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Posterior Composite Restoration

INTRODUCTION

Esthetic dentistry has shown much advancement in materials and technology since the last century.

The history of tooth colored restorative materials started with silicate cement in the year 1878 in England followed by self-curing acrylic resins which were developed in 1930 in Germany. Both of these materials showed poor physical properties like high polymerization shrinkage and coefficient of thermal expansion, lack of wear resistance, poor marginal seal, irritation to pulp and dimensional instability.

Bowen, in 1962 developed a polymeric dental restorative material reinforced with silica particles used as fillers. These materials were called “composites”.

Composite is a compound composed of at least two different materials with properties that are superior or intermediate to those of an individual component.

Over the past two decades, there has been a substantial progress in the development and application of resin-based composites. Earlier composites were recommended only as a restorative material for anterior restorations, but now they have become one of the most commonly used direct restorative materials for both anterior and posterior teeth. Principal reasons for shifting from dental amalgam to composites are reduced need for preparation and strengthening effect on remaining tooth. Nowadays, composite resins are considered as an economical and esthetic alternative to other direct and indirect restorative materials.

COMPOSITION OF DENTAL COMPOSITES

1. **Organic Matrix** Resin matrix represents the backbone of composite resin system. Most preferred monomers are Bis-GMA, Urethane dimethacrylate UDMA, or combination of them. Since these resins are very viscous, and in order to improve handling and to control viscosity, they are diluted with low viscosity monomers like triethylene glycol dimethacrylate (TEGDMA).
2. **Fillers** Commonly used inorganic fillers are silicon dioxide, boron silicates and lithium aluminum silicates. In some composites, quartz is partly replaced with heavy metal particles like zinc, aluminum, barium, strontium or zirconium. Nowadays calcium metaphosphate is also used because it is softer than glass, so cause less wear of opposing tooth. Filler content ranges from 30% to 50% by volume and 50%to 85% by weight.

Advantages

1. Reduces the coefficient of thermal expansion
2. Reduces polymerization shrinkage
3. Increases abrasion resistance
4. Decreases water sorption
5. Increases fracture toughness
6. increase tensile and compressive strength
7. Increases flexure modulus
8. Provides radiopacity
9. improves handling Properties
10. Increases translucency

3. **Goupling** Agents: coupling agent binds the hydrophilic filler particles to the hydrophobic organic resin. Interfacial bonding between the matrix phase and the filler phase is provided by coating the filler particles with silane coupling agents
4. **Initiator Agents:** These agents activate the polymerization of composites. Most common photoinitiator used is camphorquinone. Currently most recent composites are polymerized by exposure to visible light in the range of 410 to 500 nm. Initiator varies with type of composites whether it is light cured or chemically cured.
5. **Inhibitors:** These agents inhibit the free radical generated by spontaneous polymerization of the monomers. For example, butylated hydroxyl toluene (0.01%).
6. **Coloring** Agents: Coloring agents are used in very small percentage to produce different shades of composites. Mostly metal oxides such as titanium oxide and aluminum oxides are added to improve opacity of composite resins.
7. **Ultraviolet Absorbers:** They are added to prevent discoloration, in other words they act like a "sunscreen" to composites. Commonly used UV absorber is benzophenone.

TYPES OF COMPOSITES

1. **Macrofilled Composite**

   These were developed during early 1970s. Average particle size of macrofill composite resins ranges from 8-12 um. Filler content is approximately 60-65% by weight. It exhibits a rough surface texture because of the relatively large size and extreme hardness of the filler particles. Due to roughness, discoloration and wearing of occlusal contact areas and plaque accumulation take place quickly than other types of composites.

Advantage: Physical and mechanical performance is better than unfilled acrylic resins.

Disadvantages: Rough surface finish, Poor polishability, More wear.

2. **Microfilled Composites Resins**

These composites were introduced in the early 1980s Average particle size ranges from 0.04 to 0.4 micrometer. Filler content is 30 to 40%by weight Small particle size results in smooth polished surface which is resistant to plaque, debris and stains But because of less filler content, physical properties are inferior They are indicated for the restoration of anterior teeth and cervical lesions. Advantages: Highly polishable, Good esthetic

Disadvantages:

- Poor mechanical properties due to more matrix content.
- Poor color stability
- Low wear resistance
- Less modulus of elasticity and tensile strength
- More water absorption
- high coefficient of thermal expansion'

3. **Hybrid Composite Resins**

Hybrid composites are composed of glasses of different compositions and sizes with particle size diameter of less than 2 μm and containing 0.04 μm sized fumed silica. This mixture of fillers is responsible for their physical properties similar to those of conventional composites with the advantage of smoother surface texture.

Disadvantages: Not appropriate for heavy stress bearing areas, and loss of gloss occurs when exposed to tooth brushing with abrasive toothpaste.

