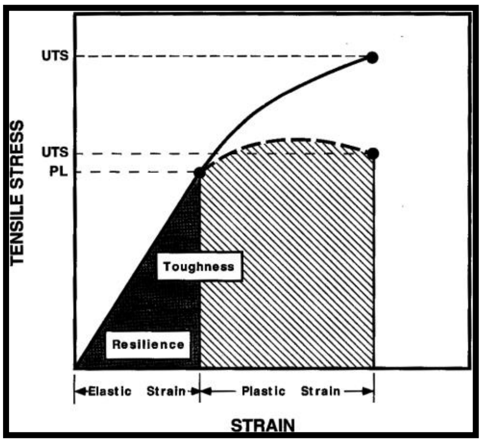
- Tensile
  - Material is pulled apart
- Compressive
  - Material is squeezed together
- Shear
  - One portion of the material is forced to slide by another portion



Strain

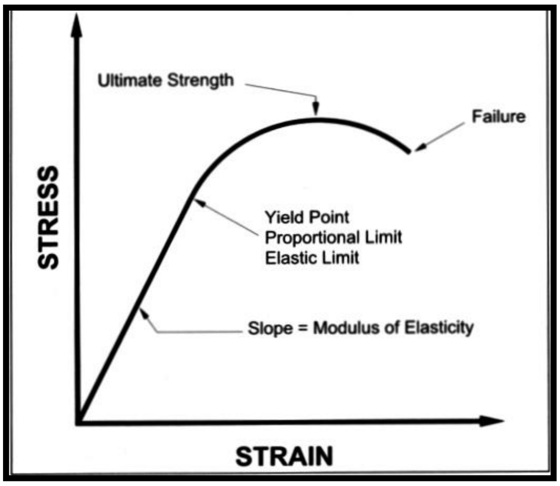
- The deformation or change in dimension an object under stress experiences.
- Strain = (L1-L0)/L0
- Stress-strain curves
  - Apply forces to a material to see what happens

Elastic vs. Plastic Strain



- Elastic strain: Completely reversible. Disappears when force is removed.
- Plastic strain: Permanent deformation of the material that never recovers after force is removed.

Stress-Strain Curves



- Straight line portion of the curve –Elastic behavior.
- Slope of the line = Stiffness of the material = Stiffness or resistance to deformation under stress = **Elastic Modulus** or **Young's Modulus**
- Proportional Limit = Elastic Limit = Stress above which the material no longer behaves totally elastically. Maximum stress at which material recovers completely.
- Yield Strength = Stress at some value of permanent deformation (usually .001). Always slightly higher than Proportional or Elastic Limit.
- Ultimate Strength = The stress at which fracture occurs.

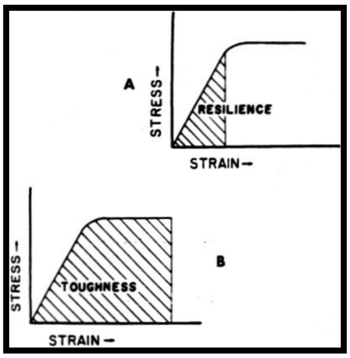
Elongation and Compression

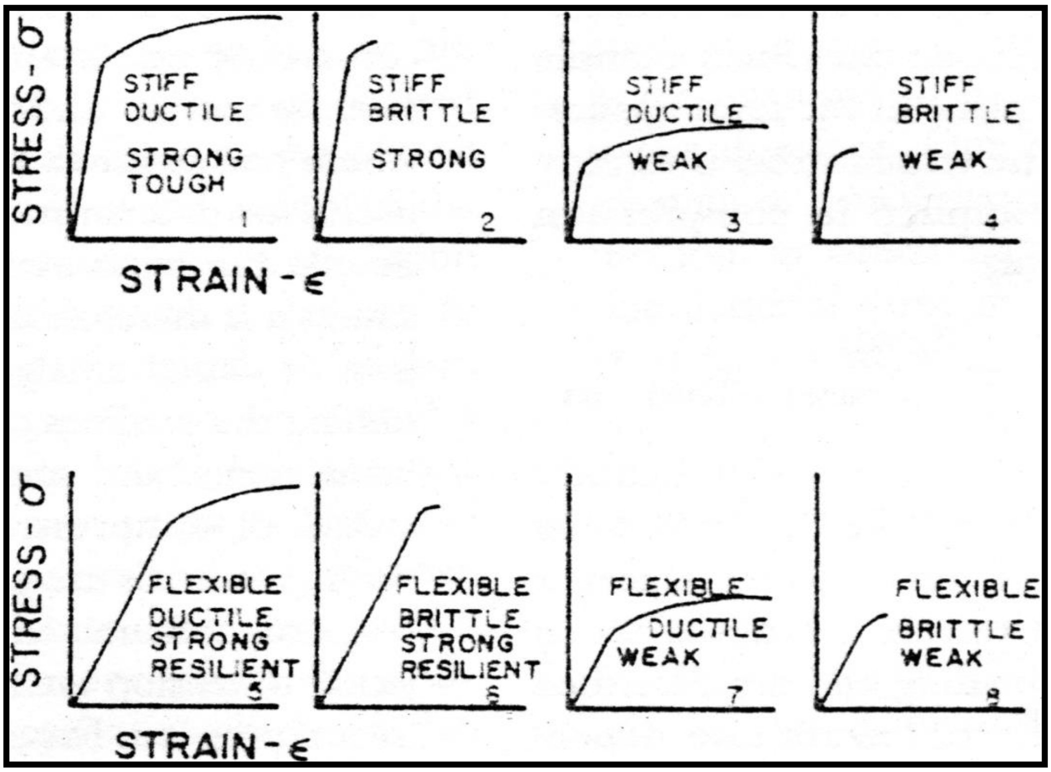
- Percent of elongation
  - Amount of deformation that material can withstand before rupture when material is under tensile stress
- Percent of compression
  - Amount of deformation before rupture when material is under compressive stress
- Both are measures of ductility and malleability

- Ductile materials = 5%elongation at rupture.
- Opposite of *ductile material* is **Brittle material.** Brittle materials have less than 5% elongation at rupture.

Resilience, Toughness

- Resilience
  - Energy required to deform a material permanently is a criterion of its resilience
- Toughness
  - Energy necessary to fracture a material is measure of toughness





Stress-Strain Curves

Strain-time Curves

- Used for materials in which the strain is dependent on the time the load is maintained
- It can be time dependent and recoverable or time dependent and not recoverable
- If a load is applied for a longer time or the magnitude of the load is great then the amount of permanent strain will be more
- Also dependent on rate of application of the load

Dynamic Properties

- Previous properties are classified as static loads due to slow application of load
- Dynamic properties are those that occur at high rates of loading, such as from an impact
- Important in mouth protectors due to stiffness of material & ability to absorb energy

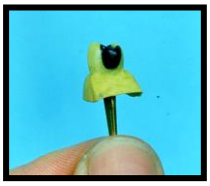
Model and Die Material

Study Models, Casts, Dies

1.Study Model = Replica of the hard and soft tissues of the oral cavity. Derived from an impression (usually alginate hydrocolloid) and used to observe teeth, tissues, consider treatment plans, etc.

2.Casts = A working model. One on which a prosthesis or appliance is being fabricated

3. Dies – Very exacting replicas of individual teeth or groups of teeth for the purpose of fabricating a cast restoration.



- By definition, it must be far more accurate than a study model
- By far most models and dies made out of gypsum products.Available in 3 types with 5 different variations recognized by the ADA.
- Plaster, stone, and high strength dental stone (die stone).

Calcium Sulfate Dihydrate

- Chemical name of gypsum. Mined as CaSO4*2H2O. Water in the formula is the water of crystallization.
- In process called *calcining* the mined stone is ground to a powder, heated, and the water is driven off. Creates hemihydrate.

Creating Dental Gypsums

- Heat gypsum to 110-130 degrees Centigrade with no pressure = Plaster. Small, irregular crystals. BetaCaSO4.
- Heat to 110-130 degrees under pressure = Stone. Larger, denser, more regular crystals. AlphaCaSO4.
- Heat to same temperature with greater pressure and boiling in 30% solution NaCl = Improved stone or Die Stone. Largest, most regular particle. Least porous.

