8. RESTORATIVE DENTISTRY

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1. What are three major categories of dental caries?

1. Smooth surface enamel caries (class II, III, and V)
2. Pit and fissure areas (class I)
3. Root surface caries (class V)

2. What organisms are responsible for caries formation?

Streptococcus mutans is the most cariogenic with contributions from *S.sanguis* and *S. salivarious*. These organisms metabolize sucrose to form acidic byproducts destructive to enamel surfaces. Root surface caries are initiated by *Actinomyces viscus* on accumulated plaque deposits.

3. How may caries be diagnosed?

Caries may be detected by a combination of techniques. First is direct inspection of pits and fissures, root surfaces, and interfaces of restorations and tooth with a sharp explorer, air-drying, and magnification. Direct inspection is supplemented by evaluating properly angulated bitewing and periapical radiographs. Finally, the use of transillumination from a visible light curing wand can reveal shadowing and discoloration on occiusal and interproximal tooth surfaces.

4. Describe two classifications of carious dentin.

Carious dentin consists of an outermost layer of *effected* (infected) dentin containing large amounts of bacteria and an underlying layer of *affected* dentin containing little or no bacteria.

5. Clinically, how are the two different types of carious dentin treated?

All infected dentin must be removed for successful tooth restoration. Because affected dentin has undergone only early demineralization, removal may not be necessary. Topical bonded dentin sealants containing fluoride effect a barrier under restorations.

6. What are caries detector solutions?

These materials (Caries Detector, J Morita USA, Tustin, CA) clinically differentiate the two layers of carious dentin by staining the outer carious layer scarlet red, yet not staining the inner affected layer or normal dentin. This carious layer is thus easily identified for removal. The composition is typically a red food dye in a propylene glycol base.

7. Describe the concept of "hidden caries."

Hidden caries refers to class I carious lesions that appear to be small and localized to one area of a pit or fissure but are much more extensive lesions and include a significant amount of internal coronal structure.

8. Describe a possible mechanism of hidden caries.

It has been suggested that intrinsic and topical fluoride exposure make enamel so resistant to bacterial acids that intracoronal caries can progress substantially before detection, given the sound-appearing nature of this enamel.

9. Explain why incipient caries may not require restorative intervention.

Incipient caries involves lesions in enamel that have not progressed to the dentin layer. Such lesions are the result of demineralization. With good home care, fluoride supplements and lowered sugar dietary intake, remineralization may take place and arrest the demineralization process.

10. How does fluoride prevent decay?

1. Incorporation into tooth surface structure as fluroappite to make the tooth structure less acid-soluble
2. Remineralization of areas of dissolution of enamel
3. Possible action on dental plaque, reducing bacterial acid production

Enamel becomes more resistant to dental caries throughout life as the uptake of fluoride and other minerals makes the surface less acid-soluble. Pit and fissure areas, because of their anatomy, require dental sealants to provide life-long protection.

11. What are some supplementai sources of topical fluoride for caries prevention?

Public water supplies: 0.7 ppm sodium fluoride (NaF)

Toothpaste: Over-the-counter regular brands contain 0.10—0.15% NaF Prescription: PreviDent 5000 Plus contains 1.1% NaF

Mouth rinses: Act, FluoriGuard, and Prevident Rinse contain 0.2—0.5% NaF Brush-on gels/fluoride trays: Prevident 1.1% NaF neutral pH

12. What is a contraindication in the use of acidulated or stannous fluoride preparations?

0.4% Stannous fluoride (pH 3.0) = 0.2% NaF (pH 7.0). Acidulated fluoride (APF) solutions and topical 0.4% stannous gels (Gel-Kam, Colgate) remove the glaze from porcelain, glass ionomer, and composite restorations. It is best to use neutral pH supplements if these restorations are present. Always check the product specifications.

13. What are some indications for fluoride gel applications using a custom tray?

Patients who exhibit high caries incidence, root caries, or cervical caries and who may fit into one or more of the following groups:

- High consumption of carbonated beverages (pH 3.2—3.5) or citric fruits (e.g., lemons, limes)
- Bulimic patients (10% female adolescents)
- Elderly and nursing home patients
- Gastric reflux patients
- Chemotherapy and radiation-treated patients

14. What is erosion? What are the possible causes?

Erosion is the loss of tooth structure by a chemical process that does not involve bacterial action. It is generally caused by the consumption of foods that contain phosphoric or citric acid such as fruits, fruit juices, and carbonated or acidic beverages. Excessive exposure to gastric acids due to vomiting also contributes.

15. What is tooth attrition?

Attrition is the physiologic wear of tooth structure resulting from normal tooth-to-tooth contact over a period of time.

16. What is the theory of tooth abfraction?

Abfraction is defined as the pathologic loss of tooth substance caused by biomechanical loading forces. The loss of structure is usually seen as wedged-shaped cervical lesions at the dentinoenamel junction (DEJ) that may not be carious. This theory is used as an alternative explanation for areas that have been attributed to toothbrush abrasion.

17. What is the structural nature of dentinal tubules?

Dentinal tubules resemble inverted cones. The smallest diameter is at the outer surface or at the DEJ; the tubule increases in diameter as it progresses to the pulp. At the enamel junction the surface area of dentin tubules is only about 1%, whereas at the pulp it increases to about 22%.

Dentin bonding systems can vary according to the depth of the dentin; the deeper the dentin, the greater the water content in the tubules. The most successful bonding systems can bond equally well to wet and dry dentin.

18. Explain the hydrodynamic mechanism as it relates to the causes of dentin hypersensitivity.

As postulated, a stimulating irritant that comes in contact with exposed dentin causes the sudden movement of fluid in the dentinal tubules. If the flow of this fluid is rapid enough, the mechanosensitive nerve fibers at the pulp-dentin interface will fire, causing sharp pain in the tooth. The stimulus may be mechanical from biting pressure, a high osmotic gradient like sucrose contact, or even touching with an instrument.

19. What are the generally accepted principles for cavity preparation?

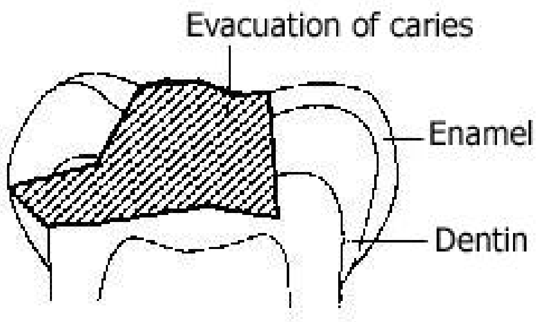
1. Cavity preparations should be governed by tooth anatomy, tooth position in the dental arch, extent of the carious lesion, and physical properties of the filling material.
2. Gingival margins should be ended on enamel whenever possible.
3. Cavity preparation margins should be supragingival whenever possible.
4. Margins of posterior cavity preparations should not end directly in occlusal contact areas. Contact areas should be composed of one material to allow for even wear. Uneven wear results if two materials meet at the contact area, thereby producing open margins.
5. Weakened and unsupported tooth structure should be removed.
6. Maintaining a dry work field with the use of a rubber dam is without equal and will always enhance the consistent quality of restorations.

20. Describe the principles of cavity preparation for composite resins and amalgam alloy.

The classic cavity preparations, according to Black's principles, are generally not needed for contemporary bonded retained composite and amalgam restorations. Dovetails, retention grooves, and extension into uninvolved occiusal grooves are generally not needed. Maximizing the tooth structure dominates the design, with sealants replacing groove extensions.

21. What is the tunnel preparation?

The tunnel preparation is a conservative approach to restoring class II caries in teeth with relatively small interproximal lesions. It conserves the proximal marginal enamel by using only the occlusal or a buccal or lingual access and then angulating either mesially or distally until the external tooth enamel is perforated. Usually prior application of a matrix band protects the adjacent tooth wall. The tooth cavity is then packed from the access dimension.



22. What is microair abrasion? What are its major applications?

This technique uses pressurized delivery of abrasive powders (aluminum oxide) to prepare teeth for restoration. Particle sizes are 10—50 microns. The claimed advantages are that microair abrasion is less traumatic, less invasive, and heatless, often not requiring local anesthesia. It is ideally suited for pit and fissure sealant preparations and conservative class I and 5 preparations using flowable composites. Disadvantages include the need for special high-speed evacuation equipment and high cost of the units.

23. What are the most common methods to lighten vital teeth?

Generally most tooth whitening is done with home bleaching kits using custom tray fabrication. Office techniques are suitable for some patients based on type and intensity of stain and the temperament and desire of the patient. Home treatment requires compliance and patience, whereas chairside techniques are faster but considerably more costly.

Direct composite or laboratory porcelain veneers are the next most conservative approach and may be used when bleaching does not produce satisfactory results. Veneers are also useful when the shape, size, or arrangements of teeth are esthetically unacceptable. Finally, full coverage porcelain and porcelain fused to metal crowns are the most invasive approaches, reserved for cases in which there is a need to replace damaged or missing tooth structure.