4. **Microhybrid, Nanohybrid, and Nanofill**

Microhybrid composites have evolved from traditional hybrid composites. Filler content in microhybrids are 56 to 66% by volume with average particle size of 0.4 to 0.8 μm. Incorporation of smaller particles make them better to polish and handle than their hybrid counterparts.

NanofiIl and nanohybrid composites have average particle size less than that of microfilled composites. Use of these extremely small fillers and their proper arrangement within the matrix results in physical properties equivalent to the original hybrid composite resins.

Advantages

- Highly polishable
- Tooth-like translucency with excellent esthetic

- Optimal mechanical properties
- Good handling characteristics.
- Good color stability
- Stain resistance
- High wear resistance
- Can be used for both anterior and posterior restorations and for splinting teeth with fiber ribbons.

5. **Flowable Composite Resin**
   Flowable composites were introduced in dentistry in late 1996. Filler content is 60%by weight with particle size range from 0.02 to 0.05 μm. Low filler loading is responsible for decreased viscosity of composites, which allows them to be injected into small preparations.
6. **Condensable (Packable) Composites**
   Condensable/packable composites have improved mechanical properties and handling characteristics. Main basis of packable composites is Polymer Rigid Inorganic Matrix Material (PRIMM). Here components are resin and ceramic inorganic fillers which are incorporated in silanated network of ceramic fibers. These fibers are composed of alumina and silicon dioxide which are fused to each other at specific sites to form a continuous network of small compartments. Filler content in packable composites ranges from 48 to 65% by volume with average particle size ranging from 0.7 to 20 μm.

PROPERTIES OF COMPOSITE

Coefficient of Thermal Expansion

Coefficient of thermal expansion of composites is approximately three times higher than normal tooth structure. This results in more contraction and expansion than enamel and dentin when there are temperature changes resulting in loosening of the restoration. It can be reduced by adding more filler content.

Wear resistance

Composites are prone to wear under masticatory forces, tooth brushing and abrasive food. Site of restorations in dental arch and occlusal contact relationship, size, shape and content of filler particles affect the wear resistance of the composites.

Polymerization Shrinkage

Composite materials shrink while curing which can result in formation of a gap between resin-based composite and the preparation wall. It accounts for 1.67 to 5.68 percent of the total volume.

Configuration or C-factor

Cavity configuration or c-factor was introduced by Professor **carol Davidson** and his colleagues in 1980s. c-factor is the ratio of bonded surface of restoration to unbonded surfaces. Higher the value of C-factor, greater is the polymerization shrinkage. Three-dimensional tooth preparations (Class I and V) have the highest (most unfavorable) C-factor and thus are at more risk to the effects of polymerization shrinkage. C-factor plays a significant role when tooth preparation extends up to the root surface causing a 'V' shaped gap formation between the composite and root surface due to polymerization shrinkage.

Microleakage

It is passage of fluid and bacteria in micro-gaps (10-6 m) between restoration and tooth. It can result in damage to the pulp

Microleakage can occur due to:

1) Polymerization shrinkage of composites'
2) poor adhesion and wetting, and
3) Thermal stresses Mechanical loading

Microleakage results in:

1) Bacterial leakage ,
2) Recurrent caries,
3) Pulpal infection, and
4) Tooth discoloration.

ADVANTAGES OF COMPOSITE

1. Conservation of tooth structure.
2. Esthetically acceptable
3. Low thermal conductivity: Composites have low thermal conductivity, thus no insulation base is required to protect underlying pulp.
4. Mechanical bonding to tooth structure: Restorations are bonded with enamel and dentin, hence show good retention.

5. Immediate finishing and polishing: Restoration with composite resins can be finished immediately after curing.
6. It can be repaired rather than replaced.
7. Restoration can be completed in one dental visit.
8. No galvanism because composite resins do not contain any metals.

DISADVANTAGES OF COMPOSITE

1. Polymerization shrinkage.
2. Time consuming: Composites restorations require good isolation and number of steps for their placement.
3. Composites restorations are more difficult to place and are Time consuming.
4. Expensive: more expensive than amalgam.
5. Technique sensitive: It is more technique sensitive than amalgam because composite placement requires careful attention to all steps of placements.
6. Low wear resistance: Composites have low wear resistance than amalgam.