PLASTER **STONE** **DIE STONE**

Desirable Qualities

- Accuracy
- Dimensional stability
- Ability to reproduce fine detail
- Strength and resistance to abrasion
- Ease of adaptation to impression
- Color
- Safety
- Reasonable setting time

Excess Water

- Water required in addition to that necessary for the chemical reaction
- Serves to wet the hemihydrate particles so that they can react to form dihydrate crystals
- Eventually lost by evaporation once gypsum is set
- Serves only to aid in mixing powder particles & is replaced by voids during evaporation

Physical Nature and Relation to Final Product

- Amount of water needed to mix is different for each product
- Amount of excess water needed depends on size, shape & porosity of powder particles
- Plaster requires more water than others
  - This is due to their porous, irregularly shaped particles which require more water to facilitate wetting and mixing

Water-powder Ratios

- Model plaster
  - 45-50ml water to 100 grams powder
- Dental stone
  - 30-32ml water to 100 grams powder
- High strength
  - 19-24ml water to 100 grams powder
- Deviation affects setting time, strength and setting expansion

Initial Setting Time versus Final Setting Time

- Initial
  - Working time
  - Occurs 8-16 minutes from start of mixing
  - Viscosity is sufficient so that gypsum product cannot flow
  - Should no longer be manipulated
  - Loss of gloss
- Final
  - Occurs 20 minutes from start of mix
  - Usually let it harden for 45-60 minutes
  - Chemical reaction is complete
  - Can be removed w/out distortion or fracture from impression

Factors Which Influence Setting Time

- The longer & more rapid product is mixed, the shorter the setting time
- The warmer the water, the more rapid the setting time
- Increasing the amount of water will slow the reaction and increase the setting time
  - Also weakens final product
- Accelerators
  - Chemicals added to increase the rate of reaction, thus reducing the setting time & reduce setting expansion (there is no enough time for further growth of crystals).
    - Potassium sulfate, table salt, calcium sulfate dihydrate crystals
- Retarders
  - Chemicals added to slow chemical reaction & thus increases the setting time & reduce setting expansion (the crystal become short & thick)
    - Borax, sodium citrate, glue, gum arabic

Setting Expansion

- Materials expand as crystals push on each other in set-up.
- Plaster expands (.3%) more than lab stone (.15%). Die stone expands least (.10%).

Hygroscopic Expansion

- Setting process under excess water
- Twice as the ordinary expansion
- An additional growth of crystals due to excess water
- No difference in the chemical reaction
- Used in crown & bridge casts

Strength and Hardness

- Two properties are related. Anything that affects strength also affects hardness.
- In general, more crystals means stronger/harder mass formed.
- Excess water and porosity decreases the strength.
- Adequate mixing time improves the strength, but excessive mixing time reduces it.
- Impurities affects adhesion, so strength is decreased.

Type I. Impression Plaster

- Impression Plaster: Impressions of edentulous mouths. Short setting time (4-5 minutes). W/P = .6 Minimal strength.

Type II. Lab/Model Plaster

- Lab or Model Plaster: Mount casts, study models, flask a denture. W/P = .5 Higher expansion than 1. Special type called Orthodontic Plaster sets in 2-3 minutes.

Type III. Laboratory Stone

- Laboratory Stone: Commonly used for study models, casts for dentures, appliances. W/P = .3 Lower expansion than plaster. Stronger and harder than plaster.

Type IV. Die Stone

- Die Stone: High strength and hardness with low expansion. W/P = .24 Used to fabricate cast restorations.

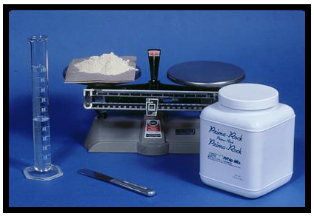
Type V. High Strength, High Expansion Die Stone

- Newest gypsum product available. Increased expansion compensates for greater shrinkage in new high melting metal alloys used. W/P = .18 to .22)

Manipulation

1. Dispense materials
2. Mixing
3. Pouring the model
4. Clean-up
5. Trimming the model

1. Dispensing



- Powder is ideally weighed on a scaled and water measured in graduated cylinder.
- Some products sold in premeasured packets.
- Not as important for plaster or simple stone study models. Critical for dies/stone casts for dentures or partials.

2. Mixing

- Add water first than powder slowly wetting the powder and getting rid of any bubbles trapped in the plaster/stone.
- Spatulate for 30-60 seconds in rubber mixing bowl by hand. Vibrate mix to reduce bubbles.
- Mix in vacuum mixer. Usually die stones.

3.Pouring the Model

- A. Dry the surface of the impression of excess water.
- B. Hold impression on vibrator and drip mix into one end of the impression.
- C. Flow material all around impression. Vibrate lightly.

<u>Model Vibrator</u>

- Vibrator to prevent air bubbles from forming in model.
- D. Larger increments of material fill impression to muccobuccal fold.
- E. Second, thicker (lower W/P) mix of material to form base.
- F. Invert on base and let dry for 1 hour before separating.

4. Clean Up

- After pouring, scrape most of residual material into trash. ***Small*** remaining amount can be washed out in sink (usually one with plaster trap).
- If it’s left behind, manipulate bowl to break up what’s left and discard.

5. Trimming the Model

- Model trimmer has large carborundum disc and flow of water to reduce and shape model.
- Bottom should be parallel to occlusal plane. Sufficient bulk for strength and stability (not to hold a door open).
- Create characteristic shape.

<u>Model Trimmer</u>

- Model trimmer with grinding disc and water to cool/clean model.

Epoxy and Metal Plated

- Special materials with increased strength and wear resistance for rare cases when necessary. Can be prohibitively expensive.

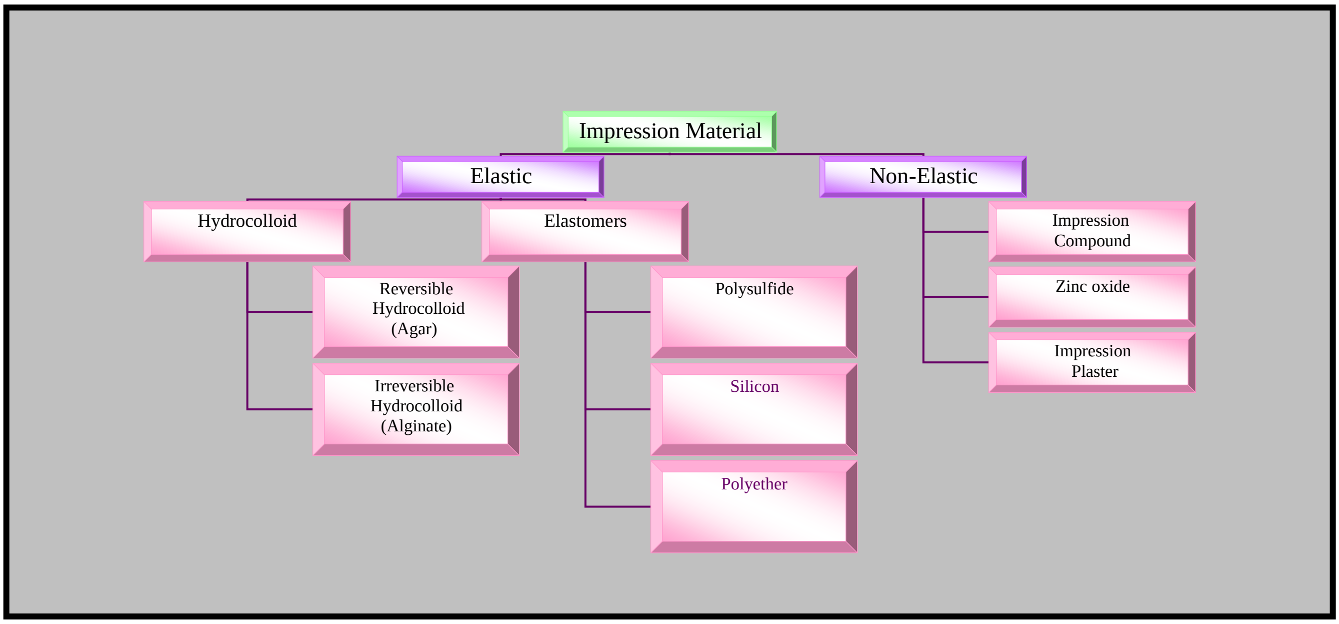
IMPRESSION MATERIALS

Function of Impression Materials

- To make a negative copy of an oral structure
  - single tooth, quadrant, or arch
  - edentulous or dentulous
- Negative copy must be accurate to produce an accurate positive replica when poured
  - model, cast or die

Properties of Ideal Impression Material

1. Ease of manipulation & reasonable cost
2. Adequate flow
3. Appropriate setting time & characteristics
4. Sufficient mechanical strength
5. Good dimensional accuracy & stability
6. Acceptable to patient
7. Safety
8. Able to disinfect
9. Compatible with die and cast materials
10. Good keeping qualities



Classification of Impression Materials

Elastic versus Inelastic

- Elastic
  - Flexible
  - Recover its shape & dimension after removal from the patient mouth
- Inelastic
  - Rigid
  - Cannot be removed from undercuts w/out fracturing
  - Edentulous mouth or for a full crown