24. What are the major expectations of present bleaching techniques?

1. Natural teeth generally darken with age. Patients over 50 accumulate brown, orange, and yellow stains that are decreased by bleaching. Light yellow or brown shades lighten better than gray shades. External stains respond better than deeper internal stains, such as those from tetracycline staining or staining due to endodontic events.

2. Teeth lighten visibly regardless of the system used, in office or home methods.

3. The degree of lightening is a function of the concentration of active ingredient and time of contact. In-office techniques use higher concentrations applied for several hours on isolated teeth, whereas at-home methods use lower concentrations applied over several weeks in custommolded trays constructed with reservoirs on the facial surfaces.

4. Generally, few side effects are reported, and they tend to be transient.

5. Teeth retain color for up to several years, although some patients request touchups at 6—12 month intervals. Patients with high consumption of coffee, tea, cola, or similar beverages may require more frequent applications.

6. All current tooth-lightening products are generally similar when adjusted for contact time, concentration, pH, and viscosity of reagent. Changes of 2—3 points on the vital shade scale may be anticipated.

25. What are the active ingredients in bleaching systems?

Hydrogen peroxide (H_2O_2) is the active ingredient in all bleaching systems. In carbamide peroxide formulations, the H_2O_2 is stabilized by urea and appears to be more stable and to produce fewer side effects than when used alone. A 10%

carbamide peroxide solution contains 7% urea and 3% H_2O_2 Formulations are presently available containing 3—50% H_2O_2 Formulations are based in viscous gels to avoid side effects and to maximize the retention to teeth. They are buffered to near neutral pH.

26. What is the mechanism of action of H in lightening teeth?

H_2O_2 oxidizes and removes interprismatic organic matter within the tooth to lighten the shade.

27. What "energized" in-office methods help to speed the lightening of teeth?

The application of heat, curing light, or laser shortens the lightening process; roughly 2 hours in office equal 2 weeks at home. The quicker action is due to much higher peroxide concentrations delivered on rubber dam isolated teeth and does not seem to be due to the type of energizing.

28. Which method of bleaching produces the best results?

Split-arch comparisons seem to indicate that no discernible differences in lightening are achieved by any single energized method; the effect is a function only of concentration and time.

29. What are the possible side effects of bleaching? What are some solutions?

Some patients report tooth sensitivity. Sensitivity is more common with energized forms of application and higher solution concentrations. The use of a prescription-strength fluoride dentifrice, such as Prevident 5000 Plus (Colgate), alleviates this problem. Using well-contoured mouth guard application trays can minimize soft tissue irritation. Sore throats can be avoided by using the minimal quantity of bleach in the tray to avoid overflow. Shorter daily contact intervals are generally as effective as overnight use of trays. Most all products lose reagent activity to < 25% by 2—3 hours so that longer daily use may cause only soft tissue irritation.

30. How effective are whitening toothpastes?

Generally they have minimal effect but may prolong the effect of direct bleaching.

31. How are endodontically treated teeth bleached?

Most discoloration of pulpal degeneration is internal and/or due to remnants of endodontic paste fillers. Such teeth generally require bleaching from the access cavity. The sooner the bleaching is started after the endodontic event, the more successful the lightening. Often access chambers are packed with a mixture of H_2O_2 and sodium perborate, the so-called "walking bleach."

32. Describe the technique of enamel microabrasion.

Microabrasion is the controlled removal of discolored enamel using a rubber cup and a mixture of pumice and an acid, usually hydrochloric acid. This technique is effective for treating superficial enamel discoloration (white or brown spots) caused by and often seen after orthodontic treatment.

33. What are helpful aids in choosing colors for anterior teeth?

Choose the color with color-corrected or natural light. Match teeth that are moist. Liquid coatings (saliva) alter reflected light. Place a cotton roll behind adjacent teeth to study changes in color, and note incisal shade changes that occur with light and dark backgrounds.

34. When is the optimal time to bleach in the treatment-planning sequence?

In general, the optimal time is before beginning the final restorative phase. Bleaching lightens tooth color. Colors of crowns and composites need to be matched to the final tooth color, because composite and porcelain restorations will not change color and will be mismatched if subsequent bleaching is performed.

35. What are the major applications for direct bonded restorations in anterior teeth?

- Small chips, fractures, cracks or caries of a single tooth
- Closing small spaces between teeth and correcting minor malpositions
- Color correction of small spots and enamel dysplasias
- Correcting esthetic problems in children and young adults

36. Which clinical variables determine the choice among direct bonding via composite resins, porcelain veneers, or full coverage crowns?

1. **Amount of remaining tooth structure.** More than 50% tooth loss requires full coverage. Small discrepancies and tooth structure loss are bondable with composite resins. -

2. **Financial consideration.** In general, full coverage is the most expensive and direct bonding is the least expensive. Porcelain veneers are moderately priced.

3. **Age of the patient.** Bonding, which is flexible and easy to change as the situation may require, may be best in younger patients.

4. **Occlusal variables**. Full coverage crowns have the greatest strength.

5. **Periodontal considerations.** Unstable periodontal maintenance and unknown outcomes or prognosis generally suggest provisional reconstruction.

6. **Correction of color discrepancy.** Darkly stained teeth are best masked with porcelain. Tooth reduction is necessary to allow room for opaquers and to mask stain properly without overcontouring.

7. **Maintenance requirements.** Bonding requires the most maintenance, porcelain the least. Porcelain is more color-stable in heavy smokers and in drinkers of alcohol, coffee, and tea.

8. **Tooth reduction issues.** With porcelain, tooth reduction is always needed. Bonding may need little to no reduction.

9. **Esthetic color issues.** For single or few color changes, bonding is esthetic in low-light conditions and with flash photography. Porcelain has poor metamerism (reflection characteristics) when mixed with natural teeth or composites.

10. **Correction of failures.** Porcelain veneers can fracture or debond. When the natural life expectancy expires, more aggressive treatment is necessary. Direct bonded restorations are relatively easy to correct and repair when failures occur.

37. What are acid etchants?

To create bonding to tooth substrate, enamel, or dentin, dilute acids of phosphoric, citric, maleic or polyacrylic compounds are applied. They create microporosity in the enamel prism layer and remove the surface smear layer of dentin.

38. What is the composition of the smear layer?

The smear layer is a film of microcrystalline debris that remains on dentin after it is cut with rotary instruments.

39. What is the meaning of total etch?

This term refers to the simultaneous etch of dentin and enamel prior to resin bonding.

40. What is the function of the addition of benzalkonium chloride (BAC) to etchant gels?

BAC is an antibacterial compound that helps to eliminate microorganisms from the cavity preparation during etching.

41. What are typical etch times for enamel etchant?

It is important to verify the produce manufacturer's specification sheet for representative times, but typically the following times apply:

10% etchants: 30 sec
20% etchants: 20 sec
37% etchants: 15 sec

42. Describe enamel/dentin-bonding systems.

Dentin-bonding agents are complex and multistep systems. Some products remove the smear layer, whereas others do not. Examples of products are

One-Step (BISCO), Scotchbond (3M), and Prime&Bond (Caulk). The components of each system include:

1. The etchant: phosphoric acid, nitric acid, or another agent that is used to etch enamel and/or precondition the dentin. There may be other dentin conditioners, such as ethylenediamine tetraacetic acid (EDTA) to remove the smear layer.

2. The primer: a hydrophylic monomer in solvent, such as hydroxymethalmethacrylate (HEMA). The primer is applied in several coatings to moist dentin and air-dried to remove solvent. It acts as a wetting agent and provides micromechanical and chemical bonding to dentin.

3. The unfilled resin is then applied and light or dual-cured. This layer can now bond to composite, pretreated porcelain luted with composite, or amalgam in some products.

43. What are the major differences between bonding to enamel and bonding to dentin?

Both enamel and dentin bonding involve micromechanical retention. The conditioned or

acid-treated surface has porosity to receive the low viscosity resins that interlock as they solidify. Acid-etched enamel, however, is more uniform, and bonding strengths are more predictable than dentin bonding, due, in part, to the varying composition of different types of dentin (i.e., normal or sclerotic, primary and secondary dentin, coronal or root dentin). The higher water and protein content of this vital tissue makes the bonding process much more complex.

44. What is the effect on pulpal biology from the etching of vital dentin?

In recent years more information has elucidated the effect of acid on pulp histology. Current knowledge indicates no apparent consequences from vital dentin etching.

45. What is the effect of vital etching on pulpal sensitivity?

When dentin is etched, the smear layer is removed. This results in removal of the tissue plugs in dentin tubules with the potential for fluid flow and subsequent neurostimulation of the pulp.

46. How may tubular flow stimulation be minimized?

By following a proper protocol for sealing the dentin tubules, any potential pulpal sensitivity may be minimized.

47. How are dentin tubular structures best sealed?

Current fifth-generation dentin-bonding systems afford the greatest sealing capacity and offer high-strength bonding to dentin.

