Prosthetic Dentistry:

Cast Restorations and Denture Fabrication

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III. Mat’ls for In/Onlays, Crowns, & Bridges

Types of materials: metals, ceramics, & composites

Choice depends upon –

1. Type and size of restoration - inlay, onlay, crown, bridge; one surface, two surface, one unit, three unit, etc.

2. Location in oral cavity - non stress-bearing, stress-bearing; anterior, posterior

3. Patient’s oral habits

4. Patient’s desires - aesthetics, cost

5. Clinician’s professional opinion - most suitable options
A. Metals (Noble metal alloys and Base metal alloys)

1. Characteristics
   - high thermal/electrical conductivity
   - ductility
   - opacity
   - luster
   - high strength/hardness
   - high melting point

2. Requirements
   - ability to withstand wear and occlusal forces
   - exhibit a very high resistance to corrosion and tarnish
   - must be biocompatible
   - ease of casting
   - not cost prohibitive
3. Production of a metallic restoration

- metal can transform between a solid and a liquid through temperature change
- metal is heated beyond its melting range (liquid), molded, and then cooled to reform a solid specific shape (casting)
4. Alloysing

- combination of two (2) or more metallic elements
- formation: atoms from one metal dissolve within the atoms of a second metal (referred to as “solid solution”)
- produces a variety of metals resulting in a wide variance of physical and mechanical properties:
  - stronger
  - harder
  - less expensive (usually)
  - easier handling/manipulation techniques (lab)
- must be compatible with the body
  - possible allergic reactions: nickel
5. Composition

a. Noble Metal Alloys:
   - Gold (Au), Palladium (Pd), Platinum (Pt), etc

• Basic composition of this alloy:

  - Gold – noncorrosive properties
  - Copper – strengthens the gold; produces a reddish cast (unappealing)
  - Silver – whitens the gold to counteract the Cu; increases the strength
  - Palladium – whitens the gold; increases the strength; less expensive than Pt
  - Platinum – whiten the gold; increases the strength, more expensive than gold

> 6% = “white gold”
ADA Classification of Gold-based Casting Alloys
- to ensure tarnish resistance and quality control

• Type I: small inlays, nonstress-bearing app’l (Cl V); largely replaced with other more aesthetically appealing restoratives (composite, glass ionomer) ~ 83% Au

• Type II: inlays with low stress-bearing app’ls

• Type III: inlays, onlays, crowns, bridge abutments; stress-bearing app’ls ~ 75% Au

• Type IV: strongest and hardest type; long-span bridges (6 units), RPD’s, clasps ~ 70% Au
Ceramometal Alloys: used to make a **metal alloy** substructure over which **porcelain** is fused to obtain a tooth-colored restorative

1. Porcelain-fused-to-Gold:
   - Au, Pd, Pt alloy

2. Porcelain-fused-to-Metal:
   - NO Au or Pt!!
   - Palladium based:
     - Pd + copper or Pd + silver
   - less expensive then PFG
   - most commonly used
Lab Tech creativity:
Lab Tech creativity:

Tooth tattoo trend puts Suburban Dental Lab in national spotlight
b. Base Metal Alloys

– does not contain “Noble” elements; referred to as “non-precious” alloy
– examples: Steels, Brasses, Aluminum
– does not indicate poor corrosion resistance – there is a formation of a protective surface oxide film which is composed of Chromium
– main element in Base Metal Alloys: nickel
1. Nickel-chromium alloy (Ni-Cr)
   - low cost
   - RPD’s and PFM castings

   ** Concern over biocompatibility:
   - nickel is a known allergen
   - 10% female vs. 1% male pop.
     manifested by wearing costume jewelry, pierced earrings
   - Nickel is a possible carcinogen; no restrictions to date on use

2. Cobalt-chromium alloy (Co-Cr)
   - used to fabricate RPD framework, palatal portion of full denture
   - Cobalt – strength and hardness
   - Chromium – corrosion resistance
B. Ceramics  (Porcelain and cast/machinable ceramics)

1. Characteristics
   - low thermal/electrical conductivity
   - brittleness
   - translucency
   - high compressive strength and stiffness
   - low tensile strength (fracturing)
   - high melting point
   - biocompatible
2. Porcelain

a. Composition –

3 main components:
- quartz (silica)
- feldspar
- kaolin clay

additives:
- glass modifiers (sodium oxide, K oxide)
- pigments (metallic oxides)
- fluorescing agents (cerium oxide) - projects translucency as do natural teeth

b. Types - 3 types
1. denture teeth – hardness exceeds enamel ~30%; abrasion concerns
2. anterior porcelain jacket crowns, laminate veneers, c & b
3. veneering for cast restoratives (PFG, PFM)
c. Production of Porcelain

Step 1: Blend of quartz, feldspar, kaolin powders, and additives is mixed with water and then painted onto the die or metal alloy of casting to form the core or dentinal layer.