Alginate Impression Material

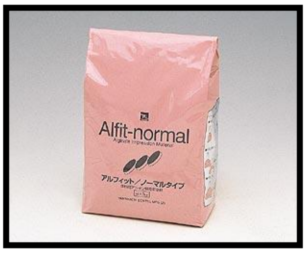
- Irreversible hydrocolloid
- Most widely used
  - Ease of mixing & manipulating
  - Minimum equipment necessary
  - Flexibility of set impression
  - Accuracy if properly handled
  - Low cost
- Uses
  - Impressions
    - study models for orthodontics, partial dentures, full dentures, and to make athletic mouthgaurd

Advantages & Disadvantages

- Advantages
  - Low cost
  - Convenience
  - Easily manipulated
  - Minimal equipment
  - Acceptable accuracy for many dental procedures
- Disadvantages
  - Does not reproduce fine detail as reliably as other elastomeric impression materials
  - Dimensional stability is poor
  - Must be poured immediately to prevent distortion

Packaging

- Powder packaged in bulk
  - Sealed screw top plastic container or hermetically sealed metal can



  - Uses plastic scoop to measure
- Preweighed individual containers
  - Made of plastic and metal foil and contain enough material for a single arch
- Both use plastic cylinder & spatula

Major Ingredients & Functions

- Sodium or potassium alginate salt
  - To dissolve in water
- Calcium sulfate
  - To form insoluble material
- Sodium phosphate
  - Retarder
    - provides working time
- Diatomaceous earth or silicate powder
  - Control consistency & flexibility
- Potassium sulfate or potassium zinc fluoride
  - Counteracts inhibiting effect of alginate on model or die material
- Organic glycol
  - Coats powder particles to minimize dust during mixing
- Quaternary ammonium compounds or chlorhexidine
  - Provides self-disinfection
- Flavoring & colouring agents

Setting or Gelation Time

- Type I
  - Fast setting
  - Gels in 1-2 minutes
  - Mixing time 30-45 seconds
- Type II
  - Normal setting
  - Gels in 2-4.5 minutes
  - Mixing time up to 2 minutes

Changes in Temperature

- High temperatures during storage deteriorates alginate (or moisture)
- Controlling setting time
  - Alter temperature of water

  - Higher the temperature, the shorter the setting time and vice versa

Manipulation

- Use correct W/P ratio
  - Too much water weakens material
- Mixing time of 1 minute sufficient
  - Over or under mixing will weaken gel
- Place in tray and seat in mouth
- 2-3 minutes after gelation time, remove with a snap motion
- Rinse thoroughly and shake
- Pour immediately if possible
- Separate from cast in 1 hour

Agar Hydrocolloid Impressions

- Reversible
- First successful elastomeric material
- Allows impression of undercut areas
- Largely replaced by rubber base elastomeric impression materials and alginate

Agar Ingredients

- Major ingredient is agar-agar
  - Seaweed extract
- Other minor ingredients
  - borax, potassium sulfate, die materials against agar, benzoates, additives and flavoring
  - Water
    - 80-85% for mixing

Method

- Carpools of very fluid impression material
  - Placed in syringes and injected in and around prepared cavity
- A more viscous impression material in tubes is used in impression trays
- Water cooled trays
  - Converts sol to a gel while in mouth

Agar-Alginate Impressions

- Syringe type agar injected around tooth
- Tray containing alginate placed over area
- Technique eliminates the use of water-cooled impression trays
- Less expensive heating equipment is needed

Uses of Rubber Impression Materials (Elastomers) in Dentistry

- Can be used for almost any type of impression
- Primarily used to create casts and dies for construction of cast appliances
- Comparable in accuracy to the reversible hydrocolloid

Definitions

- Elastomers
  - Soft, synthetic rubber (not a gel) produced by a chemical reaction called curing or polymerization
- Polymerization
  - Process of chaining together two or more similar molecules to form a more complex compound of higher molecular weight

Types of Polymerization

- Addition Polymerization
  - Results in formation of a polymer without the formation of any other chemical compounds
- Condensation Polymerization
  - Produces other chemical compounds called by-products that are not part of the polymer
- Types used in dentistry
  - polysulfide, addition silicone, condensation silicone and polyether

Polysulfide Rubber

- Polymerization occurs by condensation reaction
  - Water is by-product

Composition:

1. White paste

- Polymers of polysulfide
- Fillers (zinc oxide & potassium sulfate)

- Retarder (oleic acid &stearic acid)

2. Brown paste
- Lead dioxide
- Caster oil to improve consistency
- Sulfur (accelerator)
- Properties
  - Strong odor, stains clothing
  - Very good elastic prop.
  - Good tear resistance
  - Moderate dimensional stability (polymerization & water loss)

Manipulation

- 2 equal quantities from 2 pastes are mixed until 2 colours blend together
- Setting time is upto 8 min.
- Pouring within the 1st hour

Addition Silicone Rubber

- Polymerization occurs by addition reaction
  - No by-product
- Composition
  - Polymethylseloxane
  - Chloroplatiuic acid
- Properties
  - Odor free
  - Clean to handle
  - Good tear resistance
  - Excellent elastic prop.
  - Excellent dimensional stability
    - Curing shrinkage small
    - Pouring can be delayed up to 7 days

Condensation Silicone Rubber

- Polymerization occurs by condensation
  - Ethyl Alcohol is by-product
- Properties
  - Odor free
  - Clean to handle
  - Poor dimensional stability

- Ethyl Alcohol rapidly lost by evaporation
- Must be poured immediately

Polyether Rubber

- Curing activation occurs by aromatic sulfonate ester
  - No by-product
- Composition
  - Sulphonic acid
  - Iminterminated ether
- Properties
  - Odor free
  - Clean to handle
  - Hypersensitivity among staff high
  - Good tear resistance
  - Good elastic prop.
  - Excellent dimensional stability
  - Will absorb water but pouring can wait 24hrs

Consistencies of Rubber Materials

- Very high viscosity
  - Putty
- High viscosity
  - Heavy body; Tray material
- Medium viscosity
  - Regular
- Low viscosity
  - Light body; Syringe material

Two Techniques For Rubber Impression Materials

- Single impression technique
  - Syringe is used to inject low viscosity rubber directly into cavity preparation
  - Tray filled with heavy body seated over prep
- Putty wash technique
  - Putty type makes initial impression
  - Then syringe type injected over area
  - Two combine

Errors

- If impression not seated within the working time, a distorted image will result
- Premature removal from mouth results in deformation
  - Major cause of failure
- Always consult manufacturer's instructions
- Check material by pressing with a blunt instrument
  - When point leaves no indentation, it is ready to be removed from mouth

Impression Compound

Composition

- Natural resin (shellac) 40%
  - To give thermoplastic properties
- Waxes (bee wax) 7%
  - To give thermoplastic properties
- Synthetic resin (stearic acid)
  - Lubricant
- Fillers & Pigments

Properties

- Soften in 45°C
  - Reharden at mouth temperature (37°C)
- Poor thermal conductivity
- Poor dimension stability
  - High thermal expansion
- Unelastic
  - Undercut areas can not be recorded correctly

Manipulation

- Socking in warm water path
  - Not direct flame
- Cooling to room temperature (water spray)
- Pouring of cast

ZOE

Composition

Basic composition same for all uses

- Zinc Oxide, Eugenol and rosin
- Plasticizers, fillers and other additives as needed for intended use
- Paste A
    - Contains mainly Zinc Oxide
- Paste B
    - Contains mainly Eugenol
- Oil of cloves can be substituted for Eugenol (contains 75-80% Eugenol)

Mixing of ZOE

- Mix equal lengths of pastes A and B
- Use paper which will not soak up oil or glass slab
- Mix for one minute and of uniform color
- Setting mechanism
    - Chemical reaction
- Setting time
    - Decreases as temperature and humidity increase
    - Cooling spatula and glass slab can help lengthen setting time
- Shrinkage negligble

Impression Plaster

Used in final impression of edentulous patients and in bite registration

Properties

- Not elastic
- Good dimension stability
- Need separation medium
- Pouring within the 1st hour

Esthetic Restorative Materials

Direct Esthetic Restorative Materials
Indirect Esthetic Restorative Materials

Direct Esthetic Restorative Materials

- Composite
- Glass Ionomer

Composite

- A compound made up of 2 or more distinct materials with properties better than that of the individual components.