48. What potential problem may cause an incomplete seal of dentin tubules?

Incomplete placement of the bonding reagents may result in an increase in postoperative pulpal sensitivity. There may be incomplete wetting in application of the primer agent or incomplete curing of the bonding agent. One must be sure to place incremental layers of wetting agent until a glossy appearance is observed on gentle air dispersion. A well-calibrated curing light must be used for sufficient exposure times.

49. What factors contribute to increased pulpal sensitivity even with proper sealing protocols?

If the dentin is dried too completely, air einboli may enter the dentin tubules and the dentinbonding layer may seal over the layer of air. The layer of air creates a potential for mechanical masticatory stresses and a resultant sensitivity in biting on the tooth-restoration unit. To best avoid this problem, one must leave the dentin moist by gentle air dispersion, *not* drying. Then the hydrophilic primers will follow fluid down the tubules and fill both intertubular dentin and tubules with resin.

50. What happens when acid etchants come near pulpal tissue?

Studies confirm that healing and dentin bridge formation occur directly adjacent to acidic materials. However, overetching, improper rinsing, or improper placement of materials may lead to postoperative sensitivity. Use the correct procedure protocols for etch time, washing, and resin placement.

51. What guidelines apply to etching?

Etching is a function of time and concentration. The most common etchant is phosphoric acid at 20—40%, which may be used as a 15—20-second total etch and produces an excellent enamel etch. It is important to keep a clean surface free of contaminants and to rinse the etched surface for a period about equal to the etch time. Be careful not to overdry the dentin surface— leave it moist.

52. What is the hybrid layer?

The hybrid layer is a multilayered zone of composite resin, dentin, and collagen. After removing the organic and inorganic debris of the smear layer by etching and some hydroxyapatite from the intertubular dentin down to 2—5 1.1, a plate of moist collagen remains on the dentin floor. Priming agents penetrate this moist collagen substrate and migrate into the tubules, lateral canals and all areas of peritubular dentin. This process promotes hybridization as the dentin, collagen, and hydroxyapatite crystals become totally impregnated with bonding resin. The resin further penetrates into the dentin tubules. Light curing produces a mechanically and chemically bonded surface that can polymerize to composite restoratives.

53. What is essential for successful hybrid layer formation?

Supersaturation of the dentin substrate with primer or wetting agent is essential. If the etchant time is 15 seconds, the wash should be at least as long. The water is then dispersed to leave the dentin moist. Multiple coats of priming agent are applied to achieve a glossy surface on air dispersion. Resin is then applied and cured.

54. List criteria for successful dentin and enamel bonding.

1. Isolate and maintain a clean field free of saliva and hemorrhage.
2. Etch and rinse for equal times.
3. Dentin should not be overdried; leave it moist. Excessive air-drying may create air emboli in dentin tubules, preventing the penetration of primer.
4. Apply multiple layers of primer to dentin.
5. Air-dry enamel and dentin. Dentin should appear glossy, and enamel should appear dull and chalky.
6. Apply resin. Do not air-disperse excessively. Too thin of an adhesive film may result in a weak bond—better to have a little too much.
7. Fully cure the bonding agent before placing the composite resin to ensure a good hybrid layer formation. Otherwise the composite may pull off the bonding agent and weaken the seal.
8. Check the output of the curing light regularly. A weak light will result in insufficient curing.
9. Apply composite incrementally—not over 2 mm per layer.
10. Initiate cure through the tooth margins as composite is drawn toward the curing source.

55. What are typical bond strengths for fifth-generation bonding systems?

The formation of the hybrid layer can achieve a breakage rate of 25—28 MPa, which actually exceeds the breakage rate of dentin itself (22—24 MPa).

56. Discuss current concepts of pulpal protection.

Former concepts advocated a thermal liner or base under amalgam restorations. If 1—3 mm of dentin remains under the cavity preparation, sufficient thermal protection is present. Sealing dentin tubules is considered important to minimize postoperative pulpal sensitivity and to prevent bacterial contamination by microleakage. Microleakage can wash out such liners as calcium hydroxide. Sealing dentin tubules by bonding protects the pulp from postoperative sensitivity and offers long-term protection against bacterial contamination from microleakage.

57. What can be said about the classic role of calcium hydroxide?

Calcium hydroxide compounds have a long tradition of providing pulpal protection as a liner under restorative materials. It serves as an insulator, a stimulator of dentin repair via bridge formation, and a bactericidal agent (because of its high pH). However, it does not bond to dentin, does not seal tubules, and is prone to wash out if microleakage occurs.

58. What compounds stimulate dentin bridging?

- Calcium hydroxide
- Zinc phosphate cements
- Resin composite systems

Eugenol and amalgam compounds *do not* show bridge formation.

59. What is the recommended treatment for a direct vital pulp exposure?

1. Control hemorrhage using irrigation with saline or sodium hypochlorite.
2. Apply a calcium hydroxide capping agent (Dycal).
3. Cover with a layer of glass ionomer cement (Vitrabond).
4. Etch, bond, and restore.
5. Alternatively, some authorities advocate direct etching, priming, and bonding after hemorrhage control as a direct cap procedure.

60. Summarize the guidelines for preparing dentin.

1. Total etching is advantageous to remove debris from tubules.
2. Rinse for a time at least equal to the etch time.
3. Air-disperse liquids on dentin. Do not desiccate or overdry to avoid air eniboli.
4. Prime with multiple repetitive coats to saturate dentin.
5. Apply bonding resin and air-disperse (these steps may be combined if a single-step agent is used.)
6. Cure with a light that is regularly calibrated.
7. Fill the restoration with amalgam, compomers, composite, or other restorative materials.

This bonding of dentin ensures maximal sealing of dentjn tubules and minimizes postoperative sensitivity while ensuring protection from microleakage.

61. What were some of the pitfalls of early dentin-bonding materials?

First- and second-generation dentin-bonding systems used the smear layer to achieve strengths of 4—5 MPa but could not manage the 1 5-MPa stresses created during polymerization shrinkage of the filling resin materials. Postoperative sensitivities and recurrent decay under composite restorations without full enamel surround for bonding resulted primarily from microleakage due to the incomplete bond to dentin.

Third-generation systems achieved bond strengths up to 10 MPa by using two-component primer and adhesive systems (Prisma Bond, ScotchBond II). These agents had hydrophilic wetting primers and used total etching to achieve micromechanical retention in dentin tubules.

Fourth-generation systems formed a hybrid zone of both intertubular and tubular dentin to increase bond strengths to 18 MPa. Intertubular dentin bonding greatly increased the surface area. Characteristics of these systems were total etch, moist dentin applications, and multiple chemical components (Bisco: All-Bond; 3M: Scotchbond MP). These systems have been used for direct posterior composite restorations.

Current fifth-generation systems are characterized by single-component priming and bonding. Dentin bond strengths are 25—28 MPa, and postoperative sensitivity is well controlled. Some materials can be used without etching dentin, and most incorporate fluoride. One system contains elastomeric components to improve marginal integrity (examples: Bisco: One-Step; 3M: Single Bond; C Prime&Bond 2.1).

62. What is the clinical significance of newer product claims about retention and microleakage?

Clinical evidence clearly shows improved in vitro performance of newer products. But older restorative materials, such as gold inlays seated with zinc phosphate, often have useful service exceeding 30 years, despite higher rates of microleakage.

63. Summarize the difference between enamel and dentin bonding.

Bonding to enamel is due primarily to resin tags that mechanically lock into the acid-etched enamel surface. Resin bonding to dentin is obtained mechanically and chemic

64. Can primers affect resin bonding to enamel?

No. Original second-, third-, and fourth-generation resin-bonding agents are not affected by primers applied to etched enamel during the dentin application phase.

65. Can one apply too much or too little adhesive resin to dentin? Enamel?

Application of too little resin to dentin may result in a permeable layer with incomplete seal of the dentin tubules. An adequate layer (glossy appearance) is best. Too much sealant on the cavosurface margin (interface between composite resin and enamel) may result in a margin of lower wear resistance. It is best to lightly air-disperse the resin layer.

66. Define direct resin, indirect resin, and indirect-direct resin restorations.

Direct resin restorations are the placement of composite resins into class 1, 2, 3, and 5 preparations directly at chairside. They are the most commonly performed restorations.

Indirect resin procedures involve tooth preparation, impressions, and temporization as a first visit. Laboratory fabrication of onlays or inlays of resin or ceramic restorations are cemented on a second visit.

Indirect-direct resin restorations are a single-visit technique using fast-setting die stones that allow preparation, impression-taking, chairside fabrication of the restoration, and delivery of the final inlay or onlay.

67. What are the chemical components of composite resins?

- Principal and diluent monomers
- Coupling agents
- Polymerization initiators
- Radiation absorbers

68. Describe the function of each monomer component.

Principal monomers are high-molecular-weight compounds that can undergo free radical addition polymerization to create rigid cross-linked polymers. The most common monomer is BISGMA (an aromatic dimethacrylate that is the addition product of bisphenol A and glycidal methacrylate [GMA]). An alternative monomer is urethane dimethacrylate.