Step 2: Die or casting is transferred to a porcelain oven (kiln) and slowly heated to the point of only removing the water molecules and to coalesce the powder particles.

Step 3: After cooling, the “enamel” or outer layer is added.

Step 4: Fired a second time – cooled.

Step 5: Staining is added to match adjacent teeth.

Step 6: Final high-temperature firing completes the fusion of all powder particles and produces a glass-like surface (glaze).
3. Cast and Machinable Ceramics

a. Composition
• silica (basic “glassy” component)
• addition of feldspar layer (porcelain) to outer surface – aesthetics

b. Properties of Ceramics
• strength equivalent to porcelain
• free of porosity (due to handling technique)
• hard, but not as abrasive as porcelain, unless coated with feldspar porcelain
• brittle, but does not crack like porcelain
c. Production – 2 techniques:

1. Cast restorative – lost wax technique

2. CAD – CAM technique - a computer is utilized to design and cut a restoration (ex: veneer, inlay, onlay) 

**Computer Aided Design and Manufacturing**

• Step 1: Intraoral camera (small, hand-held handpiece) makes a video image of the prepped tooth. Image is displayed on a monitor, and by virtue of a computer software program, the outlines of the margins are defined.

• Step 2: This program transfers the information to an attached “milling” machine. A diamond disk precisely cuts away the desired proportionate shape from a ceramic block within 4 – 7 minutes!

• Step 3: Final restoration is polished, then cemented into place with a composite resin cement. Total chair time: 2+ hrs!

** Expensive equipment, immediate results **
CAD – CAM Technique:

Copy milling of ceramic blank

Finished restoration
C. Composites

(Reference week 4 notes)

1. Characteristics
   - low thermal/electrical conductivity
   - high thermal expansion (when introduced to hot/cold)
   - low compressive strength
   - polymerization shrinkage
   - high sorption (absorbs water: oral fluids)

2. Composition - hybrid composite material
   - resin matrix (BIS-GMA, urethane dimethacrylic)
   - glass filler particles (quartz, silica) coated with a coupling agent (silane)
   - chemicals to promote polymerization (amine, camphoroquine)
   - pigments (metallic oxides)
3. Fabrication of In/Onlays and Crowns

INDIRECT COMPOSITE PROCESS

Step 1: Impression and die of prepped tooth
Step 2: Fabrication on die
Step 3: Cured (polymerized) under pressure & heat – increases the mechanical properties of the composite material
Step 4: Polished and returned to the office
Step 5: Cemented into place with a composite resin cement

** Advantages of indirect technique:
• increases the mechanical properties of the material (strength & hardness)
• reduction of polymerization shrinkage
• resultant space is eliminated due to cementation; the cement occupies the space!
IV. Polymers for Prosthetics

A. Materials for Denture Fabrication

Class → Polymers → Resins
(lay term: plastic)

Acrylic
RPD, RFD,
ortho retainer, etc

composite, sealant, cement
B. Requisites for Dental Resin

1. Aesthetic qualities: translucency and color
2. Color stability
3. The plastic must be capable of being shaped into an app’l that fits accurately over the natural tissues
4. Adequate strength resilience and wear resistance
5. It should not expand, contract, or warp during usage
6. Light in weight
7. Insoluble in mouth fluids and substances normally consumed
8. Impermeable to mouth fluids so that it does not become biologically contaminated
9. Tasteless, odorless, nontoxic
10. Nonadherence of food to the resin or degradation of the resin by the food/fluids
11. Easy to repair
12. Easily fabricated, not cost prohibitive to patient

** No current plastic (resin) material completely meets all these requirements.
C. Composition

Powder: polymer –
  • poly methyl methacrylate
  PMMA
  • pigments and fibers
    (aesthetics)

Liquid: monomer –
  • methyl methacrylate
    MMA

Cautions:
1. can cause allergic reaction and skin irritations
2. vapor is flammable + hazardous if inhaled in large concentrations
3. handle in a well-ventilated area
E. Care of dentures
   - RDH plays a critical role in patient ed. of the appliance