Synthetic Resins

- Composite resin
- Composition
  - Organic resin matrix
    - BIS-GMA resin
      - Dimethacrylate
    - Urethane Dimethacrylate (UDMA)
  - Activator
    - Tertiary amine(chemical activated)
    - Benzophenon(UV cure)
    - Diketone(blue light cure)
  - Initiator
    - Benzoyl peroxide
  - Inhibitor
    - Hydroquinon
  - Stabilizer
  - Pigments
  - Coupling agents
    - Bond filler & resin

  - Inorganic Filler Particles
    - Quartz, silica, lithium aluminum silicate, barium, strontium, zinc or ytterbium glasses
    - Particles of different sizes reinforce the matrix
    - More particles, the better the properties

Properties of Composites

1. Low polymerization shrinkage
2. Low water sorption
3. Coefficient of thermal expansion similar to teeth

4. Low thermal conductivity
5. High fracture resistance
6. High wear resistance
7. Radiopacity
8. High bond strength to enamel and dentin
9. Good color match to tooth surface
10. Ease of manipulation
11. Ease of finishing and polishing
12. Some qualities more important depending on whether it is an anterior or posterior composite

Types of Composites

- Macrofilled
  - Conventional or traditional
  - Quartz filler
  - Surface becomes rough with finishing, toothbrushing, wear
  - Discolors
  - Not suitable for posteriors
- Microfilled
  - Very small colloidol silica particles
  - Very smooth surface
  - Aesthetic
  - Not suitable for posterior teeth
- Small-particle
  - Contains quartz or glass filler
  - Smaller particle size which improves mechanical properties
  - Smooth, but not as smooth as microfilled
  - Posterior
- Hybrid
  - Contains glass and colloidal silica filler
  - Smooth as microfilled
  - Mechanical and physical properties between conventional and small-particle

Two Paste versus Single Paste

- 2 paste
  - Chemically activated
  - Amine activator in one paste reacts with Peroxide initiator in another paste
  - This initiates polymerization
  - Working time limited

- Single paste
  - Light cured
  - Single paste contains photo initiator and amine activator
  - Working time is unlimited

Posterior Composites

- Should be small particle or hybrid composites
- Should be radiopaque
- Clinical problems include polymerization shrinkage and occlusal wear

Purpose of using Acid Etching

- 1 minute application of 36% Phosphoric Acid liquid or gel
- Improves seal of resin by increasing retention and intimate contact between resin and tooth
  - Reduces microleakage

Use of Bonding Agents

- Low viscosity resins which flow more readily than composite material into micropores created by the acid etch
- Provides mechanical and chemical bonding with tooth structure (enamel or dentin)

Other uses of Composites

- Bonding agents
- Restoration of incisal area
- Core buildups
- Temporary bridge construction
- Repair of porcelain or composite

Glass Ionomer Restoratives

- Supplied as powders of various shades and a liquid
- Better retention in areas of cervical erosion than composites
- Composition
  Silicate glass

Polyacrylic acid

Indirect Esthetic Restorative Materials

DENTAL PORCELAIN (Ceramic)

- Most common ceramic used in dentistry
  - Porcelain
    - A white translucent ceramic fired at high temperatures
  - Two types
    - Construct artificial teeth
    - Construct restorations

Porcelain Restorations

- Inlay
- Only
- Jacket crown
  - Porcelain covers entire crown of tooth
- Metal ceramic crown
  - Porcelain veneer is fused directly to a metal casting
- Laminate veneer
  - Thin layer of porcelain covering only the facial surface of a tooth

Steps in Constructing Porcelain Restorations

- Ceramic powder is mixed with water to form a paste
- Paste is formed into the desired shape and heated (fired) at a high temperature
- Grains of powder fuse to form a ceramic material
- After final adjustments are made in the mouth, the crown is removed and fired again to glaze its surface

Care of Porcelain Restorations

- Must be able to distinguish crown margins during scaling
  - Brittle crown margins can be easily damaged with sharp instruments
- Avoid use of Acidulated Phosphate Fluoride prophy pastes and topical APF treatments
  - Some research has shown pitting in the porcelain after 2 minutes of use

General Properties of Porcelain Restorations

- Excellent aesthetic qualities
- Completely insoluble in oral fluids

- Dimensionally stable once fired
- Biologically compatible with soft tissues
- Resistant to abrasion
- Adequate compressive strength
- Low tensile and shear strengths

Porcelain-Metal Restorations

- The most serious limitation of porcelain is its low tensile strength
- When fused to a metal casting, it is reinforced so that brittle fracture is avoided
- Use far exceeds that of porcelain jacket crowns
- Leaving occlusal surface in metal will slow down wear on opposing natural dentition

Castable Ceramic Materials

- Recently developed materials
- Liquefied at high temperatures and cast directly into the investment mold
- Most popular castable ceramic is Dicor, developed by Corning Glass Works
  - Has low tensile and shear strengths
  - Limits use to single units

Acid-etched, Resin Bonded Ceramic Restorations

- Ceramic veneers
- Ceramic inlays
- Ceramic onlays

CAD-CAM Technology

- Prepared tooth surfaces are reproduced as a three-dimensional digitized image stored in a computer
- Image used to control a milling machine which makes the block of material to be cemented into the prepared tooth
- Too expensive for average practice
- Chair-side construction in one visit

Dental Amalgam

Definitions

- Amalgam
  - Any alloy that contains mercury
- Amalgamation
  - Combining mercury with an alloy of silver, tin, and copper
    - Amalgam alloy
- Trituration
  - Mechanical mixing of amalgam alloy particles with mercury to achieve amalgamation
- Condensation
  - Use of mechanical or hand instruments to place or condense the amalgam mass into the cavity preparation
- Ditching
  - Gradual deterioration of amalgam at the tooth-restoration interface
  - Microleakage may occur

Composition of Modern Amalgam

- Dramatic changes in the past 20 years
- Predominate constituents
  - Silver
    - Increases setting expansion and strength
  - Tin
    - Helps amalgamation
    - Decreases expansion
- Other constituents
  - Copper
    - Increases strength, hardness, and setting expansion; redness
  - Zinc
    - Minimizes oxidation
  - Palladium
    - Whitens
  - Mercury
    - Forms workable mass

Tradition Amalgam (Low Copper)

Spherical or Lathe-cut

- 66-73% silver
- 25-29% tin
- 6% cupper
- 2% zinc
- 3% mercury

Spherical vs. Lathe-cut

Spherical

- Spherical particles

- 40-50 µ in size

Lathe-cut

- Different shaped particles
- 0-70 µ in size

High Copper Amalgam

  - Greater than 6% copper
  - Almost universally used today
  - Higher strength
  - Higher corrosion resistance
  - Less marginal breakdown
  - Low creep
- Types of high copper
  - Admixed
  - Single composition

Admixed Composition

Dispersion (Blended) alloys

  - Oldest type of high copper
  - Alloy powder is a mixture of powders of two alloys
    - Mix of spherical and comminuted particles
      - Various sizes
  - Adapt better to cavity walls
  - Produce better contacts

Single Composition

- Alloy powder contains powder particles of one composition
  - Spherical or comminuted
- Require less mercury for mixing
- Require less condensation force

Zinc versus Non-zinc

- Zinc aids in minimizing the oxidation of other metals present in the alloy during the manufacturing process
  - Zinc-containing

        - Zinc in excess of .01%
    - Non-zinc
        - Zinc less than .01%

Physical Properties

- Excessive expansion
    - Put pressure on pulp, protrusion of restoration or fracture
- Excessive contraction
    - Pulls away from the cavity walls
    - Permits gross leakage between tooth and restoration
- Strength
    - Gains strength in 1 week
    - Variables
        - Trituration
        - Residual Mercury
        - Porosity
- Creep
    - Deforms under a constant load
- Tarnish
    - Surface discoloration
        - Deposit of surface film that produces discoloration
        - Can be removed by polishing
- Corrosion
    - Loss of surface by chemical attack
        - Effects surface and subsurface
    - Deterioration by chemical or electrochemical action

Mercury Content and Function

- Refers to the amount of mercury in the amalgam mix
- 40-50% mercury in mix is common
- Liquid which provides the "plastic" mass so that the alloy can be inserted into cavity preparation
- Acts as a matrix material to bind alloy particles

Manipulative Variables

- Original alloy-mercury ratio of the mix
- Amount of trituration
- Pressure and technique of condensation
- Time elapsed during mixing and condensation

- Mercury content highest at margins

Excessive versus Insufficient Mercury

- Effects of excessive mercury

- Serious loss of strength
- Increase in creep and marginal breakdown
- Effects of insufficient mercury
  - Stiff, grainy mix that is difficult to condense
  - Final restoration probably contains voids that decrease strength

Trituration time

- Varies with brand of alloy, alloy-mercury ratio, size of the mix, type of amalgamator, and speed setting
- Undertrituration
  - Grainy mix with excess mercury
- Overtrituration
  - Excessive heat production
    - Causes mix to set up too quickly

Finishing and Polishing

- Finishing
  - After carving, amalgam is smoothed by burnishing it with a ball burnisher
- Polishing
  - Reduces surface roughness, eliminates pits from carving
  - Increases life of restoration if done periodically by preventing tarnish & corrosion