TOOTII PREPARATION

GENERAL CONCEPTS FOR TOOTH PREPARATION FOR COMPOSITE

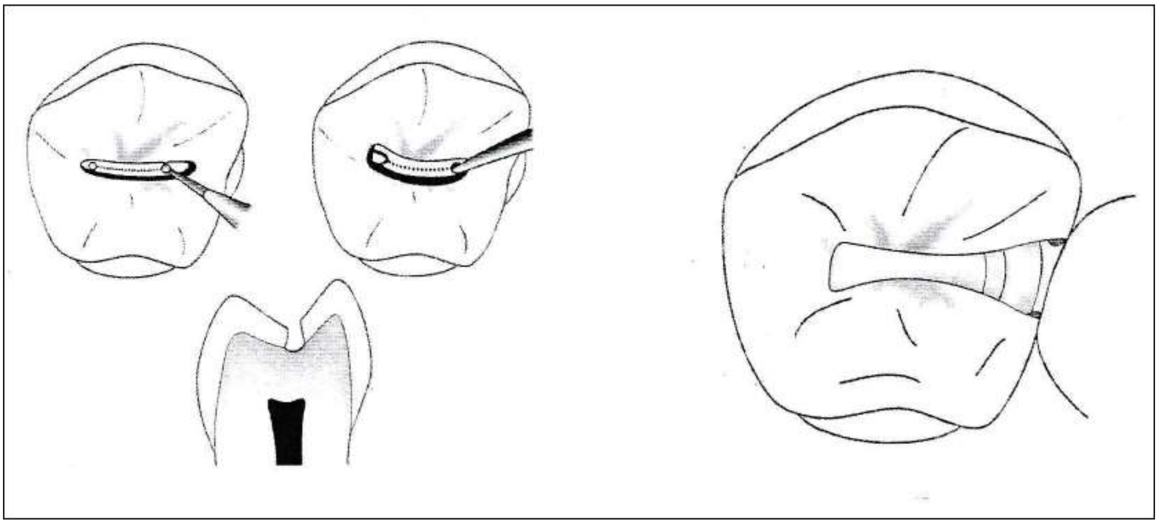
RESTORATIONS:

1. **Conservation of tooth structure:** Tooth preparation is limited to extent of the defect. For composite restorations, rule extension for prevention and proximal contact clearance, is not necessary unless it is required to facilitate proximal matrix placement.
2. **Variable depth of pulpal and axial wall depth:** Pulpal and axial walls need not to be flat.
3. **Preparation of operating site:** To facilitate bonding, tooth surface is made rough by using diamond abrasives.
4. **Enamel bevel:** Enamel bevel is given in some cases to increase the surface area for etching and bonding.
5. **Butt joint on root surface:** Cavosurface present on root surfaces has to be butt joint.

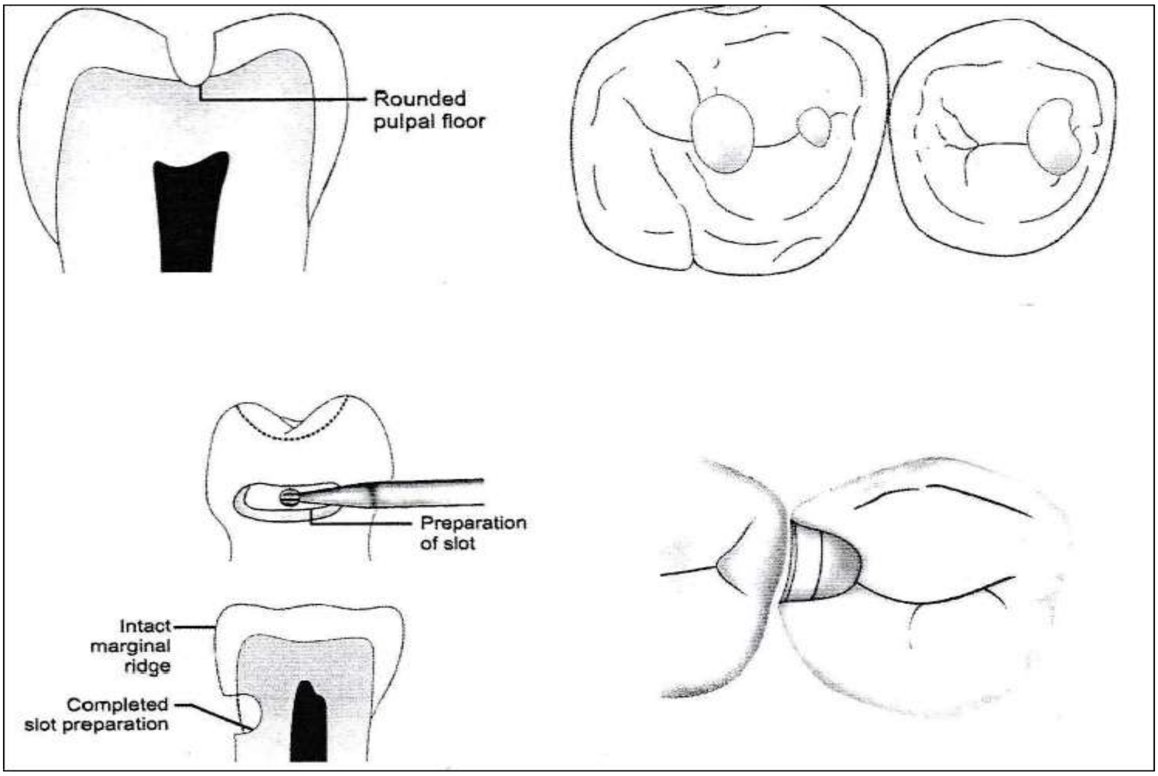
Designs of Tooth Preparation for Composites