Diluent monomers are low-molecular-weight compounds used to reduce the viscosity of the unpolymerized resins to enable better physical properties and handling. There are two types: monofunctional (methylmethacrylate) and difunctional (ethylene glycol dimethacrylate or triethylene glycol). The latter are used most often because they form harder and stronger cross-linked composite structures due to a lower coefficient of thermal expansion. They also have less polymerization shrinkage, are less volatile, and have less water absorption.

69. What are the filler particles?

Inorganic filler particles used in composite resins include quartz, glass, and colloidal silica together with additions of lithium, barium, or strontium to enhance optical properties. These fillers are coated with a silane coupling agent (organosilane) to bond adhesively to the organic resin matrix. Silane bonds to the quartz, glass, and silica particles, whereas the organic end bonds to the resin matrix.

70. What is the mechanism of silane coupling?

During free radical polymerization of organic BIS-GMA, covalent bonds are formed between this polymer matrix and the silane coupling agent, commonly gamma methacryloxypropyltrimethoxy. The coupling agent, which coats the filler particles at the silane end, thus holds the inorganic and organic phases together. This further prevents water absorption.

71. What is the mechanism of polymerization in composite resin systems?

Benzoyl peroxide and aromatic tertiary amines are used to initiate polymerization reactions by supplying free radicals. This process is induced by photoactivation with visible light in the 420—450-nm range, using alpha-diketones and a reducing agent, often a tertiary aliphatic amine. The diketone absorbs light to form a excited triplet state, which, together with the amine, produces ion radicals to initiate polymerization.

72. Describe the function of polymerization inhibitors.

Inhibitors are necessary to provide shelf life and delay the polymerization reaction, thus allowing clinical placement of composite materials. The dimethylacrylate monomers spontaneously polymerize in the presence of atmospheric oxygen. To this end monomethyl ethers of hydroquinone are used as inhibitors.

73. What are radiation absorbers?

Ultraviolet absorbers provide color stability to composite resins and thus limit discoloration.

74. How are composites classified?

In general, classification systems are based on filler particle size and how the fillers are distributed:

Particle size

- Large particle (conventional) composites): 20—50 µm in diameter
- Intermediate: 1—5 µm
- Hybrids or blends: 0.8—1.0 µm
- Fine particle and minifilled: 0.1—0.5 µm
- Microfilled: 0.05—0.1 µm

Distribution of fillers

- Homogenous microfilled: organic matrix and directly admixed microfiller particles
- Heterogeneous microfilled: organic matrix, directly admixed microfiller particles, and microfiller-based complexes

75. Which are presently the most commonly used composite blends?

The microfilled and hybrid composites.

76. What are the desirable properties of each type?

Microfills: more esthetic, with better depth of color and more lifelike reflective properties. They polish to a high gloss and are ideal for anterior esthetics and nearly invisible repairs.

Hybrids: greater strength and more opaque. They may be used as the sole restorative for both anterior and posterior restorations.

77. How are hybrids and microfilled composites used together to maximize strength and esthetics (the so-called sandwich technique)?

1. The sandwich technique is a layering of materials to create the optimal combination of desirable properties in a restoration. In a class IV anterior restoration of an incisal angle, for example, first using a hybrid composite to build

up the body of underlying dentin provides strength and dentinlike opacity. Then overlaying the final tooth structure with a microfilled composite provides incisal translucency, desired reflective characteristics, and the high polishability of a microfill.

2. A layer of hybrid, together with opaquers, may block out undesirable colors before using a microfill.

3. All posterior restorations, as well as porcelain repairs and periodontal splinting, benefit from the superior strength of a hybrid.

78. What are composite opaquers or tints? How may they be used?

Opaquers and tints are light-cured, low-viscosity, highly shaded composites used to add esthetic characteristics to restorations. They often match the Vita Shade System and can be brushed on in layers to create lifelike matches to natural teeth. They may be applied on a bonded tooth, between layers of the sandwich build-up, or even on the surface to characterize the restoration (example: Renamel Creative Color, Cosmedent).

79. What are the possible adverse effects of composite resin?

There have been reports of chronic soft tissue inflammation from composite particles imbedded during operative procedures and hypersensitivity reactions to one or more of the components in composites.

80. What are the advantages of glass ionomer restorative materials?

They bond to tooth structure, have near ideal expansion-contraction ratio and low microleakage, and release fluoride. The light-cured materials are the easiest to work with because they provide extended working times; have rapid, on-demand set; and are less technique-sensitive on mixing.

81. How are glass ionomer cements (GIC) classified?

GICs are mixed powder-liquid component systems. The powder consists of a calcium-aluminofluorosilicate glass that reacts with polyacrylic acid to form a cement of glass particles surrounded by a matrix of fluoride elements.

1. **Hydrous types:** a slower-setting material characterized by a viscous liquid of polyacrylic acid, tartaric acid, itaconic acid, and water plus fluoroaluminosilicate glass powder. Examples: GC Lining cement (GC America), Chelon-Silver (Espe-America).

2. **Anhydrous types:** fluoroaluminosilicate glass, vacuum-dried polyacrylic acid, itaconic acid powder, and a solution of water and tartaric acid. These materials have better shelf life. Example: Ketac Chem (Espe-Premiere).

3. **Hybrid forms:** combination of anhydrous and hydrous forms of glass ionomer powder and liquid. Example: Fuji II (GC America).

4. **Light-cured glass ionomers:** an acid-base setting material in a photo-initiated liquid. These materials offer extended working times and rapid, on-demand set-up and are less technique-sensitive on mixing. Examples:

Vitrabond (3M) and XR Ionomer (Kerr).

82. What are metal-reinforced GICs?

Metallic silver particles of up to 40% of weight are added to GICs to increase the strength and to speed the setting time. Metal-reinforced GICs may be used (1) for core build-ups when at least 50% of tooth structure remains (GICs alone do not have the strength to be a total core); (2) as a temporary filling material; and (3) as a filler or base/liner for undercuts in any cavity preparation. An example is KetecSilver (Espe-Premiere).

83. What are compomers?

Compomers are a single light-cured component made by adding glass ionomer particles to acidic polymerizable monomers in a resin matrix. The material is flowable, adheres to dentin with bonding resin, releases fluoride, and promises good esthetics. It is indicated for class V and I restorations and may be used under amalgams or composite resins as a base or liner due to its lower viscosity (examples: Dyract [Caulk/Dentsply], Hytack [ESPE]). Compomers are used with fifthgeneration single-component primer-adhesives and claim to bond to dentin without acid etching.

84. What are flowable composites? What are their applications?

Flowable composites are low-viscosity, visible light-cured, radiopaque, hybrid composite resins, often containing fluoride. They are dispensed by syringe directly into cavity preparations and have 37—53% filler by volume (compared with 60% in conventional composites). They are claimed to be easy to deliver via a narrow syringe tip, offer flexibility for class 5 preparations, and are able to access small areas. They may be used as a base material under class I and II restorations. Although long-term performance is not known, they seem well suited for the long channels of air abrasion preparations, cementing veneers, dental sealants, margin repairs of all types, inner layer in sandwich techniques. porcelain repairs, and sealing the head of implants. Examples are Aeliteflo (BISCO), Floresore (DenMat), Revolution (Kerr), and Ultraseal XT Plus (Ultradent).

85. What are the advantages of all-purpose composite resins?

Products such as Geristore (Den-Mat) are termed multipurpose products. They are smallparticle fluoride-releasing, self- or dual-curing composites and have high compressive strengths and low viscosity. They have applications as cements, bases and liners, or pediatric restoratives. They bond to dentin, enamel porcelain, amalgam, precious and semiprecious metals, and moist surfaces. They function as luting materials for crowns (with dentin-bonding systems) and are suitable for Maryland bridge bonding.

86. What are resin surface sealants?

Resin surface sealants are light-cured, thin-viscosity, unfilled resin compounds placed on the surface of direct resin restorations after final finishing and polishing. Their primary function is to enhance the marginal seal of the restoration. Example: Fortify (BISCO).

87. What are glass ionomer resin cements?

Resin-modified glass ionomers (RMGI) improve the properties of glass ionomers significantly:

1. They are easy to mix and place.
2. They are equal or higher in fluoride release.
3. They have higher retention, higher strength, lower solubility, and lower postoperative sensitivity than glass ionomer or zinc phosphate cements.

Current brands are Vitremere (3M), Advance (CaulklDentsply), and Fuji Duet (GC).