Effects of Moisture Contamination

- Excessive expansion
- Moisture and zinc
  - Liberates hydrogen gas within the amalgam mass which leads to delayed expansion beginning at 1 week and continues for months
- Protruding restorations lead to:
  - secondary caries at overhang, corrosion, loss of strength, postoperative pain from pressure

Marginal Breakdown

- In time, most amalgam margins become chipped or ditched
- Most likely in the following
  - Alloys with high creep values
  - Alloys with high mercury content in marginal areas
  - Areas of flash due to incorrect finishing technique

Types of failures

- Secondary or recurrent caries
- Bulk fracture

- Marginal breakdown
- Excessive dimensional change
- Excessive tarnish and corrosion

Hazard when inhaled during mixing

  - Can lead to an accumulative toxic effect
  - Vapor is colorless, odorless and tastless

- Can be absorbed through skin
- High incidence of miscarriages in staff
- Prevention
  - Ventilation of office
  - No carpet
  - For spills use a mercury-spill kit
  - Vacuum cleaners should not be used for spills
  - In cases of skin contact, wash with soap and water
  - Excess mercury (which includes waste amalgam) should be collected & stored
    - Use glycerin or x-ray fixer solution
  - Capsules should be tightly capped
  - Amalgamators should have hoods over arms
  - Use pre-proportioned capsules
  - When cutting amalgam-water spray and suction needed
  - Wear gloves and mask
  - Periodic monitoring of exposure levels

CEMENTS

Definitions

- Cements-*Luting* agents that help retain restorations on prepared teeth.
- Bases-Thick layers under restoration to provide electrical and thermal insulation to pulp. Strong enough to support restoration.
- Liner/Varnish-Thin layer sealing dentin. Protecting pulp.

Uses of Dental Cements

- As permanent, intermediate and temporary restorations
- As luting cements for indirect restorations and orthodontic bands
- As thermal insulators under metallic restorations (bases)
- As pulp capping agents and cavity liners
- As root canal sealants
- As perio packs

Zinc Phosphate Cement

- Used primarily for final cementation when high-strength needed
- Powder
  - Zinc oxide with magnesium oxide and pigments
- Liquid
  - Phosphoric acid in water buffered by aluminum & zinc ions

Properties

- Enough working & setting time
- Opaque (not used under porcelain)
- High initial acidity (2-4) p H
- Low solubility in water
- Good compressive strength

Uses

- Cement (luting) for crown fixation
- Base under restoration

ZOE Cements

- Sedative effect
- Type I

- Temporary Powder
  - Zinc oxide (69%)
  - Rosin (29%)
  - Zinc acetate
- Temporary Liquid
  - Eugenol or mixture of eugenol & other oils

- Type II
  - Permanent
    - Polymer-reinforced
      - 80% zinc oxide & 20% acrylic resin with a eugenol liquid
    - EBA alumina-reinforced
      - 70% zinc oxide & 30% alumina with a 62.5% EBA and 37.5% eugenol liquid

Properties

- Ideal working & setting time
- Interfere with polymerization (not used under composite filling)
- Very good thermal insulation
- High solubility in water
- Less strength

Uses

- Base under restoration

Zinc Polycarboxylate Cements

- Usually supplied as a powder & liquid
- Some use tap water for liquid
- Powder is mainly zinc oxide
- Liquid is a viscous solution of polyacrylic acid in water

Properties

- Bond with enamel
- Less acidity than zinc phosphate
- Moderate solubility in water
- Good strength but less than zinc phosphate

Uses

- Cement (luting) for crown fixation
- Base under restoration
- Orthodontic bracket fixation

Glass Ionomer Cements

- Powder
  - Finely ground aluminosilicate glass
- Liquid
  - Polycarboxylate copolymer in water

Uses

- Final cementation of crowns & bridges
- Class V restorations

Properties

- Chelation between polycarboxylate molecules & calcium on surface of tooth results in a chemical bond
- Used with a base
- Fluoride in powder
- High early solubility

Hybrid Ionomer Cement

- Relatively new
- Powder
  - Radiopaque, fluoroaluminosilicate glass
  - Microencapsulated potassium persulfate & absorbic acid catalyst system
- Liquid
  - Polycarboxylic acid modified with pendant methacrylate groups
  - HEMA and tartaric acid
- No measurable solubility, high fracture toughness, fluoride release

Properties of Luting Cements

- Setting time
  - Should set slowly enough for proper working time
- Adhesion
  - Many do not form a bond so retention is dependent on design of cavity prep, fit & mechanical locking
  - Thinner the film, better the retention
- Strength
  - Affects mechanical interlocking fractures
- Solubility & Disintegration
  - Thin & low solubility

    - Max powder used

High-strength Vs. Low-strength Bases

- High-strength
    - Used to provide mechanical support for a restoration & thermal protection for pulp
- Low-strength
    - Form a cement layer with minimum strength & low rigidity
    - Form a barrier to irritating chemicals & provide therapeutic benefit to pulp
- High-strength bases
    - Glass Ionomer & Hybrid ionomer
    - Polymer-reinforced ZOE (Type III)
    - Zinc phosphate & Zinc polycarboxylate
- Low-strength bases
    - Calcium hydroxide (Light & self cure)
    - Resin
    - ZOE (Type IV)

Low-strength Bases

- Calcium hydroxide
    - Direct & indirect pulp capping
    - Protective barrier beneath composites
    - Base & catalyst paste
    - Low mechanical properties, stimulate reparative dentin, low thermal conductivity
- Resin cement
    - Used w/composites & light-cured
    - Strong, low rigidity
- ZOE
    - Retards penetration of acids, reduces discomfort to pulp, low strength
    - 2 pastes

Uses of Temporary Cements

- Called temporary restorations
- Protects pulp, reduces pulpal inflammation, and maintains tooth position until permanent restoration made
- ZOE used most frequently

- Longer term
    - Modified ZOE, hybrid ionomer, zinc polycarboxylate cement

Special Applications of Cement Materials

- Root canal sealer
    - ZOE
- Gingival tissue pack
    - ZOE with cotton twills
- Periodontal dressings
    - Following surgery
- Cementation of orthodontic bands
- Direct bonding of orthodontic brackets
- Cement resin-bonded bridges
- Cement ceramic or composite inlays & onlays
- Cement ceramic veneers

Liners/Varnishes

- Seal against irritants in saliva or from restoratives.
- Cover and protect pulp in deep carious lesions.
- Direct vs. Indirect pulp cap.

Calcium Hydroxide

- Basic compound (pH=11)
- Antibacterial qualities.
- Stimulates secondary dentin.
- Paste/paste system or mixed with a resin and light cured.
- Very soluble, wash out easily.

Glass Ionomers

- Thinner layer than as base.
- Liquid/powder system, premeasured capsules, or light cured formula.
- Less soluble than CaOH, release fluoride.

ZOE

- Used in deep restorations to sooth pulp.
- Often used as temporary or interim restoration.

- Under a base to protect pulp.

Cavity Varnish

- Solutions of copal resin or cellulose in alcohol or chloroform.
- Paint on to seal tubules and liquid evaporates leaving resin
- Prevents initial leakage under amalgams.

Dental Alloys & Casting of Metals

Metals in Dentistry

- Oldest restorative material.
- First used as pure gold –24karat – foils. Direct filling.
- Dental alloys used now.

Dental Alloys

- Alloy is combination of 2 or more different metals.
- Alloys allow combining best properties of many metals for specific purposes (inlay, long span bridge, partial denture, etc)

Metal Properties

- All metals are ***Crystalline***. That is the atoms are arranged like stacked canon balls in solid state.
- All metals can be heated and converted to liquid phase.
- ***Casting*** is the process of heating a metal and pouring it into a mold.
- When heated metal cools (solidifies), forms from crystals throughout cooling mass called ***grains.*** Grains grow and meet at grain boundaries like pieces of jigsaw puzzle.
- Small grain size stronger, harder.
- Elastic modulus, elastic limit review.
- ***Work Hardening –*** Metal becomes harder with bending / working it. (Direct gold, paper clip).
- ***Annealing*** – Reversing above.