1. **Conventional preparation**
   Conventional design is similar to the tooth preparation for amalgam restoration, except that there is less outline extension and in tooth preparation, walls are

made rough. Indicated in moderate to large class I or class II restorations and in preparations located on root surface.



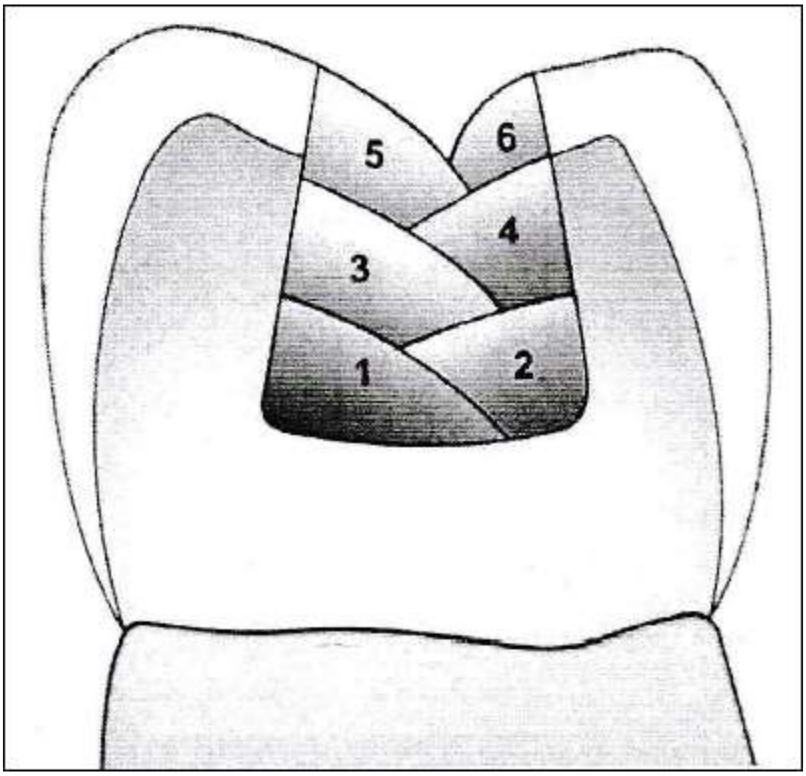
2. **Beveled conventional tooth preparation**
This design is almost similar to conventional design but some beveled enamel margins are incorporated. Specially indicated for classes III, IV, V and VI restorations.
3. **Modified (conservative tooth preparation)**
It is more conservative in nature since retention is achieved by micromechanical bonding to the tooth. It does not have specified wall configuration or pulpal and axial wall depth. Extent and depth of the preparation depends upon the extent and the depth of carious lesion. Indicated for initial or small carious lesions.



COMPOSITE PLACEMENT

Incremental Layering Technique.

- Advocated for use in medium to large posterior composite restorations to avoid the limitation of depth of cure.
- This technique is based on polymerization of resin-based composite layers of less than 2mm thickness
- It helps to attain good marginal quality
- It prevents deformation of the preparation wall
- It ensures complete polymerization of the resin-based composite
- Incremental layering of dentin and enamel composite creates layers with high diffusion which allows optimal light transmission within the restoration, thus increasing esthetics



Bulk Technique

- The composite is placed in a bulk mass of 4-5 mm thickness.
- It is done to reduce stress at the cavosurface margins.
- It is usually recommended with packable composites.

Final Contouring, Finishing and Polishing of Composite Restorations

For composite restorations, the amount of contouring required after final curing can be minimized by careful placement technique. Always take care to remove the some composite excess which is almost always present. Decreased need of contouring of the cured composite ensures that margins and surface of composite restoration remain sealed, and free of microcracks that can be formed while contouring.

Main objectives are to:

- Attain optimal contour
- Remove excess composite material
- Polish the surface and margins of the composite restoration.

For removal of composite excess, usually burs and diamonds are used. Surgical blade is used to remove proximal overhangs in the accessible area. For areas which have poor accessibility, composite strips can be used. Contact areas may be finished by using a series of abrasive finishing strips threaded below the contact point so as not to destroy the contact point.