Clinical Comparison of Popular Resin-Modified Glass lonomer (RMGI) Cements

BRAND AND COMPANY	PRIMER/ CONDITIONER	EASE OF MIX	VISCOSITY	SET CEMENT REMOVAL
Advance Caulk/Dentsply (800) 532-2855 FAX: (800)422-3591	Elective dentin-bonding agent	Excellent	High flow	Difficult
Duet G.C. America Inc. (800) 323-7063 FAX: (708) 371-5103	Dentin conditioner	Excellent	High flow	Moderately difficult
Vitremer luting cement 3M Dental Products (800) 634-2249 FAX (612) 733-2481	None	Excellent	Mousse-like, high flow	Easy

BRAND AND COMPANY	POSTOPERATIVE SENSITIVITY	OXYGEN INHIBITION	RECOMMENDATIONS AND OBSERVATIONS
Advance Caulk/Dentsply (800) 532-2855 FAX: (800)422-3591	None	Present— Leave excess before debris removal.	Strongest RMGI, excellent for short crowns or low retention fixed prostheses Elective increase in retention when primer is used Debris removal requires more time than other RMGIs.
Duet G.C. America Inc. (800) 323-7063 FAX: (708) 371-5103	None	Present— Leave excess before debris removal.	Intermediate strength Excellent for routine crown and fixed prosthesis cementation Debris more difficult to remove than Vitremer
Vitremer luting cement 3M Dental Products (800) 634-2249 FAX (612) 733-2481	None	Present— Leave excess before debris removal.	Easiest RMGI to use Weakest RMGLbut still stronger than traditional cements Excellent for routine crown and fixed prosthesis cementation

Adapted from CRA Newsletter 20(2): 1. 1996, with permission.

88. What are resin cements?

Resin cements are two-part, autocuring adhesives for single crowns, Maryland bridges, and fixed prosthetics. There are two categories: resin [(C&B Metabond, Parkell), and resin [(Paniva 21, J. Morita). They provide some of the highest bond strengths to metal and tooth and the greatest retention.

89. What are the indications and contraindications for the use of direct placement compos ite resins in class 2 restorations?

Indications

1. The best use is for narrow-slot restorations and smaller restorations of one-quarter to one-third of intercuspal distance.

2. If used in larger, greater than one-third intercuspal distance, weak cusps must be covered; longevity is not considered long-term.

Contraindications

1. Patients with known amalgam allergies and patients who wish to avoid metal restorations.

2. Bruxers, clenchers, and patients with extensive tooth loss that would place resin margins in occlusal contact.

90. Discuss the major challenges of the class 2 composite restoration.

1. All current resins wear significantly more than silver amalgam. To minimize wear, sufficient light-curing is suggested: 30—40-second cures on facial, occiusal, and lingual surfaces with a calibrated light source.

2. Class 2 composite restorations are generally time- and technique-sensitive. Contact areas are harder to establish, and finishing is time-consuming. Use magnification to view. Thin, dead, soft-matrix bands should be well burnished against the proximal tooth and held tightly with one instrument as the second instrument places composite against the band and curing occurs. Finish dry, using sharp, 12-bladed burrs and a light touch.

3. Sufficiently light-cure primer and bonding resins before placing composite to avoid postoperative tooth sensitivity. Apply composite in small 2-mm increments.

91. What are optimal characteristics of visible curing lights?

1. High-intensity output ($\geq$ 300 mW/cm^2)
2. 12-mm, 60° light wand; changeable
3. Built-in radiometer
4. Continuous on feature with overheating
5. Timer with audible beeps every 10 seconds

92. How can one achieve a tight interproximal contact in direct class 2 posterior composite restorations?

1. Use a thin burnished band, well-adapted and wedged.

2. Apply force proximally to the band with an instrument while curing the composite. This technique holds the restoration tightly against the band and provides optimal contact.

93. What are the major considerations in repairing older composite restoration?

As composites age, it is harder to bond chemically to the surface. There are fewer reactive sites on the resin surface, and impregnated proteins and debris limit the bonding capacity. It is necessary to remove the outer surface with a burr to remove contaminants and increase the surface area. Pumice followed by etching proceeds as usual. Coating with silane allows better bonding to the silica particles. Final application of unfilled resin and curing before placement of the composite should result in predictable bonding.

94. How is a fractured porcelain restoration repaired?

The first step is to determine the cause. Is it a structural weakness or perhaps an occlusal stress-related fracture? Try to resolve any causative factors first. The next step is to create some mechanical hold wherever possible. Roughen and bevel around the defect, because the restorative cannot bond to a glazed surface. Microetch when possible with a microetcher or a porcelain acid etchant such as 10—12% hydrofluoric acid gel. Then silenate and apply bonding resin, opaquers, and, finally, the appropriate color of composite restorative.

95. How does bonding to a metal surface differ from the porcelain repair?

The principal steps of bonding are similar, but the preparation of the metal surface may include air abrasion of the nonprecious metal (with a microetcher) and tin-plating of the precious metal. The bond strengths of resin cements are greatly enhanced.

96. Summarize the technique for an indirect-direct single-visit composite resin restoration.

1. Prepare a class 2 inlay/onlay restoration without undercuts.
2. Take an alginate impression.
3. Inject Mach-2 Die Silicone (Parkell) into alginate impression (sets in minutes).
4. Mal a base for the die by placing silicone impression material over the Mach-2/alginate impression.
5. Trim the Mach-2 die with a sharp blade.
6. Make the composite restoration on the die. Cure with visible curing light.
7. Remove, trim grossly, and seat on tooth. Adjust, finish, and polish the proximal contacts.
8. Seat the restoration using a bonded resin cement; fine finish and polish.

The major advantages of this technique are as follows: (1) polymerization shrinkage occurs on the die, not on the tooth, giving a better seal; (2) any size restoration may be constructed; and (3) this single-visit procedure requires no provisional restoration and a minimal amount of time.

97. What clinical procedures should be avoided because they may injure pulps of teeth?

1. Dull burrs and diamonds may result in increased heat production.
2. Noncentric handpieces traumatize teeth like minijackhammers.
3. Inadequate water delivery causes heat and dehydration.
4. Overdrying of tooth preparations dehydrates the pulp, causing sensitivity.
5. The acidity of astringent materials such as Hemodent (pH 1.9) may cause injury if left in dentin or root contact. Use only minimally on cord or in sulcus.
6. Temporary resin exothermic reactions for provisional restorations may be harmful. Cool with water often during exothermal period.
7. Poor fitting temporary restorations may result in leakage that injures pulps. Margins should fit well.
8. Overcontoured restorations may result in trauma from occlusion. Carefully adjust occlusion, and check in all excursions.

98. What is the composition of dental amalgam?

Dental amalgam is an alloy composed of silver, tin, copper, and mercury. The basic setting reaction involves the mixing of the alloy complex of silver (Ag) and tin (Sn) with mercury (Hg) to form the so-called gamma phase alloy (original silver/tin) surrounded by secondary phases called gamma-i (silver/mercury) and gamma-2 (tin/mercury). The weakest component is the gamma-2 phase, which is less resistant to corrosion.

$$AG_2Sn + Hg \longrightarrow \underset{\text{Gamma}}{Ag_3Sn} + \underset{\text{Gamma-1}}{Ag_2Hg_3} + \underset{\text{Gamma-2}}{Sn_3Hg}$$

Alloys are manufactured as filings or spherical particles; dispersed allo are mixtures of both. Smaller particle size results in higher strength, lower flow, and better carvability. Spherical amalgams high in copper usually have the best tensile and compressive characteristics.

99. What is the functional advantage of a high copper content in dental amalgam?

Copper contents over 6% eliminate the gamma-2 phase and result in alloys of much better marginal stability.

100. How can one tell when an amalgam is properly triturated?

A properly triturated amalgam mix appears smooth and homogenous. No granular appearance or porosity should be evident. An overtriturated mix is preferable to an undermixed preparation.

101. What are the common types of amalgam alloys used today?

Alloys are supplied in different particle shapes and sizes to influence the handling and setting properties. The blended alloy is a mixture of fine-cut and spherical particles, whereas all spherical alloys are composed of spherical particles (Dispersalloy, Caulk). Because spherical alloys are fast-setting, they are particularly suitable for core build-ups and impression taking in one visit. A new breed of non—mercury-containing alloy uses gallium and silver (Galloy, Southern Dental Industries). This alloy requires a moisture-free environment on setting and is best as a bonded restoration.

102. Should all amalgams be bonded?

State-of-the-art technique says yes. Amalgam bonding effectively seals dentin tubules, nearly eliminating postoperative sensitivity. It has the added benefits of retention of the restorative and a stronger total cohesive mass to support all remaining cuspal segments of the tooth.

103. What is the mechanism of bonding amalgams?

The use of a self-curing resin liner (Amalgambond, Parkell, or All Bond 2, BISCO) provides a bond to tooth substrate and amalgam. As the amalgam is condensed into the unpolymerized resin, a micromechanical bond is formed.

104. What is considered the most important requisite for successful adhesive dentistry?

The formation of maximal strength bonding requires a clean operating field free of debris and contamination. Whenever possible, this is best achieved with a rubber dam.

105. What factors help to retain alloy restorations?

Optimal retention warrants the use of pins, groves, channels, or holes placed in sound tooth areas.