Gold and Non-precious Alloys
Noble Metals & Base Metals

- Noble or Precious
  - Gold
  - Platinum
  - Palladium
  - Iridium
- Silver
  - Considered precious but it is not noble because it tarnishes & is inexpensive

- Base or Non-Precious
  - Chromium
  - Aluminum
  - Do not depend on noble metal content for corrosion resistance
  - Commonly used for partial frameworks

Karat & Fineness

- Karat (K)
  - Traditional unit expressing gold content in an alloy
    - Pure gold is 24 karat
    - Karat of alloy is # of parts of pure gold in 24 parts of alloy
  - Fineness (F)
    - % of gold multiplied by 10
    - 24 K alloy fineness - 100 X 10 or 1000

Gold As A Direct Filling Material (24 K)

- Gold foil
  - Compact layer upon layer w/condensers
- Sponge gold
- Mat gold
- Fibrous foil
- Powdered gold-calcium alloy

Casting and Classes of Gold Alloys Utilized

- Process of pouring a molten alloy into a mold to form restorations
- Gold alloys used in casting
  - Addition of copper, silver, metals of the platinum group and other metals
- Type I - IV
  - Soft to extra hard

Porcelain-Fused to Metal and Low-Karat Gold Alloys

- PFM
  - Outer coating of porcelain for a natural appearance
  - Layer of porcelain enamel is fused to the alloy
  - Esthetics and cost of gold has increased use of PFM crowns

- Low-karat
  - Yellow and white gold alloys
    - Gold content as low as 30%
  - Price of gold has increased use
  - White gold
    - Gold-based alloys that have a silver color

Composition of Precious Metal Alloys and Purpose

- Gold
  - Provides tarnish resistance, color, & ductility (16K)
- Copper
  - Provides strength & hardness to gold
  - Red color, lowers fusion temp and tarnish resistance
- Silver
  - Counteracts redness but causes tarnish
  - Contributes to hardness & strength
- Platinum Group
  - Includes platinum, palladium and iridium
- Platinum
  - Strengthen alloy & raise fusion point
- Palladium
  - Same function but also whitens
- Iridium
  - Grain refiner
- Zinc
  - Prevents oxidation of other metals

Soldering & Brazing

- Soldering
  - Method of joining metal components together by fusion with a lower melting alloy (lead-tin solders)
- Brazing
  - Preferred term when the joining alloy melts above 500 degrees Centigrade
- Soldering alloys used to join units

Composition of Solder

- Depends on alloy being joined
- For Gold Alloy Types I-IV the solder is a lower content gold alloy containing additional zinc and tin

- Solder must be completely molten at a temp at least 80 degrees below that of the cast gold alloy
- Gold solders stamped w/two #'s which give K and solder's fineness
- PFM solders
  - Must not soften during firing of porcelain
- Silver solders
  - Used to join wires for ortho appliances
  - Used w/stainless steel as well as precious metals
- Fluxes
  - Prevent oxidation of parts being soldered
    - Contain borates or fluorides in paste or liquid form

Alloys For Bonding to Porcelain

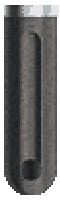
- High-gold alloys
  - Noble metal content of 80-98%
    - Gold plus platinum & palladium
  - Other content
    - Iron, tin, & indium
  - Higher melting temperatures
- Palladium-silver alloys
  - 50-60% palladium
  - 30-40% silver
  - Remaining %
    - Base metals for hardening
  - Green discoloration of porcelain by silver contamination
- Palladium-copper alloys
  - 70-80% palladium
  - 10-15% copper
  - 5-10% gallium
  - Do not produce greening
  - Not recommended for long-span bridges
- Nickel-chromium alloys
  - Non-precious alloys
  - 70-80% nickel
  - 15% chromium & aluminum, beryllium and manganese
  - Allergy potential
  - Maryland bridges

Use of Cobalt-Chromium Alloys

- Used for partial denture frameworks
- 60% cobalt & 25% chromium
  - also nickel, carbon, molybdenum, etc.
- Density half of Type IV gold so lightweight
- Lower cost & adequate mechanical properties
  - Strength comparable to Type IV gold alloys
- Also used for palatal areas of complete dentures

Use of Titanium and Its Alloys

- Used for dental implants, self-threading pins and to retain amalgam cores and large amalgam restorations
- Resistant to corrosion, low density and modulus, high strength, and exceptional biocompatibility with tissues



Wrought Alloys

- Pulling a cast metal through a die produces a ***wrought wire.***
- Many dental products are made this way. Ex. Ortho. wires, endodontic files, some RPD clasps.

DENTAL CASTING OF METALS

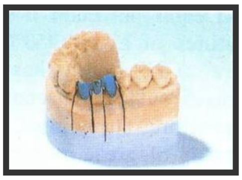
Casting of Dental Alloys

- Process of turning a wax pattern of the restoration into metal.
- Use the ***lost wax technique.***
- Extremely accurate and extremely demanding and technique sensitive.

Casting

- Create wax pattern on die.
- Sprue the pattern.
- Invest the wax pattern.
- Burn-out the invested pattern.
- Cast the metal.
- Pickle the casting.
- Finish and polish.

Wax-up of Full Crown



- Complete wax-up of full crown ready for spruing.

Patterns on Sprue

- Wax-up on sprues (channel for metal to flow into ring) ready for investing.

Burnout Oven

- Place ring with invested wax pattern to burn out wax and leave hole for metal.

Casting Machine/Crucible

Casting machine to melt alloy and "shoot" molten metal into ring

Waxing/Spruing

- Direct/Indirect techniques
- Easily distorted due to properties of wax.
- Sprue and invest as soon as possible.

Investing/Burnout

- Investment made of binder (usually gypsum) and refractory material (silica) to resist heat of molten metal. Need phosphate binder for alloys with higher burnout temps.

Investments/Burnout

- Pour investment into ring.
- Use moistened ceramic paper to line ring and aid in expansion.
- Hygroscopic and thermal expansion of investment to overcome shrinkage of metal on cooling.

Casting/Pickling

- Metal melted with blowtorch or electric current in crucible then shot into hole left by burned out wax pattern and sprue in casting machine (centrifuge).
- Clean casting in acid bath to remove oxides from firing metal.

Finishing/Polishing

- Cut off sprue.
- Seat on die and go through steps as discussed in previous chapter.
- Special care must be taken on margins/contacts, occlusal.

WAXES

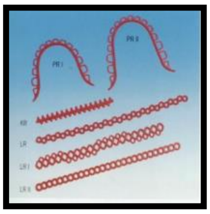
Compositions & Classes

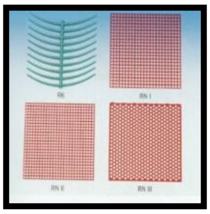
- z Composition
    - Natural & synthetic waxes, gums, fats, fatty acids, oil, natural & synthetic resins, pigments
- Classification
    - Pattern
    - Processing
    - Impression

Differences between Classifications

- Pattern
    - A pattern of wax that duplicates the shape & contour of the desired metal casting is made
    - Inlay, casting & baseplate waxes
    - Onlays, crowns, bridge units
- Processing
    - Auxiliary materials or aids
    - Boxing, utility, sticky
- Impression
    - Record detail in oral cavity
    - Corrective & bite waxes

<u>Pattern Wax</u>





- Uses lost wax pattern technique
    - Wax pattern is made
        - Carved wax pattern is embedded in gypsum-silica investment material to form a mold
    - Wax is eliminated by heating & mold is ready for molten alloy
- Composition
    - Combinations of paraffin, microcrystalline wax, ceresin, carnauba, candelilla, beeswax
        - Hydrocarbon waxes make up major portion
    - Type I or II depending on hardness (flow)

Properties of Pattern Wax

- Flow at working temperature.
- Melting range higher than working space (mouth, lab, etc.)
- Burn out with no residue.

Types of Pattern Wax

- Casting wax
  - Patterns for metallic framework of removable partial dentures & similar
  - Sheets, ready-made shapes, bulk
  - Must vaporize with minimum residue
- Baseplate wax
  - Used on a baseplate tray
    - Establishes vertical dimension, plane of occlusion, & initial arch form for complete dentures
    - Produces desired contour of denture after teeth are set in position

Processing Wax

- Boxing wax
  - Adapting a long, narrow stick or strip of wax to fit around an impression, then following with a wide strip of wax
    - Produces a form around entire impression
    - Edentulous impressions
- Utility wax
  - Adhesive wax
  - Use on impression trays to customize contour
  - Stick and sheet form in dark red or orange
  - Orthodontics
    - Called periphery wax
    - White sticks
- Sticky wax
  - Mixture of waxes and resins
  - Sticky when melted
  - At room temp is firm & brittle
    - Used to make metallic or resin pieces in fixed temporary position
    - Seals plaster splints to stone cast for facings

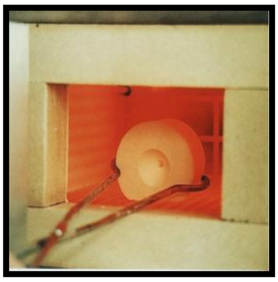
Impression Wax

- Record fine details

- Used in specific areas
- Softening temperature close to the mouth temp.

- Corrective impression
  - Used as wax veneer over an original impression to give detail of soft tissues
- Bite registration wax
  - Used to articulate certain models of opposing quadrants
  - Distort easily

Investments



Investments

- Investing materials is ceramic materials used to form a mold for casting alloys or polymers.