1. kept moist when outside of mouth
2. do not clean with an abrasive agent
3. tissue surface should be cleaned with a soft brush
4. do not clean or immerse in HOT water – could distort
5. if metal is an exposed component of a denture (as in an RPD), do not soak in a chlorine-based solution; corrosion/tarnish will occur on the metal
F. Denture Liners and Conditioners

1. Liners
   - covers the tissue-bearing aspect of a denture to improve its fit or comfort for a patient who cannot tolerate the denture “hardness” on their mucosal tissues
   - as soft tissue changes occur during the lifetime of a denture, adjustments are necessary to conform the denture to the new contours and occlusal relationships
   - prime candidates: patients with thin residual alveolar ridges. WHY? – lack of support for the appliance
   - composition: acrylics or silicone
   - properties: resilient, not spongy

2. Conditioners
   - temporary liner placed for patient with irritated tissues to the point of not being able to wear their appliance
   - allows time for the tissue to heal; acts as a shock absorber
   - composition: polyethylmethacrylate plus alcohol to retain the softness
   - lasts only one or two weeks
What’s this???
G. Immediate Denture

• placed during the same appointment in which teeth are extracted
• serves to restore function as well as protect the extraction sites while healing
• typically relined several months after placement
H. Other Uses of Plastics in Dentistry: Maxillofacial Materials, Mouth Protectors, Lightening Trays, Ortho Retainer, etc.

1. Maxillofacial Materials
   a. Purpose – replacement of portions of facial anatomy that are congenitally missing or have been damaged by disease or accident/trauma.
      - nose, ears, eyes, portions of the maxillary or mandible arch
b. Material requirements:

- flexible; tear resistant
- nontoxic; dimensionally stable
- capable of being accurately molded
- aesthetically appealing/color stable
- resistant to the environment (sun, elements)
- resist staining from body oils, easily cleaned
- acceptance of an adhesive for attachment to soft tissue; may involve attachment to the facial bones with implant
- acceptance of cosmetics
- service life – typically 1 – 3 years

** None of the current materials fulfills all of these requirements **

Material of choice: silicone elastomer similar to silicone impression mat’l
2. Mouth Protectors

a. Purpose: to protect the dentition by absorbing the impact from direct or indirect trauma during sporting activities or through grinding/bruxism

b. Composition: ethylene vinyl copolymer (polyvinylacetate) - thermoplastic resin supplied in sheet form – 4mm thickness
c. Types: Commercial and Custom-fitted Vacuum-formed

1. Commercial
   • Stock – inexpensive, limited sizes, minimal fit, retention and comfort
   • “Boil and Bite” – hinders air exchange and speaking abilities. Patient must remain clenched to retain in mouth.
      ** Heated in warm water, placed into mouth, patient bites down to mold the fit to the arch

2. Custom-fitted Vacuum-formed
   • Dental office – heat and vacuum former; night guards (grinding) and lightening trays (vital bleaching) – same technique
   • Dental lab - heat and pressure
      • multilaminated (layers)
      • 3-5 mm thick
d. Fabricated on cast of max. arch (exception: Cl. III – mand.) of thermoplastic resin. Softened and molded upon heating, becomes rigid when cooled.
- precision fit provides comfort; less interference with breathing and speech
- disadvantages: cost and changing spatial relationships of young dentition

e. Care of mouth protectors

1. cleansed after each use

2. gently brushed with ultra soft-bristled toothbrush with non-abrasive agent (soap)

3. stored in a vented plastic container
3. Lightening Trays

a. Purpose: to hold lightening solution (gel-like consistency) against dentition

b. Composition: ethylene vinyl copolymer
   - thermoplastic resin supplied in sheet form in a thickness of 1mm

c. Fabricated on vacuum former over model for custom fit

d. Care: same as mouth protector
4. Orthodontic Retainers

a. Purpose: to hold or retain the alignment of dentition after fixed orthodontic therapy (commonly referred to as “braces”)

b. Composition: acrylic resin and stainless steel wire

c. Care: same as removable partial denture
5. Snoring Prevention Devices

a. Purpose: positions mandible and tongue forward (anteriorly) to prevent snoring and airway obstruction. Worn only at night during sleeping hrs.

b. Composition: ethylene vinyl copolymer

c. Care: same as mouth protector
6. Occlusal Bite Splints

a. Purpose: aid in the treatment of temporomandibular disorder (TMD). The splint is designed to open the patient’s bite to provide relief from associated pain and mobility, and to reduce attrition of the dentition.

b. Composition: clear acrylic resin

c. Care: same as removable full denture
V. Charting - blue ink used for paper charting

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On/inlay

splints
On that note

... out the door we go.