106. What are the guidelines for use of pins to retain dental amalgams?

1. Pins should extend 2 mm into tooth structure.
2. Pins should be placed fully in dentin. If they are too close to the dentoenamel junction, the enamel may fracture from the tooth. In general, they should be placed at the line angles where the root mass is the greatest.
3. Pins should extend 2 mm into amalgam; further extension only weakens the tensile and shear strength of the amalgam.
4. Pins should be aligned parallel to the radicular emergence profile or to the nearest external enamel wall. Additional angulations may be used when there is no danger of pulpal or periodontal ligament perforation.
5. If the tooth structure is flat, the small retentive channels cut into the tooth structure pre vent potential torsional and lateral stress.

107. What are the potential complications of the use of pins to retain restorations?

Pin placement may result in pulpal exposure, perforation through the periodontal ligament, and fracture of a tooth. In addition, pins may weaken an amalgam if they extend farther than 2 mm into the mass. The use of a dentin-bonded resin liner helps to seal potential fracture lines, but placement requires skill and expert technique.

108. What should be done if accidental exposure of the pulp or perforation of the periodontal ligament occurs during pin placement?

If the pulp is exposed by the pinhole, allow the bleeding to stop, dry with a sterile paper point, and place calcium hydroxide in the hole. Do not place a pin in the hole. Usually the pulp will heal. If a penetration of the gingival sulcus or periodontal ligament space occurs, clean, dry, and place the pin to the measured depth of the external tooth surface to seal the opening.

109. What is the purpose of finishing and polishing amalgam restorations?

Amalgam restorations should be finished and polished for three main reasons: (1) to reduce marginal discrepancies and create a more hygienic restoration; (2) to reduce marginal breakdown and recurrent decay; and (3) to prevent tarnishing and increase the quality of appearance of the restoration. Polishing is often a neglected part of treatment, either for lack of opportunity to recall or from the feeling of not being compensated for the added service. However, polishing a restoration or two at each recall may define the state-of-the-art dental practice.

110. What is the sequence for polishing amalgams?

Begin gross contouring with multifluted finishing burrs usually at least one day after insertion. Burrs come in a vaI of shapes—round, pear, flame, and bullet-nosed—and allow anatomic contouring. Shufu-type brownie and greenie points may be used to create a high luster. Final pumicing with rubber cups completes the finishing.

111. What is the purpose of a cavity varnish?

Classically, cavity varnishes, such as Copalite, were used to seal dentin tubules without adding bulk and to protect pulpal tissue from the phosphoric acid in zinc phosphate cements. Current fifth generation dentin-bonding systems, such as One-Step (3M) and Prime&Bond (Caulk/Dentsply), fulfill the concept of a cavity varnish more ideally. Thus the use of copal varnishes is diminishing.

112. What is a cavity liner? What are the indications for its use?

A cavity liner is a relatively thin coating over exposed dentin. It may be self-hardening or light-cured, and it is usually nonirritating to pulpal tissues. The purpose is to create a barrier between dentin and pulpally irritating agents or to stimulate the formation of reparative, secondary dentin. Calcium hydroxide has traditionally been placed on dentin with a thickness of 0.5 mm as a pulpal protective agent. Contemporary practice uses newer dentin-bonding agents for liner materials. These agents not only provide a barrier to pulpally toxic agents but also seal the dentin tubules from bacterial microleakage and provide a bondable surface to increase the retention of the restoration. Glass ionomer cements and dentin-bonding systems have become the standard liner materials in restorative dentistry.

113. What is a base? What are the indications for use?

Generally, cements that are thicker than 2—4 mm are termed bases and as such function to replace lost dentin structure beneath restorations. A base may be used to provide thermal protection under metallic restorations, to increase the resistance to forces of condensation of amalgam, or to block out undercuts in taking impressions for cast restorations. A base should not be used unnecessarily. Pulpal thermal protection requires a thickness of a least 1 mm, but covering the entire dentin floor with a base is not thought to be necessary. Generally, the following guidelines may be used:

1. For deep caries with frank or near exposures or with <0.5 mm of dentin, apply calcium hydroxide.
2. Under a metal restoration, a hard base may be applied (over the calc hydroxide) up to 2.0mm in thickness to increase resistance to forces of condensation.
3. If> 2 mm of dentin is present, usually no base is needed under amalgam; a liner may be used under composite.
4. Use of a dentin-bonding agent that seals the dentin tubules and bonds to the restorative material is desirable.

114. What is the function of a post and core?

The post and core links the missing coronal portion of the tooth with the remaining root structure, allowing retention of the crown.

115. Does a post strengthen endodontically treated teeth?

Contrary to former thought, posts do not reinforce teeth, and they may weaken some root structures. Widening a canal space for a larger post can weaken a root. Long posts are more retentive, but too much length may perforate a root or cause compromise in the apical seal. A good guide is to make the length about one-half of the bone-supported root length, to allow at least 1 mm of dentin lateral to the apical end of the post and to leave at least 3—5 mm of apical gutta purcha filling.

116. Which canals are generally chosen for post space?

Generally the largest canal is chosen: the palatal canal in maxillary molars and the distal canal in mandibular molars. Two-rooted bicuspids with minimal tooth structure may require one post in each canal.

117. How may vertical fractures develop in roots?

1. Wedged or tight-fitting posts may cause fractures.
2. Overpreparation of the internal canal space may weaken a root and cause fractures.

118. When are posts indicated? When are they not needed?

Indicated

I. If more than one-half of the coronal tooth structure is missing, place a post to attach the core material to the root structure.

2. If all of the coronal tooth structure is missing, a post is needed to retain the core material and to provide antirotational features.

Not needed

1. If minimal coronal tooth structure is missing, as when an access cavity is made centrally with no caries on the proximal wall, no post is required. Placement of a bonded filling material to the level of bone will adequately restore the endodontic access preparation.

2. Up to one-half of coronal tooth structure missing may not need a post except for teeth with high lateral stresses such as cuspids with cuspid rise occlusion. Place a bonded crown build-up.

119. How are antirotational features created?

1. Cast cores can be placed in anterior teeth with recessed boxes to limit rotation.
2. Small cut boxes or channels 1-1½ mm deep and about the width of a no. 330 burr may be placed into remaining tooth structure.
3. An accessory pin (Minium or Minikin) may be placed nonparallel to the posts.

120. When a crown preparation is made, where should the finish line be placed?

The gingival margin should be 1-1½ mm apical to the core build-up material and on the root surface for optimal retention and antirotational resistance. If a ferrule post and core is used, the crown margin may be placed on the core material.

121. What are the characteristics for ideal posts?

- The post space must provide adequate retention and support for the core, and the core must provide adequate support for the fixed restoration.
- Passive fitting is best.
- Resin-bonded posts transmit less force to the root and increase the structural by bonding the post to the root.

122. What are the indications for a cast post?

For build-up of single-rooted teeth with little supragingival structure, a cast post and core with an inset lock preparation and ferrule design will strengthen the root significantly and prevent rotation.

123. What is the best post design for thin-walled roots?

A cast post incorporating a circumferential ferrule that embraces the root with a full bevel may be used. The post is abraded and bonded to the tooth root.

124. Of what materials are prefabricated posts constructed?

The most common are stainless steel (nickel, chrome), but titanium alloys and carbonfiber are gaining popularity.

125. What type of core material is best for prefabricated posts?

Bonded amalgam and bonded composite are equally strong. However, composites are faster and generally easier.

126. Outline the clinical steps in resin-bonding casts or prefabricated posts.

I. Prepare the canal space with a hot instrument to remove gutter purcha to a depth of onehalf of the bone-supported root length, or as governed by root shape.

2. Refine the canal preparation with Parapost drills or diamonds.

3. Cleanse the canal of debris with H_2O_2 with a syringe.

4. Treat with etchant 37% for 15 seconds or with 17% EDTA for one minute to remove the smear layer.

5. Rinse well with water and lightly dry.

6. Microetch the post with air abrasion.

7. Apply resin cement primers and resins to the pbst and the canal according to product directions.

8. Mix the resin cement and inject into the canal quickly, seating the post.

9. Wipe the excessive cement with a brush dipped in resin while holding the post until the cement has set.

127. Summarize the guidelines for fillers, build-ups and post and cores.

For full-crown preparations, all old restorative material should be removed after preliminary tooth preparation. Small areas or missing tooth can be replaced with a bonded filler (compomer or reinforced glass ionomer); larger sections of missing tooth should be replaced with a build-up (bonded composite or amalgam); and an endodontically treated tooth with more than one-half missing coronal structure should have a titanium alloy post and core with a bonded amalgam or composite build-up.

128. What is the current status of the use of amalgam?

Dental amalgam continues to be the most common material worldwide for the restoration of carious teeth. To date there are no epidemiologic links to its use and ill health. Countries such as Sweden and Germany have suspended or limited its use primarily to lower environmental mercury levels by eliminating mercury in manufacturing. As newer materials that are durable and cost-effective evolve, it is likely that mercury-containing restorations will be phased out. Until that time, it is the opinion of world health agencies, medical and dental societies, and the scientific community at large that amalgam is a safe, durable, and cost-effective restorative material.