Requirements

1. Withstand high temp. without decomposition
2. Break easily after casting
3. Do not react with the casting materials
4. Produce the fine details of the patient mouth
5. Easily manipulated and reasonable setting time
6. Have enough strength at room temp. to withstand the impact force of molten metals
7. Porous to allow the escape of gases
8. Inexpensive
9. Have expansion to compensate the metal shrinkage

Types of Investing materials :

- Gypsum bounded investmentwithstand temperature upto 700°C
- Phosphate bounded investment withstand temperature upto 1500°C
- Ethyl silicate bounded investment withstand temperature upto 1500°C

Composition

Powder

- Silica
- Quartz
- Binder
  - calcium sulfate or
    phosphate or
    ethyl silicate

Liquid

- Water or
- Special fluid
  -soluble form of silica in water

Plastics in Prosthodontics

Use of Plastics in Dentistry

- Also called polymers
- Greatest use in prosthetic dentistry
- Examples of plastics
    - Acrylic
        - 95%
    - Rubber-reinforced acrylic polymers
- Acrylic plastics
    - May be soft & flexible or rigid & brittle
    - Complete or partial denture base (rigid)
    - Soft liner (soft)
    - Artificial denture teeth
    - Esthetic facings
    - Impression trays
    - Mouth protectors

Definitions

- Polymerization
    - Conversion of low-molecular weight compounds called monomers to high-molecular weight compounds called polymers
    - Converts material to a solid
- Monomer
    - One unit
- Polymer
    - Many units
- Free radicals
    - From decomposition of an organic peroxide
        - Once radicals react w/monomer molecules, polymer chains result
    - Peroxide is decomposed into free radicals either by heating or by the addition of an organic accelerator (amine)
    - Use heat
        - Heat-curing plastics
    - Use amine
        - Cold-cure plastics or chemical plastics

- Cross-linked polymers
  - High-molecular weight network polymer
  - Called cross-linked plastics
- Copolymers
  - Consist of two or more different monomers
- Modified polymers
  - Addition of compounds that do not enter into the polymerization reaction
  - Oily organic esters (Oils)
    - Soft liners since oils cause softening of material
  - Rubber
    - Produces resistance to fracture
  - Fillers
    - Make material putty-like for impressions

Denture Bases

1.Conventional Heat Cured

Powder=

- Copolymer of PMMA
- Initiator (Benzoyl peroxide).

Liquid=

- MMA
- Inhibitor (hydroquinone).
- Activator=Heat

MMA is allergen. More left unreacted, better chance for problems with mucosa.
Using heat as activator assures long, slow and *complete* polymerization.
However, heat activation also causes shrinkage.

2.Cold Cure Materials

Powder=Same formulation as heat cured
Liquid=MMA

- Organic amine.
- Activator=Chemical.

Process occurs at room temperature upon mixing.
More MMA left unreacted in this process. More chances for skin irritation.
•Much less dimensional change than in heat processing.

3.Light Activated Material

- Supplied in sheets or tubes.
- Dimethacrylate *composite*.
- Activator=Blue light unit.
- No shrinkage.
- Good for repairs, trays, relines. Not commonly used as full denture.

Properties

- Poor thermal conductivity-decrease in heat/cold sensation.
- Water sorption-absorbs water and expands. Can pick-up stain and odor.
- Low abrasion resistance-care when scrubbing, cleaning
- Low impact strength-Many dentures broken when dropped during cleaning.
- Warping-If cleaned or stored in very hot water or during polishing procedure.
- Poor adhesion to metal/porcelain.

Other Uses of Plastics

- Maxillofacial materials
- Temporary crown and bridge materials
- Tray materials
- Plastic-metal combinations
  - Metal-base complete denture
  - Removable partial dentures
  - Facings for fixed bridges
  - Orthodontic appliances

Finishing, Polishing & Cleansing Materials

Definitions

<u>Cutting</u>

Cutting tooth structures with a dental bur in a dental handpiece

<u>Abrasion</u>

Sharp edges of random particles used to produce a surface with irregular grooves

Particles may be loose, fused to one another, or bonded to a carrier

<u>Cleaning</u>

Removing soft debris

Abrasives are soft materials with small particle sizes

<u>Finishing</u>

Used primarily for developing desired contours of a restoration or tooth preparation or for removing gross irregularities

Particles are coarse and hard

<u>Polishing</u>

Remove material from the surface, molecule by molecule

Produces fine scratches and irregularities which are filled in by the fine particulate being removed

Examples of Abrasive Tools

- Diamond abrasive tool
- Mounted stones
- Grinding wheels
- Whetstone for instrument sharpening
- Sandpaper discs
- Finishing strips
- Particle-impregnated polymer abrasives
- Abrasive paste or slurry

Types of Abrasives

- Emery (Corundum)

  - Silicon carbide on a disc
- Aluminum Oxide
  - Not suitable for natural teeth
  - Used on metals
- Garnet
  - On polishing discs
- Pumice
  - Teeth & restorations
  - Coarse
    - Abrasive
  - Fine
    - Polishing
- Zirconium silicate
  - Prophy polishing paste
- Diatomaceous earth
  - Abrasive or polishing agent
  - Filler in dental materials
- Tripoli
  - Mild abrasive action or polishing
- Rouge
  - Fine red powder
  - Composed of iron oxide
  - Great for gold and noble metal alloys
- Tin
  - Paste for teeth and metallic restorations
- Sand
  - Impregnated on paper
  - Used as abrasive
- Carbides
  - Abrading agents in dental stone or bur
- Diamond
  - Hardest and most effective abrasive for enamel
  - Chips are impregnated in a binder to form diamond burs or disks

Reasons for Polishing Teeth and Restorations

- Aesthetics
- Smooth surface reduces potential for accumulation of food debris
- Prevents tarnish and corrosion of metals
- A highly polished tooth is more resistant to caries

Polishing Technique

- Gross surface irregularities are removed by coarse abrasives
- Then finer grade abrasives are used to remove deep scratches produced by the coarse abrasive
- This is followed by the use of finer & finer abrasives until scratches are small enough to be removed by a polishing agent

The Dentifrice

- Essential for removal of pellicle and stains
- Composition
    - Abrasive or polishing agent
        - Cleaning & pellicle removal
    - Humectant
        - Retards drying
        - Improves appearance
    - Detergent
        - Loosens & facilitates removal of deposits
    - Binders
        - Prevent separation of liquid & solid components
    - Coloring & flavoring agents
        - Promote consumer acceptance

Types of Denture Cleansers for Home Use

- Abrasive creams
    - Dentu-Crème
- Alkaline hypochlorite
    - Calgon, Clorox
- Alkaline perborate
    - Efferdent, Polident
- Dilute acids
    - Rembrandt Denture Renewal Whitener Liquid
- Enzymes
    - Rembrandt Daily Denture Renewal Gel

Bleaching

- Bleaching purpose
    - To improve esthetics
- Major ingredients (In-office)
    - 30-35% hydrogen peroxide
    - Other ingredients which may be used
        - Silica, calcium, acids phosphate, fluoride
- Three major technics

  - Heat & light
  - Gel
  - Microabrasion
- Home bleaching
  - Plaque removal followed by use of a tray or gel

Preventive Materials

Preventive Dentistry

- Main goal is to minimize discomfort and tooth loss.Best way is to keep teeth from decaying.
- Dates back to G.V.Black and "extension for prevention".
- Profession radically changed by fluoride and improved hygiene methods.

Fluorides

- Very effective in lowering smooth surface caries.
- Available in dentifrices, rinses, gels, varnishes, some restoratives for in office and at home use.

Fluoride Sources/Doses

- Fluoridated water=1ppm
- Supplement=250-1000/ppm daily
- Rinse=200-900ppm daily
- Dentifrice=500-1500ppm bid
- Gel (office)=6000-7000ppm biannually
- Varnish=22600ppm 2-4 times/year

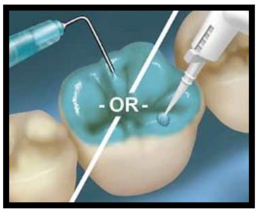
Types of Fluoride

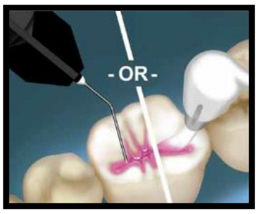
- Acidulated phosphate fluoride (APF) – Around 1.25%fl. Contains phosphoric acid (pH 3to5). Can etch restorations.
- Sodium fluoride and stannous fluoride – Neutral pH won't etch restorations. Slightly lower conc. of fluoride.
- Varnish- 5% sodium fluoride mixed with alcohol to form sticky paintable varnish. Applied several times/year.

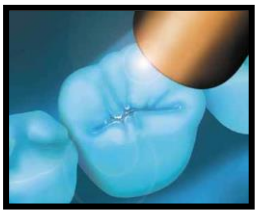
Pit and Fissure Sealants

- Formerly supplied as 2 liquids that had to be mixed to get react. Air bubbles/Limited working time.
- Single component more common now. Activated by shining light on liquid dispensed on etched grooves.
- Monomer=BisGMA

Technique







1.Clean occlusal surface with pumice or sand blaster.
2.Isolate with rubber dam or cotton rolls.
3.Apply acid-etch to areas to be sealed for 15-30 seconds.
4. Thoroughly wash acid from surface for 20 seconds.
5. Dry surface well leaving frosted glass appearance.
6. Dispense sealant into grooves/pits and fissures.
7. Wipe surface to remove excess resin uncured due to *air inhibition.*
8. Check for voids/incomplete coverage. Redo if needed.
9. Check the occlusion.

<u>Mouthguards or Mouth Protectors</u>

- Used by participants in sports to prevent traumatic injury to the teeth and periodontal structures.
- Prevent thousands of accidents annually.
- Made of semirigid but soft plastics.

Prevalent Dental Injuries in Football

- Blows under chin from forearm blocking
- Blows that slip past face bar
- Gritting teeth or snapping jaws shut
- Blows on top of head that cause jaws to snap shut
- Types of injuries
    - Chipped, broken or dislodged teeth, concussions from blows to chin

Types of Mouth Protectors

- Stock
    - Fit poorly, have an odor, material not as strong
- Mouth-formed
    - Material not as strong, odor
- Custom-made
    - Clean, lack of taste or odor, durable, low speech impairment, comfort

Custom-made Properties

- Formed from thermoplastic polymers
  - polyvinylacetate-polyethylene polymer, polyurethane, rubber latex, vinyl plastisol
  - Po-Po-Po
    - Most common
    - After use more flexible
    - Better able to absorb impact but less strength in tension
    - Easiest to make
  - Polyurethane
    - Higher strength, hardness, & energy absorption
    - Higher values of water sorption and require higher processing temperatures
- Vinyl plastisols and latexes
  - Slightly lower values than Po-Po-Po materials in strength, hardness, and energy absorption
  - Difficult to fabricate

Reasons for Non-use

- Feel of harder materials
- Gagging, taste, irritation, impairment of speech, durability, staining, deformation and changes in the mouth
- A protector may last 1 week or an entire season of play
- Permanently deform due to poor storage and heat

Basic Steps in Fabrication

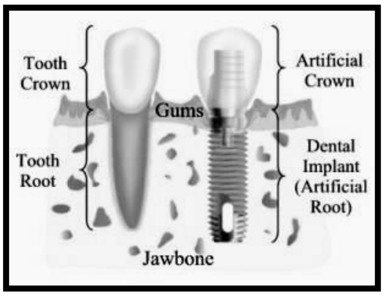
- Alginate impression of maxillary arch
- Pour model in stone (Type IV)
  - May be used several times
- Form thermoplastic material over model
  - Vacuum method more accurate
- Finishing
  - Trimming, occlusal adjustment, strap

Patient Instructions

- Rinse in cold water
- Occasionally clean using soap and cool water
- Do not scrub with abrasive toothpaste
- Do not use alcohol solutions or denture cleansers to clean

- Store in container provided

DENTAL IMPLANTS



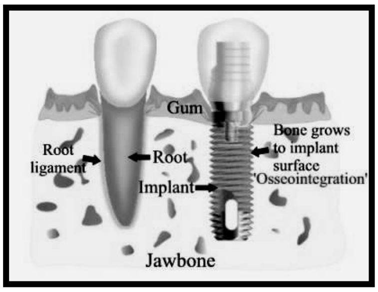
Definition

–an endosteal (within bone) alloplastic biologically compatible material surgically inserted into the edentulous bony ridge

Use

–to serve as a foundation for prosthodontic restoration

History

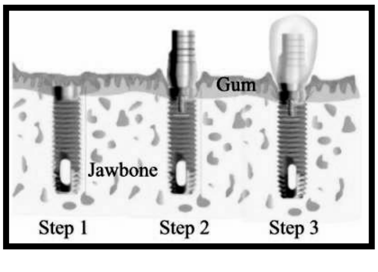


- In 1952, Professor Per-Ingvar Branemark, a Swedish surgeon, while conducting research into the healing pattern of bone tissue, accidentally discovered that when pure titanium comes into direct contact with living bone tissue, the two literally grow together to form a permanent biological adhesion.
- He termed this phenomenon “oseointegration”.

Implant Types

- Subperiosteal implant
- Transosteal implant
- Endosseous implant

Implant Steps



- Step 1. A small metal post or screw is surgically placed beneath the gum into the jawbone.
- Step 2. After a few months following implant placement, another post called an ‘abutment’, which will hold the new tooth or denture in place, is attached to the implant with a screw.
- Step 3. A replacement tooth or denture is then attached to the abutment.

Implant Materials

Metals

- Stainless steal
- Cobalt-Chromium Molybdenium
- Titanium

Metals with surface coating
Ceramics
Polymers and composites
Others

Stainless steal

- High strength and ductility
- 18% Chromium to resist corrosion

Cobalt-Chromium Molybdenum

- 63% Cobalt
- 30%Chromium
- 5% Molybdenum
- Small conc. Of carbon, manganese & nickel
- The least ductility

Titanium

commercially pure (CP) titanium
titanium-aluminum-vanadium

- 90%titanium, 6%aluminum and 6%vanadium
- Light weight
- High strength
- Biocompatible
- Corrosion resistant(dynamic inert oxide layer)
- Low-priced

Metals with surface coating

Titanium substructure coated with thin layer of

- Hydroxyapatite or
- Tricalcium phosphate

Ceramics

Bioactive Ceramics

- Hydroxyapatite or
- bioglass

Nonreactive Ceramics

- Sapphire

Polymers and composites

- Tissue attachment and replacement augmentation
- Coating for force transfer to soft and hard tissues

Other Implant Materials

Early

- Gold, palladium, tantalium and platinium

Recent

- Zirconium, tungsten and carbon compounds

Components & terminology

- coping or prosthesis screw (top)
- coping
- analog
  - » implant body
  - » abutment
- transfer coping (indirect or direct)
- hygiene screw
- abutment
  - » for screw, cement or attachment
- second stage permucosal abutment
- first stage cover screw
- implant body or fixture (bottom)

Modern types

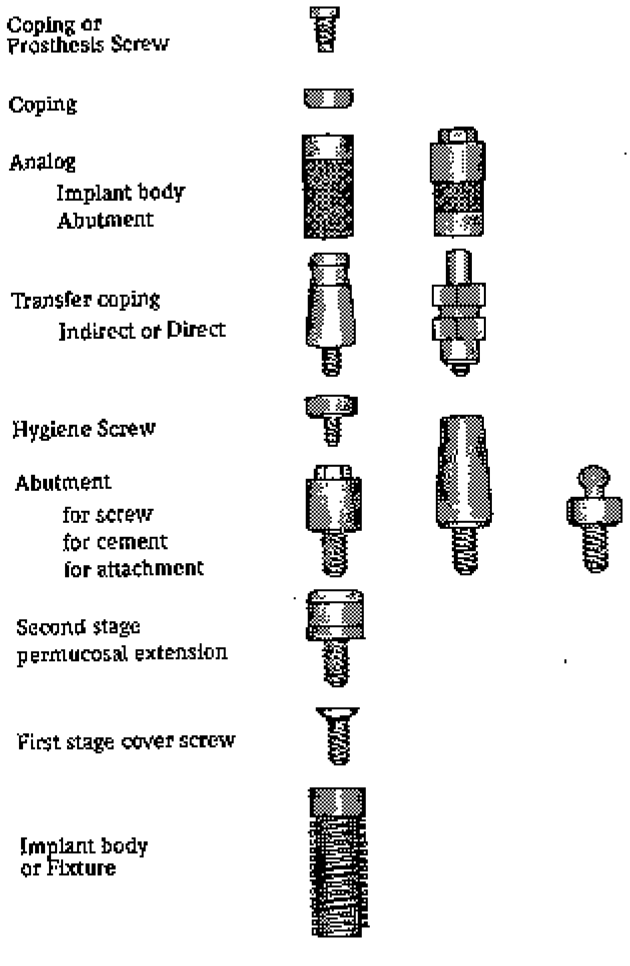
implants are small -

- standard abutment - usually 3.75mm or larger in diameter
- wide-body or wide-platform - up to 6.0mm

– lengths - typically range from about 7 to 18mm

– Navy uses “external hex”

- good research literature
- able to be maintained
- (3i or Nobel Biocare systems)



Schematic of generic implant components and terminology developed by C.E. Misch and C.M. Misch.