129. What should a dentist know to respond to a patient's inquiry about amalgam restorations and safety?

A clinician must know all of the related facts about amalgam, health-related sensitivities, ethics of replacements, and alternative restorative choices.

130. What consideration should be given to a patient's concern about sensitivity to dental alloys?

It is important to differentiate the type of inquiry:

1. A real allergy or hypersensitivity (as differentiated from toxicity) to dental alloys and metals is not uncommon. Approximately 3% of the population has some type of metal sensitivity.

Health questionnaires should pose questions about skin reactions to jewelry andlor known metal sensitivities. Allergy testing can confirm these sensitivities.

2. Some patients have esthetic concerns and do not wish to have non—tooth-colored restorations.

3. Some patients have phobias about the alleged toxicity of various dental materials.

4. Some patients have chronic diseases, such as multiple sclerosis, and are looking for some causative agent and a miracle cure.

Each group of patients requires appropriate information from dental and medical sources to help them make informative choices about their dental health.

131. What dental materials are reported to be the most allergenic? What are the manifestations of these exposures?

Allergic reactions have been reported to involve chromium, cobalt, copper, and nickel, which has the highest allergic potential; palladium, tin, zinc, silver, and gold/platinum have the lowest. The symptoms may range from localized chronic inflammation around restorations and crowns to more generalized oral lichen planus, geographic glossitis, angular cheilitis, and plicated tongue.

132. Are certain people hypersensitive to mercury?

Yes. But according to the North American Contact Dermatitis Group, true sensitivity to mercury in subtoxic doses is rare. Studies show that 3% of people respond to a 1% mercury patch test. Of these, <0.6% have any clinical manifestations of mercury sensitivity allergy.

133. Are there any known harmful effects from the mercury content of dental amalgam?

As a restorative material, silver amalgam has been used in dentistry for over 150 years. The safety of this material has been studied throughout this period, and no epidemiologic evidence associates general health problems with silver amalgam. Many health groups around the world have reviewed and contributed to this conclusion. The World Health Organization, the Swedish Medical Research Council and the Swedish National Board of Health and Welfare (1994), the British Dental Association (1995), and U.S. Public Health Service (1993), the National Institutes of Health and the Institutes of Dental Research, the Food and Drug Administration (1991), and even Consumer Reports (1991) attest that dental amalgam fillings are safe to use and that no beneficial health benefits will result from removal of existing restorations. Organizations such as the National Multiple Sclerosis Society characterize claims of recovery after removal of dental amalgams as unsubstantiated, unscientific, and a "cruel hoax." A recent study on aging and Alzheimer's disease found no evidence that amalgams reduced cognitive functions in a group of 129 Roman Catholic nuns between the ages of 75 and 102 years.

In conclusion, repeated studies in humans with and without amalgam restorations show no significant difference in any organ system. Comparisons of immune cells show no difference in function. Furthermore, no recoveries or remissions from any chronic diseases after removal of amalgams has been scientifically demonstrated.

134. What are the physical pathways for mercury to enter the body?

Elemental mercury is abundant in the earth's environment. It exists in the soil, ocean, and air. The burning of fossil fuels and even volcanic eruptions have contributed to its widespread dissemination. The use of mercury in manufacturing through the centuries has led to much of the environmental contamination. In high enough doses, mercury is neurotoxic. The questions of exposure to mercury from dental amalgams require clinical elucidation.

Dental amalgam fillings contain 40—45% mercury and elements of silver, tin, and copper, bound into a metallic complex from which the mercury is not free. Small amounts of mercury vaporize from the surface with function, pass into the air, and are exhaled. The amount that is absorbed into the body as a function of the number of amalgam surfaces is largely excreted by the kidneys into the urine. The smaller amount that may accumulate in other organs has caused concern. There are accumulations in the brain, lungs, liver, and GI tract. The ultimate question is what percentage of a person's total exposure to mercury from all sources comes from dental amalgams.

The daily intake of mercury attributable to dental amalgams, as measured by blood levels of mercury, is reported to be only one-seventh (14%) of the amount measured from eating one seafood meal per week. The total daily intake from 8—12 amalgam surfaces is about 1—2 µg— again, seven times lower than the intake from one seafood meal per week and only about 10—20% of the average total exposure (9 µg/day) from all environmental sources. Clearly the general environment exposure is much more of a concern. Sweden and Germany have eliminated dental amalgam manufacturing and use as part of the solution.

Clearly there should be an overall effort to lower environmental mercury. As newer substi tutes for silver amalgam prove to be as durable, simple to use, and cost-effective, we may see the gradual phasing out of mercury.

135. What has contributed to "amalgam phobia"?

Because it is well known that elemental mercury is an environmentally toxic waste, and because hundreds of millions of people have dental amalgams containing mercury, it is only natural to question the safety to human health. In what has become a disservice to many, the media have used sensationalism in reporting stories related to health and dental amalgam in much the same distorted way that fluoride has been reported to be harmful as a water additive for caries prevention. Furthermore, as scientific efforts continue to describe the biocompatibility of mercury, various animal models have been extrapolated to humans without scientific validity (e.g., studies of the absorption of elemental mercury for different species require adjustment for the fact that sheep absorb 18—25 times more mercury than humans). Even the dental profession was implicated when analytical mercury vapor detectors found distortedly high levels of mercury vapor over amalgam restorations because their calibrations were inaccurate. The sampling rate of the intake manifolds of the vapor analyzers was much greater than the rates of human inspiration, and the air intake calculated for humans was in error by as much as sixteen times. The use of such detectors left many a responsible dental clinician with erroneous conclusions.

Finally, the reports of many people who experienced a health improvement when their amalgams are replaced or removed must be viewed carefully before assuming causal links. A few weeks of monitoring the newsgroup AMALGAM@Listserv.gme.de on the World Wide Web will show hundreds of cases of people who experience better health after amalgam removal. Many psychodynamic issues can be observed in people who report such changes, and direct links to the amalgam contribution need scientific scrutiny. After all, some people have genuine allergies to certain materials. From observation of human experience we as a profession learn to ask the questions that lead to productive clinical research.

136. What are the ethical issues related to removing a patient's amalgams?

According to the ADA's Advisory Opinion in the Principles of Ethics and Code of Professional Practice, it is considered improper and unethical to remove amalgam restorations from a nonallergic patient for the alleged purpose of removing toxic substances from the body when such treatment is solely at the recommendation of the dentist. If a dentist indicates that such dental treatment has the capacity to cure or alleviate systemic disease, when no scientific evidence or knowledge supports such a claim, the dentists' action is consid unethical. However, a dentist may remove amalgams at a patient's request, as long as no inference is made about improving the patient's health. A dentist also may ethically decline to remove the amalgam if there is no sound medical reason.

137. What options are available for amalgam restorations?

Cast gold
Cast, fired, and pressed ceramics
Direct, direct-indirect, indirect placement composite resins
CAD-CAM and mechanically milled restorations

138. What are the major uses of the stainless steel crown (SSC) in adult dentition?

1. Extensive decay in the dentition of young adults may leave a vital tooth with limited structure that requires a crown. If a permanent cast or ceramic restoration is not feasible, one may use the SSC in conjunction with a pin/bonded composite core build-up to stabilize the tooth until a permanent crown is constructed. A typical restoration involves the following steps: (1) complete excavation; (2) application of a glass ionomer liner or dentin bonding; (3) placement of pins at the four corner line angles; (4) beveling of the cervical enamel or dentin margin; (5) trial fitting of the SSC with careful adaptation of the cervical margins and checking for occlusal clearance; (6) etching of the cervical bevel; (7) application of a bonding resin; (8) filling of a well-adapted SSC with self-curing composite core material; and (9) seating of the crown. Removal of excessive and expressed composite leaves a well-sealed re that may serve for many years. When it is time to prepare the tooth for the permanent crown, slitting the SSC leaves the core build-up ready for final preparation.

2. SSCs may be used to stabilize rampant decay at any age.

3. SSCs may be used as a substitute for the copper band to stabilize a tooth before endodontic treatment. The SSC is more hygienic and kinder to the periodontium when it has been well adapted. Traditional access is through the occiusal dimension.

4. SSCs may be used as a temporary crown when lined with acrylic.

139. What techniques may be used to achieve marginal exposure and to control hemorrhage in a class V cavity preparation?

If the preparation is < 2 mm below the gingival sulcus, an impregnated retraction cord with a gingival retraction rubber-dam clamp may be effective. If the defect approaches 3 mm or greater, hemostasis and margin exposure often require surgical exposure (crown lengthening) or excision via electrosurgery.

140. Outline the major design criteria for closing spaces in the anterior dentition.

1. Most commonly, composite bonding and/or porcelain veneers may close the maxillary central diastema. Careful space analysis with calipers allows the most esthetic result. The width of each central incisor is measured, along with the diastema space. One-half the dimension of the diastema space is normally added to each crown unless the central incisors are unequal. Then adjustment is made to create equal central incisors.

2. If the central incisors appear too wide esthetically, one can reduce the distal incisal to narrow the tooth and bond it over to seal any exposed dentin. One then adds to the mesial incisal of the lateral incisor to effect closure of space.

3. A tooth in the palatal crossbite may even be transformed into a two-cuspid tooth by building up the facial to the buccal profile. This bicuspidization is reasonably durable and esthetically pleasing.

4. Peg laterals and congenitally absent laterals replaced by cuspids may similarly be transformed with bonding and/or porcelain veneers. Reduction of protrusive contours, followed by addition to mesial and distal incisal areas, establishes esthetic results.

141. List the indications for the porcelain veneer restoration.

1. Stained teeth or teeth in which color changes are desired
2. Enamel defects
3. Malposed teeth
4. Malformed teeth
5. Replacement for multisurfaced composite restoration when adequate tooth structure remains (at least 30%)

Each patient must be evaluated on an individual basis. A general requirement is excellent periodontal health and good hygiene practices. In the case of stained teeth, prior bleaching (either at home or in office) helps to ensure better color esthetics.

142. Describe the basic tooth preparation for the porcelain veneer restoration on anterior teeth.

1. **Vital bleaching** (optional)

2. **Preparation.** Enamel reduction of at least 0.5 mm, which may extend to 0.7 mm at the cervical line angles, is necessary to avoid overcontouring. The only exception may be a tooth with a very flat labial contour and slight linguoversion. Chamfer-type labial preparations can be achieved with bullet-type diamonds, and the use of self-limiting 0.3-, 0.5-, 0.7-mm diamond burrs is essential for consistent depth of preparation. The gingival cavosurface margin should be level with the free gingival crest. The mesial and distal proximal margins are immediately labial to the proximal contact area. The contacts are not broken but may be relaxed with fine separating strips. This allows placement of smooth metal matrix strips. The incisal margin is placed at the crest of the incisal ridge. Placing retraction cord into

the gingival sulcus before preparing the gingival cavosurface margin helps in the atraumatic completion of the preparation.

3. **Impressions.** Standard impression techniques use vinyl polysiloxane materials.

4. **Temporization,** if at all possible, should be limited in use; it may be time-consuming and add to the expense of the procedure. One should use fine discs on the labial enamel surface for polishing the rough surface of the diamond-cut preparation to limit the accumulation of stain and debris. If it is necessary to temporize, preconstructed laboratory composite veneers or chairside direct temporization may be used. The techniques are similar. Spot-etch two or three internal enamel areas on the labial preparation. Apply unfilled resin and tack-bond the veneer, or place light-cured composite on the tooth and spread it with a gloved finger dipped in unfilled resin to a smooth finish. The preparation should be light-cured, and one should be able to lift it off relatively easily at the unetched areas and polish down the etched spots.

143. Describe the technique for insertion of porcelain veneers.

1. After isolation, pumicing, and washing, the fragile porcelain veneers are tried on the chamfer-prepared tooth. First, the inside surface of the veneer is wetted with water to increase the adhesion. Margins are then carefully evaluated.

2. Next, try-in pastes are used to determine the correct color-matching. Water-soluble pastes are the easiest to use. The try-in pastes closely match the final resin cements but are not light-activated.

3. The porcelain veneers are prepared for bonding. Apply a 30-second phosphoric acid etchant for cleaning. Wash and dry. Apply a silane coupling agent, and air-dry. Apply the unfilled light-cured bonding resin, and cure for 20 seconds.

4. To bond the porcelain veneer to the tooth, first clear interproximal areas with fine strips. Pumice and wash thoroughly. Place strips of dead, soft interproximal matrix, and etch the enamel for 30 seconds. Wash for 60 seconds and dry. Apply the bonding resin. Any known dentin areas should be primed (with dentin primer materials) before applying the bonding resin. Any opaquers or shade tints may now be applied. The light-cured resin luting cement is now applied to tooth and veneer. The veneer is carefully placed into position, and gross excessive composite is removed. Precure at the incisal edge for 10 seconds, and remove any partially polymerized material gingivally and proximally. Light-cure fully for 30—60 seconds. Finish the margins with strips, discs, and finishing burst. Check for protrusive excursions. Apply the central incisors first, then the laterals and cuspids.

144. What are the technical considerations for posterior cast-porcelain, partial-coverage restorations?

1. Remove all old restorative material, and excavate any caries.

2. Cavosurface margins are butt-jointed at 90°; otherwise, a fine porcelain flange is prone to fracture.

3. Hard-setting calcium hydroxide may be placed at the pulpal floor area when dentin thickness is estimated to be 0.5 mm or less.

4. Glass ionomer cement is placed on all exposed dentin, and any undercuts are blocked out accordingly to create an ideal inlay form. The result is a fully bondable surface.

5. Impressions are taken, and temporization is performed with acrylic resin and cemented with noneugenol temporary cement.

6. The porcelain inlay received from the laboratory is trial-fitted, but occlusion is not adjusted at this time because of possible fracture.

7. The porcelain and the tooth are prepared in the usual manner for bonding.

8. Cementation with a composite luting cement, preferably with a dual-cured material, allows better polymerization, especially at interproximal areas.

9. Finishing and final occlusal adjustment are done in the usual manner.

145. List advantages of the porcelain inlay/onlay.

- The restoration is highly esthetic.
- The restoration is highly wear-resistant.
- As a fully bonded restoration, adjacent tooth structure is strengthened.
- Polymerization shrinkage is negligible.
- Marginal adaptation is excellent.
- Postoperative sensitivities are rare

146. What are the benefits of cast gold inlays and onlays?

1. Low restoration wear
2. Low wear of opposing teeth
3. Lack of breakage
4. Burnishable and malleable restoration
5. Proven long-term service
6. Bonded cast gold restoration improves their main weakness (the cementing media).

147. What are the indications for light-cured, dual-cured, and autocured composite resin cements?

Light-cured resin cements are generally used for cementation of porcelain veneers. Dual-cured resins may be used for veneers, but color stability may change with continued polymerization of the cement. Therefore, dual-cured cements are usually reserved for cementation of porcelain and composite inlays and onlays. In these cases the dentist can light-cure the material at the margins, and the autocure feature enables the cement to penetrate deeper within the restoration, where light is excluded, and to set properly. Auto- or self-cure cements are used when the curing light is completely excluded, such as for post and core cementation or the luting of porcelain/gold and full gold crowns.

148. What is cracked tooth syndrome?

Cracked tooth syndrome is generally described as an incomplete fracture of a tooth. The patient typically complains of sharp pain with biting hard food; the pain is often upon the release of biting. The pain goes away immediately, and usually the tooth does not hurt otherwise. Occasionally, there is some temperature sensitivity, but the inability to bite food on the tooth is the primary complaint.

149. If a patient presents with tooth sensitivity on biting and to cold in a clinically normal- appearing molar with an MOD amalgam, what is the differential diagnosis? What is the suggested treatment?

First attempt to duplicate the symptoms with cold spray and biting on a wet cotton roll to confirm the specific tooth. Take a radiograph to rule Out recurrent decay, periapical pathology, or periodontal involvement. If there are no positive radiographic findings, we may consider a cracked tooth, or a pulp that is hyperemic and may or may not be approaching irreversible change. The best first treatment is to remove all old amalgam and explore the tooth for cracks or decay. Placing a bonded, nonmetallic restoration allows observation to see if the pulp can resolve. If symptoms subside within 3—6 weeks, a permanent restoration (full coverage crown or onlay) may be placed. If symptoms persist or at any time worsen, endodontic treatment should begin. If endodontic treatment does not resolve the pain, one may conclude that the fracture proceeds subgingivally or through the furcation. At this time extraction must be considered.

150. What is the biologic width? Explain its relationship to restorative dentistry.

The biologic width is an area that ideally is approximately 3 mm wide from the crest of bone to the gingival margin. It consists of approximately 1 mm of connective tissue, 1 mm of epithelial attachment, and 1 mm of sulcus. If a restorative procedure violates this zone, there is a higher likelihood that periodontal inflammation will ensue, causing the attachment apparatus to move apically.

151. When it becomes necessary for restorative reasons to impinge on the biologic width, what steps can be taken before final restoration to create a maintainable periodontal environment?

Crown lengthening and orthodontic extrusion are the two most common ways to deal with this problem. Crown lengthening exposes more tooth structure surgically and is in effect surgical repositioning of the biologic width. Orthodontic extrusion is done when crown lengthening would unduly compromise the periodontal health of the adjacent teeth or create an unfavorable esthetic situation, as often occurs in the anterior maxilla.

152. Describe the options for treatment of root surface sensitivity.

Root sensitivity is a common problem and can be adequately resolved in many instances by modifying the patient's toothbrushing technique and having patients use a desensitizing toothpaste such as Sensodyne or fluoride gels. Other desensitizing agents, such as Protect by Butler, use oxalate precipitates to occlude the dentin tubules. Dentin-bonding systems also work well to reduce sensitivity. Others advocate iontophoresis to apply fluoride to the sensitive surface.

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